Types of Solutions

Solutions are homogeneous mixtures of two or more substances. The component present in the largest quantity is known as the solvent. The other components present in the solution are called solutes.

Solutions can be classified into the following types:

- **Solid solutions:** In a solid solution, the solute is dissolved in a solid solvent. An example of a solid solution is an alloy, such as brass (an alloy of copper and zinc).
- **Liquid solutions:** In a liquid solution, the solute is dissolved in a liquid solvent. An example of a liquid solution is salt water (a solution of sodium chloride in water).
- **Gaseous solutions:** In a gaseous solution, the solute is dissolved in a gaseous solvent. An example of a gaseous solution is air (a solution of oxygen, nitrogen, and other gases in nitrogen).

The concentration of a solution can be expressed in terms of mole fraction, molarity, molality, and percentages.

- **Mole fraction:** The mole fraction of a component in a solution is the ratio of the number of moles of that component to the total number of moles of all components in the solution.
- **Molarity:** The molarity of a solution is the number of moles of solute per liter of solution.
- **Molality:** The molality of a solution is the number of moles of solute per kilogram of solvent.
- **Percentages:** The concentration of a solution can also be expressed in terms of percentages. The percentage by mass of a component in a solution is the mass of that component divided by the total mass of the solution, multiplied by 100.

The dissolution of a gas in a liquid is governed by Henry's law, which states that, at a given temperature, the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas.

The vapour pressure of the solvent is lowered by the presence of a non-volatile solute in the solution. This lowering of vapour pressure is governed by Raoult's law, which states that the relative lowering of vapour pressure of the solvent over a solution is equal to the mole fraction of a non-volatile solute present in the solution.

Solutions which obey Raoult's law over the entire range of concentration are called ideal solutions. Two types of deviations from Raoult's law, called positive and negative deviations, are observed.

Azeotropes arise due to very large deviations from Raoult's law.

The properties of solutions which depend on the number of solute particles and are independent of their chemical identity are called colligative properties. These are lowering of vapour pressure, elevation of boiling point, depression of freezing point, and osmotic pressure.

The process of osmosis can be reversed if a pressure higher than the osmotic pressure is applied to the solution.

Colligative properties have been used to determine the molar mass of solutes. Solutes which dissociate in solution exhibit molar mass lower than the actual molar mass and those which associate show higher molar mass than their actual values.

Quantitatively, the extent to which a solute is dissociated or associated can be expressed by van't Hoff factor i. This factor has been defined as ratio of normal molar mass to experimentally determined molar mass or as the ratio of observed colligative property to the calculated colligative property.

Exercises

1. Define the term solution. How many types of solutions are formed? Write briefly about each type with an example.
2. Give an example of a solid solution in which the solute is a gas.
3. Define the following terms:
    a. Mole fraction
    b. Molality
    c. Molarity
    d. Mass percentage
4. Concentrated nitric acid used in laboratory work is 68% nitric acid by mass in aqueous solution. What should be the molarity of such a sample of the acid if the density of the solution is 1.504 g mL–1?