CHAPTER

6

Solutions

Introduction

- A **solution** is a homogeneous mixture of two or more substances.
- The substance which is dissolved in a liquid to make a solution is called 'solute' and the liquid in which solute dissolved is called 'solvent'.
- A **true solution** does not scatter light and its particles cannot be seen even by microscope.
  e.g., salt solution, sea water, sugar solution, copper sulphate solution, vinegar etc.

Strength of a Solution

- The amount of solute dissolved in unit weight or volume of solution is called strength (concentration) of a solution.
  So, concentration of a solution

$$= \frac{\text{Amount of solute (in gram)}}{\text{Weight of solution}}$$

$$= \frac{\text{Amount of solute (in gram)}}{\text{Volume of solution}}$$

Methods of Expressing Concentration of Solution

- **Parts per million** $= \frac{\text{Mass of solute (in gram)} \times 10^6}{\text{Volume of solution}}$
- **Molarity (*M*)** The number of moles of solute dissolved in one litre solution is called its molarity.
- Thus,

$$M = \frac{\text{Weight of solute (in gram)} \times 1000}{\text{Molecular weight} \times \text{volume of solution (in mL)}}$$

- **Molality (*m*)** The number of moles of solute dissolved in 1000 g of a solvent, is called its molality. Thus,

$$m = \frac{\text{Weight of solute (in gram)} \times 1000}{\text{Molecular weight} \times \text{weight of solvent (in gram)}}$$

- **Normality (*N*)** The number of equivalents of solute dissolved in one litre of solution, is known as normality

$$N = \frac{\text{Weight of solute (in gram)} \times 1000}{\text{Equivalent weight} \times \text{volume of solution (in mL)}}$$

Normality and molarity are affected by temperature as these depend upon the volume whereas molality remains unaffected from temperature change.

Henry's Law

- According to this law, the solubility of a gas in a liquid is directly proportional to the pressure of the gas. Its main applications are
  (a) Soft drinks and soda water bottles are sealed under high pressure in order to increase the solubility of CO_2 in them.
  (b) To minimise the painful effects accompanying the decompression of deep sea divers, oxygen diluted with less soluble helium gas is used as breathing gas.

Oxygen diluted with nitrogen cannot be used for this purpose due to high solubility of N_2.

Osmosis

It is the process of movement of solvent molecules from the solution of low concentration to high concentration through semi-permeable membrane.

- If pressure greater than osmotic pressure (pressure require to stop osmosis) is applied on solution of high concentration, reverse osmosis takes place. e.g., desalination of sea water.

Exercise

1. Scuba divers are at risk due to high concentration of dissolved gases while breathing air at high pressure under water. The tanks used by Scuba divers are filled with **(CDS 2010 II)**
   (a) air diluted with helium
   (b) O_2
   (c) N_2
   (d) a mixture of N_2 and helium

2. The sum of mole fractions of the two components of a binary solution is always
   (a) more than one (b) less than one
   (c) exactly one (d) not fixed

3. In which mode of expression, the concentration of the solution remains independent of temperature?
   (a) Normality (b) Molality
   (c) Molarity (d) Formality

4. The number of moles of solute per kg of a solvent is called
   (a) mole fraction (b) normality
   (c) molality (d) molarity

5. The number of moles of solute per litre solution is called
   (a) molality (b) normality
   (c) molarity (d) mole fraction

6. 8 g NaOH is dissolved in one 1 L solution. Its molarity is
   (a) 0.8 M (b) 0.4 M
   (c) 0.2 M (d) 0.1 M

7. The molarity of pure water at 298K is
   (a) 5.5 (b) 5.55 (c) 5.50 (d) 55.55

8. Which one of the following is involved for desalination of sea water? **(CDS 2007 II)**
   (a) Reverse osmosis
   (b) Simple osmosis
   (c) Use of sodium aluminium silicate as zeolite
   (d) Use of ion selective electrodes

9. A solution which contains the maximum amount of the solute that can be dissolved in a given amount of solvent at a particular temperature is called
   (a) saturated solution (b) unsaturated solution
   (c) super saturated solution (d) None of these

10. The solubility of a gas in liquid increases with
    (a) increase in temperature
    (b) reduction is gas pressure
    (c) decrease in temperature and increase in gas pressure
    (d) amount of liquid taken

11. At high altitudes the boiling point of water lowers because
    (a) atmospheric pressure is low
    (b) temperature is low
    (c) atmospheric pressure is high
    (d) None of the above

12. Unit of molarity is known as
    (a) mol L^{-1} (b) mol kg^{-1}
    (c) gram equiv L^{-1} (d) None of these

Answers

I. (a)	2. (c)	3. (b)	4. (c)	5. (c)	6. (c)	7. (d)	8. (a)	9. (a)	10. (c)
II. (a)	12. (a)								

Hints and Solutions

1. The tanks used by Scuba divers are filled with air diluted with helium (*i.e.*, $He-O_2$ mixture) because unlike nitrogen, helium is not soluble in blood even under high pressure.

8. Reverse osmosis method is used to obtain pure water from water containing a salt or for desalination of sea water.

6. $$\text{Molarity} = \frac{\text{Mass of solute}}{\text{Molar mass of solute} \times \text{volume of solution}}$$
$$= \frac{8}{40 \times 1} \quad [\because \text{NaOH} = 23+16+1 = 40 \text{ g mol}^{-1}]$$
$$= \frac{1}{5} = 0.2 \text{ M}$$