Because of Today, Tomorrow Will Be Better

RK Academy

One Step Ahead To Your Success...

SOLUTION(Physical chemistry):

Solution: Solution is a homogeneous mixture of two or more pure substance relative ratio of which can be changed within certain limits .

- When the constituents of the solutions are two it is called binary ,if 3 then ternary, if 4 then quaternary and so on.
- The two constituents of the solutions are s**olvent** and **solute**.
- **Solvent(A):** it is the component of solution which is present in large proportion and whose physical state is same as that of the resulting solution.
- **Solute(A):** it is the component of a solution which is present in small proportion .

solutions are generally categorized by the physical state of the solute and solvent or by how much solute is dissolved.

By Physical State

While we often think of liquids, solutions can exist in any phase:

- **Gaseous Solutions:** Both solute and solvent are gases (e.g., **Air**, which is mostly nitrogen and oxygen).
- **Liquid Solutions:** A gas, liquid, or solid dissolved in a liquid (e.g., **Saltwater** or **Vinegar**).
- **Solid Solutions:** A gas, liquid, or solid dissolved in a solid (e.g., **Steel** or **Brass** alloys).

By Concentration (Saturation)

- **Unsaturated:** The solvent can still dissolve more solute at that specific temperature.
- **Saturated:** The solvent has dissolved the maximum amount of solute possible; any more will sit at the bottom as a precipitate.
- **Supersaturated:** Contains more dissolved solute than normally possible, usually achieved by heating the solution and cooling it slowly (e.g., **Sodium acetate** heat pads)
- **Solubility:**It may be defined as the concentration of solute in a saturated solution the solubility of a solid into liquid depends upon the following factors **one nature of solute and solvent to temperature .**
- **Aqueous solution :**a solution in which solvent is water **.**
- **Diluted solution**: A solution in which extra solvent is added is called diluted solution

(i) Nature of the solute and the solvent: Polar solutes dissolves in a **polar solvent** and non-polar solutes dissolves in **non-polar solvents.**

For example, sodium chloride (polar) dissolves readily in water (polar), naphthalene (non-polar) dissolves readily in benzene (non-polar). A polar solute does not dissolve in a non-polar solvent, and vice versa. For example, sodium chloride (polar) does not dissolve in benzene (non-polar). In general, like dissolves like**.**

Solubility of Solid in liquid:

a**) Lattice energy of solute**: It is defined as the energy required to break apart one mole of an ionic solid into its gaseous ions

(b**) Solvent - solvent interactions (ΔH):** Energy is required to break existing intermolecular solvent-solvent interactions to form new solute-solvent interactions. For e.g., H-bonding, dipole-dipole interactions etc.

(The solute which form hydrogen bond with water can dissolve in water.)

(c) Solvation energy: It represents force of attraction between solute and solvent molecules. If the solvent is water then the energy released is called hydration energy.

If Solvation energy > lattice energy+ΔH, then solution is easily formed. Both the ions of the solute

get hydrated to overcome the lattice energy of the solute.

(ii) Temperature: Saturated solution represents equilibrium between undissolved solute and dissolved solute.

Undissolved solute + Solvent ↔ Solution, $\Delta H(Sol)$ =±x

IF , $\Delta H(Sol)$ =(-ve), the dissolution is exothermic. In this case, as the temperature increases, solubility decreases(Le Chatelier's principle).

If , $\Delta H(Sol)$= (+ve), there is endothermic dissolution. In this case, increase in temperature increases the solubility.(Le Chatelier's principle).

Note: Pressure has no significant effect on the solubility of solids in liq.

(b) Liquid-liquid solutions: When two liquids are mixed, three different situations result:

(1) Miscible liquids: The two components are completely soluble. They are miscible only when they have similar nature or belong to the same homologous series. Example: water and alcohol (both polar), benzene-toluene (both belong to the same homologous series). This is due to the rule of like dissolves like.

(ii) Partially miscible liquids: This happens only when the intermolecular forces of one liquid is greater than that of the other is. Solubility, however, increases with increasing temperature. Examples: aniline-water, phenol-water.

(iii) Immiscible liquids: Two components are completely insoluble. This happens when one liquid is polar and the other is non-polar. Examples: carbon tetrachloride-water; kerosene-water

(c) SOLUBILITY OF GAS IN LIQUIDS(Gas-liquid solutions):

The gases are generally soluble in water and to a limited extent in other solvents too.Solubility, however, depends on the following factors:

(1) Nature of gas: Easily liquefiable gases are generally more soluble in common solvents.

(i) Nature of liquid: Those gases which easily form ions in solution are more soluble in water than in other.

Ex- $HCl(g) + H_20 \rightarrow H_30^+_{(aq)} + Cl-_{(aq)}$

$NH_3 + H_20 \rightarrow NH_4^+_{(aq)} + OH-_{(aq)}$

$CO_2 + H_20 \rightarrow H_2CO_3\ (aq) \rightarrow 2H^+(aq) + C0_3^{-2}\ _{(aq)}$

(iii)Temperature: With rise in temperature, the solubility generally decreases because the process of dissolution of a gas in a liquid is exothermic as the entropy of the system decreases with dissolution i.e., $\Delta S < 0$, therefore, for the dissolution of gas to be spontaneous, ΔH ie, the reaction should be exothermic. According to Le-chatelier's principle, the increase in temperature favours the reverse process in an exothermic reaction. Therefore, as temperature increases, the solubility of the gas decreases.

(iv) Pressure: Pressure is an important factor affecting the solubility of gas in liquids. This is governed by Henry's law**.**

Henry's law: It states that at a constant temperature, the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas.

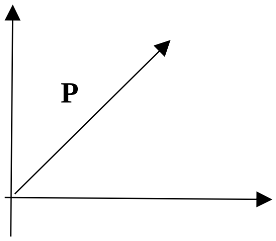
The most commonly used form of Henry's law states that the partial pressure (p) of a gas in vapour **phase is proportional to the mole fraction of the gas (x) in the solution and is expressed as**

$$P \alpha K_H X$$

Here “X” is the mole fraction of the gas and K_H is the Henry's law constant. Its value depends on the **nature of solute, nature of solvent and temperature.**

$K_H \propto 1/X$

if T increases , K_H Increase ,solubility decreases ,



Applications of Henry's Law:

1) To increase the solubility of CO, in soda water and soft drinks, the bottle is sealed under high pressure.
2) To avoid the formation of bends, as well as, toxic effects of high concentration 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).
3) At high altitudes, low blood oxygen causes climbers to become weak and make them unable to think clearly, which are symptoms of a condition known as anoxia.

Concentration: Concentration of solution is defined as the number of mole of solute present in one litre volume of solution or 1 kilograms weight of solvent .

Molarity (M):It is the number of mole of solute present in one liter volume of solution.

MOLALITY (m): It is the number of mole of solute present in one kg weight of solvent.

Mass percentages (w/w): it may be defined as mass of solute per 100g of solution.

Volume percentages (v/v): it may be defined as vol. of solute per 100ml of solution.

Mass by volume percentages (w/v): it may be defined as mass of solute per 100ml of solution.

Parts per million(ppm): it is the parts of the component per million(10^6) parts of solution.

Mole fraction(x): it may be defined as the ratio of the number of moles of one component (solute or solvent) to the total number of moles of all the components present in the solution. If in a solution.

Vapour Pressure of Pure Liquid and Solution

Vapour pressure: When a liquid is taken in a closed vessel, a part of the liquid evaporates and its vapours occupy the available space. vapour pressure of a liquid may be defined as ***the pressure exerted by the vapours above the liquid surface in equilibrium with the liquid phase at a given temperature***.

The vapour pressure of a liquid depends on the following factors:

Nature of the liquid: Liquids having weak intermolecular forces are volatile and therefore have greater vapour pressure.

Temperature: the vp of a liquid increases with increase in temperature.

VP $\propto I/BP$

(a) Vapour pressure of liquid-liquid solution:(Raoult's Law for solutions of volatile liquids):

It states that for a solution of volatile liquids the partial pressure of each component of the solution is directly proportional to its mole fraction present in a solution.

Mathematically:

Ideal and Non-Ideal Solutions

(a) Ideal solution:

A solution is called an ideal solution if it obeys Raoult's law over a wide range of concentration at a specified temperature.

$P_s = PA + PB = P°_A X_A + P°_B X_B$

Liquids having similar nature and structure are likely to form ideal solutions. Examples are:

- Mixture of methanol and ethanol
- Mixture of n-hexane and n-heptane
- Mixture of benzene and toluene.

Reasons for ideal solutions: A solution of two miscible liquids A and B will be ideal if two essential conditions are fulfilled.

(i) If the F_{A-A} force of attraction between molecules of A and F_{B-B} is that of molecules of B, then A and B will form an ideal solution only when F_{A-A} and F_{B-B} are similar to F_{A-B}, ie

$\mathbf{F_{A-B} = F_{A-A} = F_{B-B}}$

(ii)The solution of liquids will be ideal if A and B have similar structures and polarity. Methanol and ethanol have the same functional group and almost same polarity and therefore, form ideal solutions

For an ideal solution ,Raoult's law is obeyed

(i) $P_A = P°_A X_A$ $P_B = P°_B X_B$ (ii)ΔH mix = 0 (iii)ΔV mix =0 (iv)$\Delta G = 0$ (iv) $\Delta S = +ve$

(b) **Non-ideal solution:**

A solution which does not obey Raoult's law over a wide range ofconcentrations is called a non-ideal solution.

For a non-ideal solution Raoult's law is not obeyed,

(i) $P_A \neq P°_A X_A$ $P_B \neq P°_B X_B$ (ii)ΔH mix $\neq 0$ (iii)ΔV mix $\neq 0$ (iv)$\Delta G \neq 0$ (iv) ΔS=+ve

<u>A non-ideal solution can show either positive or negative deviation from Raoult's law.</u>

So Vapour pressure of solution is more .

(A) **<u>Positive Deviation</u>**: The deviation will be called positive when the partial pressure of each component and the resultant total pressure is greater than the pressure expected on the basis of raoults law.

In such cases, the intermolecular forces between solvent-solute molecules (F_{A-B}) are weaker than those between solvent-solvent (F_{A-A}) and solute (F_{B-B}) molecules.

That is **$F_{A-B} < F_{A-A}$ and F_{B-B}**

Characteristics of a Solution Showing Positive Deviation:

(i) $P_A > P°_A X_A$, $P_B > P°_B X_B$ (ii)ΔH mix >0 (iii)ΔV mix >0 (iv)ΔG >0 (iv) ΔS=+ve

Some examples of the solution exhibiting positive deviations are:

(i) Ethyl alcohol and water (ii) Acetone and carbon disulphide (iii) Carbon tetrachloride and benzene (iv) Acetone and ethanol.

<u>Negative Deviation:</u> The deviation is called negative deviation, if the partial pressure of each component (A and B) and resultant total vapour pressure is less than the pressure expected on the basis of Raoult's law.

- This type of deviation is shown by the solutions in which $F_{A-B} > F_{A-A}$. and F_{B-B}
- Due to this, there is decrease in the escaping tendency of A or B molecules from the surface of solution.Consequently, the vapour pressure of the solution will be lower.

<u>Characteristics of a Solution Showing Negative Deviation</u>

(i) $P_A < P°_A X_A$, $P_B < P°_B X_B$ (ii)ΔH mix <0 (iii)ΔV mix <0 (iv)ΔG <0 (iv) ΔS=+ve

ΔH mix –ve because weal A-A and B-B bond are broken and strong A-B bond is formed. Heat is consequently released.

Some examples of the solution showing negative deviations are

(i)HNO, and water (ii) Chloroform and acetone (iii) Acetic acid and pyridine (iv) Hydrochloric acid and water

Azeotropes or Azeotropic mixture:

Azeotropes are binary mixtures having the same composition in liquid and vapour phase and boil at a constant temperature.

Types of Azeotropes:

- **Minimum boiling azeotrope**: These are the binary mixtures whose boiling point is less than either of the we components. The non-ideal solutions which show a large positive deviation from Raoult's law form minimum boiling azeotrope at a specific composition, e.g., a mixture of 95.5% ethyl alcohol and 4.4% water by volume at 351.3 K
- **Maximum boiling azeotrope**: These are the binary mixtures whose boiling point is more than either of the two components. The solutions that show large negative deviation from Raoults's law form maximum boiling azeotrope at a specific composition, e.g., a mixture of 68% HNO, and 32% H_2O by mass at 393.5 K.

Colligative Properties:

The properties of a solution which depend on the number of solute particles (molecules, atoms or ions) but not upon their nature are called colligative properties.

The following are the colligative properties**:**

(a) Relative lowering of vapour pressure of the solvent.

(b) Elevation of boiling point of the solvent,

(c) Depression of freezing point of the solvent,

(d) Osmotic pressure of the solution.

(a) Relative lowering of vapour pressure:

The addition of a non-volatile solute to a volatile solvent decreases the escaping tendency of the solvent

(b)Elevation of boiling point:

- Boiling point is the temperature at which the vapour pressure of a liquid becomes equal to the atmospheric pressure.
- When a non-volatile solute is added to a volatile solvent, the vapour pressure of the solvent decreases. In order to make this solution boil, its vapour pressure must be increased by raising the temperature above the boiling point of the pure solvent. The difference in the boiling point of solution and that of pure solvent is called elevation of boiling point
- Elevation of boiling point = $\Delta T_b = T_b - T°_b$
- For dilute solution, it has been found that the elevation of boiling point is directly proportional to the molal concentration of the solute in the solution. Thus,

  $\Delta T_f \propto m$,$\Delta T_f = K_b m$

- where K_b is a constant called molal elevation constant or ebullioscopic constant.
- When m = 1 mol/kg, $\Delta Tb = Kb$

Hence, molal elevation constant may be defined as the elevation in boiling point when one mole of a non-volatile solute is dissolved in one kilogram (1000 g) of solvent. The unit of Kb is K kg mol^{1}

(c)Depression of freezing point: Freezing point is defined as the temperature at which the vapour pressure of a substance in its liquid phase is equal to its vapour pressure in the solid phase.

- A solution freezes when its vapour pressure equals the vapour pressure of the pure solid solvent.
- Whenever a non-volatile solute is added to the volatile solvent, its vapour pressure decreases and it would become equal to that of solid solvent at a lower temperature.
- The difference in the freezing point of pure solvent and that of the solution is known as depression of freezing point .

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

- It has been found that for a dilute solution, depression in freezing is directly proportional to molality of Solution.

$$\Delta T_f \propto m \ , \Delta T_f = K_f \, m$$

- where K_f is constant called molal depression constant or cryoscopic constant. When m=1 mol/kg , $\Delta T_f = K_f$ Hence, molal depression constant may be defined as the depression in freezing point when one mole of non-volatile solute is dissolved in one kilogram (1000 g) of solvent.
- The unit of K_f =K kg/mol
- The values of K_b and K_f which depend upon the nature of the solvent and concentration of the solution, can be ascertained from the following relations:

OSMOTIC PRESSURE:

- Flow of solvent molecules from solvent _compartment to solution compartment. The phenomenon is_ called **osmosis.** This movement of solvent is only in one direction. In diffusion, however, movement takes place in both the directions.
- **Semipermeable membrane (SPM):** A membrane through which only solvent molecules can pass but not the solute ones. **Cellophane, parchment paper and the wall of living cell** are the examples of SPM. It is also made of **inorganic material, copper ferrocyanide ($Cu_2[Fe(CN)6]$)**
- **Osmotic pressure (π):** The osmotic pressure of a solution is the excess pressure that must be applied on the solution to prevent osmosis, that is to stop the passage of solvent molecules from the solvent to the solution through semipermeable membrane.
- **Osmotic pressure (π) is proportional to molarity (C) of the solution at a given temperature Thus,**

$$\pi = CRT$$

- **Reverse osmosis**: If a pressure larger than the osmotic pressure is applied to the solution side, the pure solvent (or water) flows out of the solution through the semipermeable membrane. In this way the direction of a smosis is reversed and so the process is called reverse osmosis.
- Thus, we can say that reverse osmosis is just opposite to the osmosis when pressure greater than osmotic pressure is applied on the solution. Reverse osmosis is used in desalination to get pure water from sea water.
- **Isotonic solutions**: Two solutions are said to be isotonic when they exert the same osmotic pressure because they have the same molar concentration. **All intravenous injections must be isotonic with body fluids.**
- **Isosmotic solutions**: When two isotonic solutions are separated by a semipermeable membrane, no osmosis occurs. The solutions are called isosmotic solutions.
- **Hypotonic solutions**: A solution having lower osmotic pressure than the other solution is said to be hypotonic respect to the other solution.
- **Hypertonic solution:** A solution having higher osmotic pressure than the other solution is said to be h with respect to other solution.

Abnormal Molar Masses:

Association: Association of molecules leads to decrease in the number of particles in the solution resulting in a decrease in the value of colligative property. As colligative property is inversely related to the molecular mass. Therefore, higher value is obtained for molecular mass than normal values.

Dissociation: Dissociation leads to an increase in the number of solute particles in the solution resulting in an increase in the value of colligative property. Since the colligative property is inversely related to the molecular mass, therefore, the molecular mass of such a substance as calculated from the colligative property will be less than its normal value.

Van't Hoff Factor (i): It may be defined as the ratio of normal molecular mass to the observed molecular mass of the solute.

In case of association, $i < 1$,In case of dissociation, $i > 1$,When there is neither association nor dissociation, $i = 1$

***2/3 mark questions*.**

1.Difference between ideal and non-ideal solution .

2. In non-ideal solution, what type of deviation shows the formation of maximum boiling azeotropes?

3. What type of azeotropic mixture will be formed by a solution of acetone and chloroform? Justify on the basis of strength of intermolecular interactions that develop in the solution.

4. Define azeotropes. What type of azeotrope is formed by positive deviation from Raoult's law? Give an example.

5. Define azeotropes. What type of azeotrope is formed by negative deviation from Raoult's law? Give an example.

6. The relative lowering of vapour pressure of an aqueous solution containing non-volatile solute is 0.0225. The mole fraction of the non-volatile solute is __________.

7. Define the following term: Colligative properties.

8. A solution is prepared by dissolving 10 g of non-volatile solute in 200 g of water. It has a vapour pressure of 31.84 mm Hg at 308 K. Calculate the molar mass of the solute. (Vapour pressure of pure water at 308 K = 32 mm Hg).

9. Give reasons:
(a) Measurement of osmotic pressure method is preferred for the determination of molar masses of macromolecules such as proteins and polymers.
(b) Aquatic animals are more comfortable in cold water than in warm water.
(c) Elevation of boiling point of 1 M KCl solution is nearly double than that of 1 M sugar solution.

10. Vapour pressure of water at 293 K is 17.536 mm Hg. Calculate the vapour pressure of aqueous solution when 20 g of glucose (Molar mass = 180 g/mol) is dissolved in 500 g of water.

11. 30 g of urea (M = 60 g/mol) is dissolved in 846 g of water. Calculate the vapour pressure of water for this solution if vapour pressure of pure water at 298 K is 23.8 mm Hg.

12. (a) State Henry's law and mention its two applications.
(b) 5% aqueous solution of a non-volatile solute was made and its vapour pressure at 373 K was

found to be 745 mm. Vapour pressure of pure water at this temperature was 760 mm. Calculate the molar mass of solute.

13. The boiling point of a 0.2 m solution of a non-electrolyte in water is (Kb for water = 0.52 K kg /mol):
(a) 100° C
(b) 100.52° C
(c) 100.104° C
(d) 100.26° C

14. Why does a solution containing non-volatile solute have higher boiling point than the pure solvent? Why is elevation of boiling point a colligative property?

15. (i) Boiling point of water at 750 mm Hg pressure is 99.63 °C. How much sucrose (Molar mass = 342 g/mol) is to be added to 500 g of water such that it boils at 100 °C? (Kb for water = 0.52 K kg mol-1)
(ii) State Henry's law and write its any one application.

16. In the vapour pressure vs temperature graph for depression of freezing point, what does the intersection point of the liquid solvent and solution curves represent?
(a) boiling point of solution
(b) freezing point of solvent
(c) boiling point of solvent
(d) freezing point of solution

17. A solution containing 60 g of a non-volatile solute in 250 g of water freezes at 270.67 K. Calculate the molar mass of the solute. (K_f of water = 1.86 K kg mol-1)

18. Nisha took two aqueous solutions - one containing 7.5 g of urea (Molar mass = 60 g/mol) and the other containing 42.75 g of substance Z in 100 g of water, respectively. It was observed that both the solutions froze at the same temperature. Calculate the molar mass of Z.

19. Calculate the freezing point of a solution containing 60 g of glucose (molar mass = 180 g/mol) in 250 g of water. (K_f of water = 1.86 K kg mol-1)

20. An antifreeze solution is prepared by dissolving 31 g of ethylene glycol (Molar mass = 62 g/mol) in 600 g of water. Calculate the freezing point of the solution. (Kf for water = 1.86 K kg mol-1)

21. Calculate the mass of ascorbic acid (Molar mass = 176 g/mol) to be dissolved in 75 g of acetic acid, to lower its freezing point by 1.5°C. (Kf = 3.9 K kg mol-1)

22. A 4% solution (w/w) of sucrose (M = 342 g/mol) in water has a freezing point of 271.15 K. Calculate the freezing point of 5% glucose (M = 180 g/mol) in water. (Given: Freezing point of pure water = 273.15 K)

23. 1.00 g of a non-electrolyte solute dissolved in 50 g of benzene lowered the freezing point of benzene by 0.40 K. The freezing point depression constant of benzene is 5.12 K kg mol-1. Find the molar mass of the solute.

24. A 5% solution (by mass) of cane-sugar in water has freezing point of 271 K. Calculate the freezing point of 5% solution (by mass) of glucose in water if the freezing point of pure water is 273.15 K. (Molecular masses: Glucose = 180 amu; Cane-sugar = 342 amu)

25. A 10% solution (by mass) of sucrose in water has freezing point of 269.15 K. Calculate the freezing point of 10% glucose in water, if freezing point of pure water is 273.15 K. (Given: Molar mass of sucrose = 342 g/mol, molar mass of glucose = 180 g/mol)

26. Calculate the freezing point of the solution when 31 g of ethylene glycol (C2H6O2) is dissolved in 500 g of water. (Kf for water = 1.86 K kg mol-1)

27. (i) Ishan's automobile radiator is filled with 1.0 kg of water. How many grams of ethylene glycol (Molar mass = 62 g/mol) must Ishan add to get the freezing point of the solution lowered to -2.8 °C? (Kf for water is 1.86 K kg mol-1)
(ii) What type of deviation from Raoult's law is shown by ethanol and acetone mixture? Give reason.

28. Define the following term: Osmotic pressure.

29. A 6% solution of glucose (molar mass = 180 g/mol) is isotonic with 2.5% solution of an unknown organic substance. Calculate the molecular weight of the unknown organic substance.

30. For a 5% solution of urea (Molar mass = 60 g/mol), calculate the osmotic pressure at 300 K. [R = 0.0821 L atm K^{-1} mol^{-1}]

31. Give reasons:
(a) Cooking is faster in pressure cooker than in cooking pan.
(b) Red blood cells (RBC) shrink when placed in saline water but swell in distilled water.

32. (i) Out of 1 M glucose and 2 M glucose, which one has a higher boiling point and why?
(ii) What happens when the external pressure applied becomes more than the osmotic pressure of solution?

33. Blood cells are isotonic with 0.9% sodium chloride solution. What happens if we place blood cells in a solution containing:
(i) 1.2% sodium chloride solution?
(ii) 0.4% sodium chloride solution?

34. At 300 K, 30 g of glucose present in a litre of its solution has an osmotic pressure of 4.98 bar. If the osmotic pressure of a glucose solution is 1.52 bar at the same temperature, what would be its concentration?

35. (i) Define reverse osmosis.
(ii) Why are aquatic species more comfortable in cold water in comparison to warm water?
(iii) A solution containing 2 g of glucose (M = 180 g/mol) in 100 g of water is prepared at 303 K. If the vapour pressure of pure water at 303 K is 32.8 mm Hg, what would be the vapour pressure of the solution?

36. van't Hoff factor for KCl solution assuming the complete dissociation is:
(a) 1(b) 2(c) 0.5(d) 1.5

MCQ

1. An azeotropic solution of two liquids has boiling point lower than either of them when it:
(a) is saturated.
(b) shows positive deviation from Raoult's law.
(c) shows negative deviation from Raoult's law.
(d) shows no deviation from Raoult's law.

2. The relative lowering of vapour pressure of an aqueous solution containing non-volatile solute is 0.0225. The mole fraction of the non-volatile solute is:
(a) 0.80(b) 0.725(c) 0.15(d) 0.0225

3. Which of the following solutions will have the highest conductivity at 298 K?
(a) 0.01 M HCl solution

(b) 0.1 M HCl solution
(c) 0.01 M CH3COOH solution
(d) 0.1 M CH3COOH solution

4. Which of the following is an example of a solid solution?
(a) Sea water
(b) Sugar solution
(c) Smoke
(d) 22 carat gold

5. One kilogram of sea water sample contains 6 mg of dissolved O2. The concentration of O2 in ppm in the sample is
(a) 0.06
(b) 60
(c) 6
(d) 0.6

6. An azeotropic mixture of two liquids has a boiling point higher than either of the two liquids when it
(a) shows large negative deviation from Raoult's law.
(b) shows no deviation from Raoult's law.
(c) shows large positive deviation from Raoult's law.
(d) obeys Raoult's law.

7. 50 mL of an aqueous solution of glucose C6H12O6 (Molar mass : 180 g/mol) contains 6.02 x 10^22 molecules. The concentration of the solution will be
(a) 0.1 M(b) 0.2 M(c) 1.0 M(d) 2.0 M

8. 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

9. Solubility of gases in liquids decreases with rise in temperature because dissolution is an
(a) endothermic and reversible process.
(b) exothermic and reversible process.
(c) endothermic and irreversible process.
(d) exothermic and irreversible process.

10. Which of the following factor(s) affect the solubility of a gaseous solute in the fixed volume of liquid solvent?
(i) nature and 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

11. Value of Henry's constant KH
(a) increases with decrease in temperature.
(b) decreases with increase in temperature.
(c) increases with increase in temperature.
(d) remains constant.

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

13. Which one of the following pairs will not form an ideal solution?
(a) Benzene and Toluene(b) Nitric acid and Water(c) Hexane and Heptane
(d) Ethyl chloride and Ethyl bromide

14. Considering the formation, breaking and strength of hydrogen bond, predict which of the following mixtures will show a positive deviation from Raoult's law?
(a) Methanol and acetone(b) Chloroform and acetone(c) Nitric acid and water
(d) Phenol and aniline

15. 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 is not true?
(a) ΔmixH = zero
(b) ΔmixV = zero
(c) These will form minimum boiling azeotrope.
(d) These will form an ideal solution.

16. When 1 mole of benzene is mixed with 1 mole of toluene, the vapour will contain (Given: vapour pressure of benzene = 12.8 kPa and vapour pressure of toluene = 3.85 kPa).
(a) equal amount of benzene and toluene as it forms an ideal solution.
(b) unequal amount of benzene and toluene as it forms a non ideal solution.
(c) higher percentage of benzene.
(d) higher percentage of toluene.

17. In the vapour pressure vs temperature graph, the point 'X' (the lower intersection point of the solvent curve) represents
(a) boiling point of solution(b) freezing point of solvent(c) boiling point of solvent
(d) freezing point of solution

18. An unripe mango placed in a concentrated salt solution to prepare pickle, shrivels because __________.
(a) it gains water due to osmosis.
(b) it loses water due to reverse osmosis.
(c) it gains water due to reverse osmosis.
(d) it loses water due to osmosis.

19. In which of the following cases blood cells will shrink?
(a) when placed in water containing more than 0.9% (mass /volume) NaCl solution.
(b) when placed in water containing less than 0.9% (mass /volume) NaCl solution.
(c) when placed in water containing 0.9% (mass/volume) NaCl solution.
(d) when placed in distilled water.

20. The colligative property used for the determination of molar mass of polymers and proteins is
(a) osmotic pressure.
(b) depression in freezing point.
(c) relative lowering in vapour pressure.
(d) elevation in boiling point.

21. 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.

22. The values of Van't Hoff factors for KCl, NaCl and K_2SO_4 respectively, are __________.
(a) 2, 2 and 2(b) 2, 2 and 3(c) 1, 1 and 2(d) 1, 1 and 1

23. The boiling point of a 0.2 m solution of a non-electrolyte in water is (Kb for water = 0.52 K kg mol^-1)
(a) 100° C(b) 100.52° C(c) 100.104° C(d) 100.26° C

24. Which of the following aqueous solution will have highest boiling point?
(a) 1.0 M KCl(b) 1.0 M K_2SO_4(c) 2.0 M KCl(d) 2.0 M K_2SO_4

25. How much ethyl alcohol must be added to 1 litre of water so that the solution will freeze at -14°C? (Kf for water = 1.86°C/mol)
(a) 7.5 mol(b) 8.5 mol(c) 9.5 mol(d) 10.5 mol

26.

27. Which of the following statements is false?
(a) Two different solutions of sucrose of same molality prepared in different solvents will have the same depression in freezing point.
(b) The osmotic pressure of a solution is given by the equation $\pi = CRT$ (where C is the molarity of the solution).
(c) 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.
(d) 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.

28. On mixing 20 mL of acetone with 30 mL of chloroform, the total volume of the solution is
(a) < 50 mL(b) = 50 mL(c) > 50 mL(d) = 10 mL

29. Which of the following analogies is correct?
(a) Gaseous solution : Camphor in nitrogen gas :: Solid solutions : Copper dissolved in Gold
(b) Molarity : Moles/litre :: Molality : Grams/litre
(c) Ideal solution : $\Delta H_{mix} = 0$ :: Negative deviation : $\Delta H_{mix} > 0$
(d) Minimum boiling azeotrope : Ethanol and water mixture :: Maximum boiling azeotrope : Acetone and CS2 mixture

30. A compound undergoes complete dimerization in a given organic solvent. The Van't Hoff factor 'i' is
(a) 2.0(b) 0.5(c) 0.25(d) 1.0