Solution

Multiple Choice Questions (Type-I)

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

Ans. **(i)**
Explanation: $p=k_H$ × (According to Henry's law)

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.

Ans. **(iv)**
Explanation: Higher the surface area higher will be the solubility and on increasing the temperature dissolution of sugar will increase since it is an endothermic process.

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

Ans. **(iii)**

4. **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_________.**
(i) saturated
(ii) supersaturated
(iii) unsaturated
(iv) concentrated

Ans. **(ii)**

5. **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

Ans. (iii)

Explanation: Solubility of a solid in liquid does not depend upon pressure since solid and liquids are almost incompressible.

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

Ans. (ii)

Explanation: At high altitude, due to low atmospheric pressure the solubility of oxygen in blood get decreased.

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.

Ans. (i)

Explanation: A-A interaction is greater than the A-B interaction. Intermolecular hydrogen bonding in methanol is more than methanol and acetone. So, methanol and acetone mixtures will show a positive deviation from Raoult's law.

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.

Ans. (ii)

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

Ans. (ii)

Explanation: In 1.0 N Na_2SO_4 solution i> 1. So, the no. of ions dissociated will be more.

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 $K(molality)$

Ans. (i)

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

Ans. **(iii)**

Explanation: Depression in freezing point is a colligative property in case of $MgCl_2$ value of van't. Hoff factor will be more. No. of ions dissociated in $MgCl_2$=3 that is why depression in freezing point of $MgCl_2$ will be three times.

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.

Ans. **(iv)**

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 osmotic pressure of dilute solution.

Ans. **(i)**

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

(i) Two different solutions of sucrose of 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.

Ans. **(i)**

Explanation: $\Delta T_f = K_f m$ (k_f depends on the nature of the solvent)

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

Ans. (ii)

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 nature of solvent.

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

Ans. (ii)

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 decreases.

Ans. (i)

18. The value of Henry's constant K_H 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.

Ans. (ii) greater for gases with lower solubility.

$p = k_H x$

$k_H = p/x$

19. Consider the Fig. 2.1 and mark the correct option.

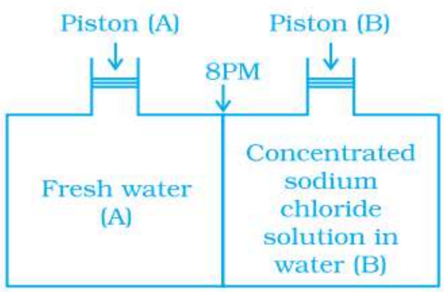


Fig. 2.1

(i) water will move from side (A) to side(B) if a pressure lower than osmotic pressure is applied on piston (B).

(ii) water will move from side (B) to side(A) if a pressure greater than osmotic pressure is applied on piston (B).

(iii) water will move from side (B) to side(A) if a pressure equal to osmotic pressure is applied on piston (B).

(iv) water will move from side (A) to side(B) if pressure equal to osmotic pressure is applied on piston (A).

Ans. (ii)

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

(i) $i_A < i_B < i_C$
(ii) $i_A > i_B > i_C$
(iii) $i_A = i_B = i_C$
(iv) $i_A < i_B > i_C$

Ans. (ii)

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 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 negative deviation from Raoult's law.
(iv) Solution (C) will show positive deviation from Raoult's law.

Ans. (ii)

Explanation: For an ideal solution A-A and B-B interaction should be nearly equal to A-B interaction.

22. Two beakers of capacity 500 mL were taken. One of these beakers, labelled 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 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.

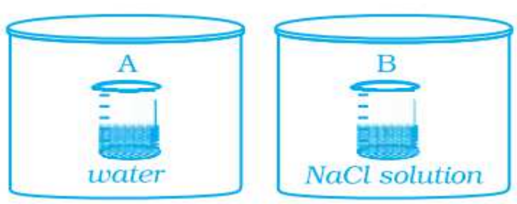


Fig. *2.2*

(i) vapour pressure in container (A) is more than that in container (B).
(ii) vapour pressure in container (A) is less than that in container (B).
(iii) vapour pressure is equal in both the containers.
(iv) vapour pressure in container (B) is twice the vapour pressure in container (A).

Ans. (i)

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.

Ans. **(i)**

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

Ans. **(iv)**

Explanation: Given M_1=0.02M, V_1=4L, M_2=? V_2=5L $M_1V_1=M_2V_2$ $0.02\times4L=M_2\times5L$

M_2=0.08/5=0.016 M

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.

Ans. **(i)**

Explanation: A-A interaction is more than the A-B interaction.

26. **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.

(i) HCHO < CH_4< CO_2<Ar

(ii) HCHO < CO_2< CH_4<Ar

(iii) Ar< CO_2< CH_4< HCHO

(iv) Ar< CH_4< CO_2< HCHO

Ans. **(iii)**

Explanation: Higher the value of K_H lower will be the solubility of the gas at a given pressure.

Solution
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 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

Ans. **(i)** and **(ii)**

28. Intermolecular forces between two benzene molecules are nearly of same strength as those between two toluene molecules. For a mixture of benzene and toluene, which of the following are not true?

(i) Δ_{mix} H= zero

(ii) Δ_{mix} V= zero

(iii) These will form minimum boiling azeotrope.

(iv) These will not form ideal solution.

Ans. **(iii)** and **(iv)**

Explanation: In a mixture of benzene and toluene strength of the solution will be same and they will form ideal solution according to Raoult's law.

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

(i) It depends on the concentration of a non-electrolyte solute in solution and does not depend on the nature of the solute molecules.

(ii) It depends on number of particles of electrolyte solute in 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 non-electrolyte solute in solution as well as on the nature of solute molecules.

Ans. **(i)** and **(ii)**

Explanation: Clligative property depends on the concentration and as well as numbers of particles. It does not depend on the nature of particles.

30. Van't Hoff factor i is given by the expression ____________.

(i) $i = \frac{Normal\ molar\ mass}{Abnormal\ molar\ mass}$

(ii) $i = \frac{Abnormal\ molar\ mass}{Normal\ molar\ mass}$

(iii) $i = \frac{Observed\ colligative\ property}{Calculated\ colligative\ property}$

(iv) $i = \frac{Calculated\ colligative\ property}{Observed\ colligative\ property}$

Ans. **(i)** and **(iii)**

31. Isotonic solutions must have the same ___________.

(i) solute

(ii) density

(iii) elevation in boiling point

(iv) depression in freezing point

Ans. **(ii)** and **(iii)**

32. Which of the following binary mixtures will have same composition in liquid and vapour phase?

(i) Benzene - Toluene

(ii) Water-Nitric acid

(iii) Water-Ethanol

(iv) n-Hexane - n-Heptane

Ans. **(ii)** and **(iii)**

Explanation: At particular composition Water-Nitric acid and water-Ethanol form azeotropic mixture which have same composition in vapour phase and liquid phase.

33. In isotonic solutions _____________.

(i) solute and solvent both are same.

(ii) osmotic pressure is same.

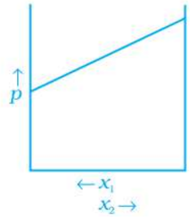
(iii) solute and solvent may or may not be same.

(iv) solute is always same solvent may be different.

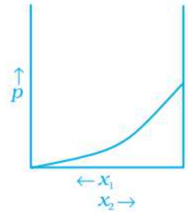
Ans. **(ii)** and **(iii)**

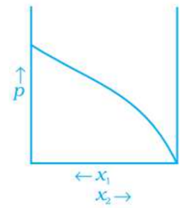
34. For a binary ideal liquid solution, the variation in total vapour pressure versus composition of solution is given by which of the curves?

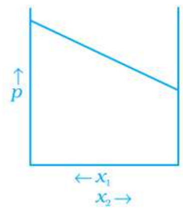
(i)



(ii)



(iii) 

(iv) 

Ans. **(i)** and **(iv)**

35. Colligative properties are observed when ____________.

(i) a nonvolatile solid is dissolved in a volatile liquid.

(ii) a nonvolatile liquid is dissolved in another volatile liquid.

(iii) a gas is dissolved in nonvolatile liquid.

(iv) a volatile liquid is dissolved in another volatile liquid.

Ans. **(i)** and **(ii)**

Solution
Matching Type

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

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

Column I	Column II
(i) Saturated solution	(a) Solution having same osmotic pressure at a given temperature as that of 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 maximum amount of solute that can be dissolved in a given amount of solvent at a given temperature
(v) Solid solution	(e) A solution whose osmotic pressure is more than that of another.
(vi) Hypertonic solution	(f) A solution in solid phase.

Ans. (i)- (d)
(ii)- (c)
(iii)- (a)
(iv)- (b)
(v)- (f)
(vi)- (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 gas in solid
(ii) Sugar solution	(b) A solution of 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 gas in liquid
	(f) A solution of liquid in solid

Ans. (i)- (e)
(ii)- (c)
(iii)- (d)
(iv)- (b)
(v)- (a)

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

Column I	Column II
(i) Raoult's law	(a) $\Delta T_f = K_f m$
(ii) Henry's law	(b) $\pi = CRT$

(iii) Elevation of boiling point	(c) $p = x_1 p_1^0 + x_2 p_2^0$
(iv) Depression in freezing point	(d) $\Delta T_b = K_b m$
(v) Osmotic pressure	(e) $p = K_H.x$

Ans. (i)- (c)
(ii)- (e)
(iii)- (d)
(iv)- (a)
(v)- (b)

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

Column I	Column II
(i) Mass percentage	(i) $\frac{Number\ of\ moles\ of\ the\ solute\ component}{Volume\ of\ solution\ in\ litres}$
(ii) Volume percentage	(ii) $\frac{Number\ of\ moles\ of\ the\ solute\ component}{Volume\ of\ solution\ in\ litres}$
(iii) Mole fraction	(iii) $\frac{Volume\ of\ the\ solute\ in\ solution}{Total\ volume\ of\ solution} \times 100$
(iv) Molality	(iv) $\frac{Number\ of\ moles\ of\ the\ solute}{Mass\ of\ solvent\ in\ ki\log rams} \times 100$
(v) Molarity	(v) $\frac{Number\ of\ moles\ of\ the\ solute}{Mass\ of\ solvent\ in\ kilo\, g\, rams}$

Ans. (i)- (d)
(ii)- (c)
(iii)- (b)
(iv)- (e)
(v)- (a)

Solution
Assertion and Reason Type

Note: **In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.**
(i) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(iii) Assertion is correct statement but reason is wrong statement.
(iv) Assertion and reason both are incorrect statements.
(v) Assertion is wrong statement but reason is correct statement.

51. **Assertion:** Molarity of a solution in liquid state changes with temperature.
Reason: The volume of a solution changes with change in temperature.
Ans. (i)
Explanation: $Molarity = \frac{No.of\ moles\ of\ solute\ component}{Volume\ of\ solution\ in\ litres}$. So, on increasing the temperature volume of the solution will increase.

52. **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.
Ans. (iv)
Explanation: When methyl alcohol is added to water A-B interaction< A-A or B-B interaction that is why it will show positive deviation from Raoult's law and boiling point will decrease.

53. **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.
Ans. (i)
Explanation: On addition of nonvolatile solute to solution lowering of vapour pressure takes place and it cause depression in freezing point.

54. **Assertion:** When a solution is separated from the pure solvent by a semipermeable 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.
Ans. (ii)
Explanation: Flow of solvent molecule from solvent side to solution side through semipermeable membrane is called osmosis.

Solution
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 composition of vapour phase became same as that of liquid phase. Both the components started coming in the distillate. Explain why this happened.

Ans. Since both the components are appearing in the distillate and composition of liquid and vapour is same, this shows that liquids have formed azeotropic mixture and hence cannot be separated at this stage by distillation.

37. Explain why on addition of 1 mol of NaCl to 1 litre of water, the boiling point of water increases, while addition of 1 mol of methyl alcohol to one litre of water decreases its boiling point.

Ans. NaCl is a nonvolatile solute, therefore, addition of NaCl to water lowers the vapour pressure of water. As a result, boiling point of water increases. Methyl alcohol on the other hand is more volatile than water, therefore its addition increases, the total vapour pressure over the solution and a decrease in boiling point of water results.

38. Explain the solubility rule "like dissolves like" in terms of intermolecular forces that exist in solutions.

Ans. A substance (solute) dissolves in a solvent if the intermolecular interactions are similar in both the components; for example, polar solutes dissolve in polar solvents and nonpolar solutes in nonpolar solvents thus we can say "like dissolves like".

39. Concentration terms such as mass percentage, ppm, mole fraction and molality are independent of temperature, however molarity is a function of temperature. Explain.

Ans. Molarity of a solution is defined as the number of moles of solute dissolved in one litre of solution. Since volume depends on temperature and undergoes a change with change in temperature, the molarity will also change with change in temperature. On the other hand, mass does not change with change in temperature, as a result other concentration terms given in the question remain unchanged by changing temperature. According to the definition of all these terms, mass of the solvent used for making the solution is related to the mass of solute.

40. What is the significance of Henry's Law constant K^H?

Ans. Higher the value of Henry's law constant K_H, the lower is the solubility of the gas in the liquid.

41. Why are aquatic species more comfortable in cold water in comparison to warm water?

Ans. At a given pressure the solubility of oxygen in water increases with decrease in temperature. Presence of more oxygen at lower temperature makes the aquatic species more comfortable in cold water.

42. **(a) Explain the following phenomena with the help of Henry's law.**
(i) Painful condition known as bends.

Ans. According to Henry's law pressure of a gas is directly proportional to solubility. Scuba divers when comes towards surface the pressure gradually decreases. This reduce pressure releases the dissolve gas present in blood and leads to the formation of bubbles of nitrogen in the blood. This blocks capillaries and creates a medical condition known as bends, which is painful and dangerous to life.

(ii) Feeling of weakness and discomfort in breathing at high altitude.

Ans. At high altitude, partial pressure of oxygen is less than that of ground level. This leads to low concentration of oxygen in blood and tissues of people living at high altitude. Low blood oxygen causes weakness and discomfort.

(b) Why soda water bottle kept at room temperature fizzes on opening?

Ans. When the bottle is opened to air the partial pressure of CO_2 above the solution decreases. As a result, solubility decreases and CO_2 bubbles come out of the bottle.

43. **Why is the vapour pressure of an aqueous solution of glucose lower than that of water?**

Ans. In pure liquid water the entire surface of liquid is occupied by the molecules of water. When a nonvolatile solute, for example glucose is dissolved in water, the fraction of surface covered by the solvent molecules gets reduced because some positions are occupied by glucose molecules. As a result, number of solvent molecules escaping from the surface also gets reduced, consequently the vapour pressure of aqueous solution of glucose is reduced.

44. **How does sprinkling of salt help in clearing the snow-covered roads in hilly areas? Explain the phenomenon involved in the process.**

Ans. When salt is spread over snow covered roads, snow starts melting from the surface because of the depression in freezing point of water and it helps in clearing the roads.

45. **What is "semi permeable membrane"?**

Ans. Continuous sheets or films (natural or synthetic) which contain a network of submicroscopic holes or pores through which small solvent molecules like water can pass; but the passage of bigger molecules of solute is hindered, are known as semi permeable membrane.

46. **Give an example of a material used for making semipermeable membrane for carrying out reverse osmosis.**

Ans. Cellulose acetate.

Solution

Long Answer Type

55. Define the following modes of expressing the concentration of a solution. Which of these modes are independent of temperature and why?

(i) w/w (mass percentage)

Ans. Mass percentage (w/w):

Mass % of a component= $\frac{W\ of\ the\ component\ in\ the\ solution}{W\ of\ the\ solution}\times 100$

(ii) V/V (volume percentage)

Ans. Volume percentage (v/v):

Volume % of a component = $\frac{V\ of\ the\ component}{V\ of\ the\ solution}\times 100$

(iii) w/V (mass by volume percentage)

Ans. Mass by volume percentage (w/v):

$= \frac{W\ of\ solute}{100\,ml\ of\ solution}\times 100$

(iv) ppm. (parts per million)

Ans. 1 Parts per million (ppm):

$= \frac{No\ of\ parts\ of\ the\ component}{Total\ number\ of\ parts\ of\ \text{in}\ the\ solution}\times 10^6$

(v) x(mole fraction)

Ans. Mole Fraction (x):

Mole fraction of a component (x)= $\frac{No.of\ moles\ of\ the\ component}{Total\ number\ of\ moles\ of\ all\ the\ component}$

(vi) M (Molarity)

Ans. The no. of moles of solute per litre of solution.

(vii) m (Molality)

Ans. The no. of moles of solute per kg of solvent.

Effect of temperature: mass %, ppm, mole fraction and molality do not change with temperature whereas molarity, volume percentage and mass by volume percentage changes with temperature because volume of solution (liquid) changes with temperature.

56. Using Raoult's law explain how the total vapour pressure over the solution is related to mole fraction of components in the following solutions.

(i) $CHCl_3$ (l) and CH_2Cl_2 (l)

Ans. For a binary solution having both components as volatile liquids, the total pressure will be

$$p = p_1 = x_1 p_1^0 + x_2 p_2^0$$
$$= x_1 p_1^0 + (1 - x_1) p_2^0$$
$$= (p_1^0 - p_2^0) x_1 + p_2^0$$

p= total vapour pressure
p_1= partial vapour pressure of component 1
p_2= partial vapour pressure of component 2

(ii) NaCl(s) and H_2O (l)

Ans. For a solution containing non-volatile solute, the Raoult's law is applicable only to vaporisable component (1) and total vapour pressure is written as

$$p = p_1 = x_1 p_1^0$$

57. Explain the terms ideal and non-ideal solutions in the light of forces of interactions operating between molecules in liquid solutions.

Ans. **Ideal solution:** The solution which obey Raoult's law at all concentration and at all temperature i.e $PA = P_{oA.xA} P_B = P_{oB.xB}$

If the intermolecular attractive forces between the solute- solvent (A-B interaction) are nearly equal to those between the solvent- solvent (A-A) and solute-solute (B-B) it forms ideal solutions. Enthalpy of mixing, Δmixing H=0. Volume change on mixing, Δmixing V=0.

Examples: n- hexane and n-heptane.

Non Ideal solution: The solution which do not obey Raout's law at all concentration and at all temperature i.e $P_A \neq P_{oAxA}$ $P_B \neq P_{oBxB}$. If the intermolecular attractive forces between the solute- solvent (A-B interaction) are not equal (either stronger or weaker) to those between the solvent- solvent (A-A) and solute-solute (B-B) it forms non- ideal solutions. Enthalpy of mixing, Δ_{mixing} H is not equal to 0. Volume change on mixing, Δ_{mixing} V is not equal to 0. Example: CS_2 and acetone.

58. Why is it not possible to obtain pure ethanol by fractional distillation? What general name is given to binary mixtures which show deviation from Raoult's law and whose components cannot be separated by fractional distillation. How many types of such mixtures are there?

Ans. Azeotropes are binary solutions (liquid mixtures) having the same composition in liquid and vapour phase and it is not possible to separate the components of an azeotrope by fractional distillation. Ethanol- water mixture (obtained by fermentation of sugars) on fractional distillation gives a solution of approx. 95% ethanol by volume of ethanol. This has the same composition in liquid and vapour phase and it is not possible to separate them.

Minimum boiling azeotrope: The non-ideal solutions showing positive deviation form minimum boiling azeotrope at a specific composition. Example; 95% ethanol and 5% water (by volume): Ethanol= 351.3 K, Water= 373 K, Azeotrope= 351.1 K.

Maximum boiling azeotrope: The non-ideal solutions showing negative deviation form maximum boiling azeotrope at a specific composition.

59. When kept in water, raisin swells in size. Name and explain the phenomenon involved with the help of a diagram. Give three applications of the phenomenon.

Ans. Phenomenon involved in the above process is known as osmosis.

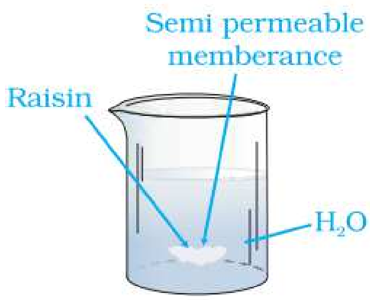


Fig. 2.3

Osmosis is the process of flow of solvent molecules from pure solvent to the solution through semi permeable membrane. Three applications of osmosis are:

(i) Movement of water from soil into plant roots and subsequently into upper portion of the plant is partly due to osmosis.

(ii) Preservation of meat against bacterial action by adding salt.

(iii) Preservation of fruits against bacterial action by adding sugar. Bacterium in canned fruit loses water through the process of osmosis, shrivels and dies.

60. Discuss biological and industrial importance of osmosis.

Ans. The process of osmosis is of immense biological and industrial importance as is evident from the following examples:

(i) Movement of water from soil into plant roots and subsequently into upper portion of the plant is partly due to osmosis.

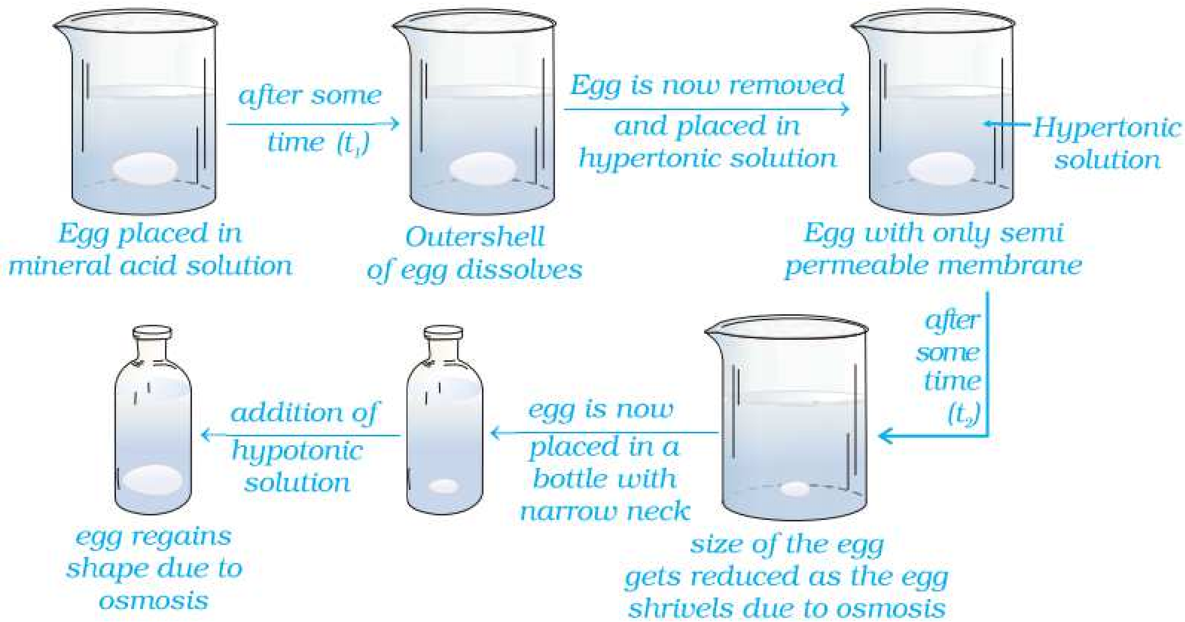
(ii) Preservation of meat against bacterial action by adding salt.

(iii) Preservation of fruits against bacterial action by adding sugar. Bacterium in canned fruit loses water through the process of osmosis, shrivels and dies.

(iv) Reverse osmosis is used for desalination of water.

61. How can you remove the hard calcium carbonate layer of the egg without damaging its semiprermiable membrane? Can this egg be inserted into a bottle with a narrow neck without distorting its shape? Explain the process involved.

Ans. Egg is placed in mineral acid solution – after some time egg is removed and placed in hypertonic solution – after some time size of the egg gets reduced and shrivels due to osmosis – egg is now placed in a bottle with narrow neck – on adding hypotonic solution egg regains shape due to osmosis.



62. Why is the mass determined by measuring a colligative property in case of some solutes abnormal? Discuss it with the help of Van't Hoff factor.

Ans. Certain compounds when dissolved in suitable solvents either dissociate or associate. For example, ethanoic acid dimerises in benzene due to hydrogen bonding, while in water, it dissociates and forms ions. As a result, the number of chemical species in solution increases or decreases as compared to the number of chemical species of solute added to form the solution. Since the magnitude of colligative property depends on the number of solute particles, it is expected that the molar mass determined on the basis of colligative properties will be either higher or lower than the expected value or the normal value and is called abnormal molar mass.

In order to account for the extent of dissociation or association of molecules in solution, Van't Hoff introduced a factor, i known as the Van't Hoff factor. It can be defined as follows.

$$i = \frac{Expected\ molar\ mass}{Abnormal\ molar\ mass}$$

$$= \frac{Observed\ colligative\ propoerty}{Calculated\ colligative\ property}$$

$$= \frac{Total\ number\ of\ moles\ of\ particles\ after\ association / dissociation}{Number\ of\ moles\ of\ particles\ before\ association / dissociation}$$