Class XII

CHEMISTRY

SOLUTIONS (CHAPTER-2)

Solution – A homogeneous mixture of two or more substances mixed in varied proportions.

Solution = Solute + Solvent

Binary solution contains one solute dissolved in a solvent

Ternary solution contains two solutes dissolved in a solvent.

Types of solutions:

Type of solution	Solute	Solvent	Example
Gaseous solutions	Gas	Gas	Mixture of O_2 and N_2 gases
	Liquid	Gas	Chloroform + N_2 gas
	Solid	Gas	Camphor in N_2 gas
Liquid solutions	Gas	Liquid	O_2 dissolved in water
	Liquid	Liquid	Ethanol dissolved in water
	Solid	Liquid	Glucose dissolved in water
Solid solutions	Gas	Solid	Solution of H_2 in Palladium
	Liquid	Solid	Amalgam of Hg with Na
	Solid	Solid	Copper dissolved in Gold

Important Formulas:

1) **Molarity** = No. of moles of solute dissolved in 1 L of solution
   M = No. of moles of solute / Volume of solution in L
   $$M = \frac{w_B \times 1000}{M_B \times V_{solution}(mL)}$$
   Unit = M or Molar or moles/L

2) **Molality** = No. of moles of solute dissolved in 1 Kg of solvent
   M = No. of moles of solute / Weight of solvent in Kg
   $$M = \frac{w_B \times 1000}{M_B \times w_A\ (g)}$$
   Unit = m or Molal or moles/Kg
   - Molality is preferred over molarity as molarity is temperature dependent term because volume of solution changes with temperature.
   - Concentration of 1 M > 1 m because 1 Kg > 1 L

3) **Normality** = No. of gram equivalents of solute in 1 L of solution
   Gram equivalents = M.Mass / n-factor
   Where n-factor = acidity or basicity or no. of electrons
   $$N = \frac{w_B \times 1000 \times \text{n-factor}}{M_B \times V_{solution}(mL)}$$

4) **Mole fraction (χ)**: $X_A = \frac{\text{no. of moles of component A}}{\text{Total no. of moles}} = \frac{n_A}{n_A + n_B}$

   $X_A + X_B = 1$

5) **Mass percentage** = $\frac{\text{Given mass of component}}{\text{Total mass}} \times 100$

6) **Parts per million (ppm)** = $\frac{\text{No. of atoms of component}}{\text{Total no. of atoms}} \times 10^6$

$$= \frac{\text{Given mass of component}}{\text{Total mass}} \times 10^6$$

Solubility: The maximum amount of solute that can be dissolved in 100gm of solvent.

Saturated solution: When no more solute can be added in the solvent.

1) **Solubility of solid in liquid**: Like dissolves like
When solid is added to the solvent, concentration of solute increases and a stage is reached when an equilibrium is achieved where the number of solute particles going into the solution becomes equal to solute particles separating out.
Solute + Solvent ↔ Solution (Dissolution)

At this stage, solution is known as saturated solution.
Effect of temperature on solubility of solids in liquids: Solubility increases with increase in temperature. As according to Le Chatlier's principle, solubility should increase with increase in temperature if dissolution process is mostly endothermic ($\Delta H > 0$) while solubility should decrease with increase in temperature if dissolution process is exothermic ($\Delta H < 0$).

Effect of pressure: Pressure has no significant effect on solubility of solids in liquids because solids are incompressible.

2) **Solubility of gas in liquid**:
Oxygen is found in dissolved form in sea water, dry HCl gas is highly soluble in water.
Effect of temperature: A temperature increases, solubility of gases decreases in liquids because on increasing temperature, K.E. of molecules increases. That is why, aquatic species are more comfortable in cold water due to more availability of oxygen in cold water.

Effect of pressure: Solubility of gases increase with increase in pressure. As pressure increases, there is increase in number of gaseous particles per unit volume over the solution due to which solubility increases until a new equilibrium is attained between gaseous particles and solution.

It is explained by **Henry's Law**, a quantitative relationship between Pressure and solubility of gas in a solvent.
Pressure of a gas is directly proportional to solubility of a gas.
i.e. $P \propto \chi$
$P = K_H \chi$ where K_H is known as Henry's constant.

Different gases have different K_H values at the same temperature. This suggests that K_H is a function of the nature of the gas.

Higher the value of K_H at a given pressure, the lower is the solubility of the gas in the liquid.
K_H values at 293K: $N_2 > H_2 > O_2$.

Applications of Henry's Law:

a) To increase the solubility of CO_2 in soft drinks, bottles are sealed under high pressure.

b) At high altitudes, partial pressure of oxygen is less than that at normal level. This leads to less solubility of oxygen in blood and tissues of human. Hence, mountaineers should carry oxygen cylinders with them to avoid anoxia.

c) Scuba divers generally take tanks filled Helium (11.7%), Nitrogen (56.2%) and Oxygen (32.1%) to avoid a condition known as bends and toxic effects of bubbles of N_2.
Bend is a condition in the blood which is formed due to changing pressure condition which can block blood capillaries and could be harmful to life while coming out of deep water.
Scuba divers must cope with high concentrations of dissolved gases while breathing air at high pressure underwater. Increased pressure

increases the solubility of atmospheric gases in blood. When the divers come towards surface, the pressure gradually decreases. This releases the dissolved gases and leads to the formation of bubbles of nitrogen in the blood. This blocks capillaries and creates a medical condition known as bends, which are painful and dangerous to life.