Some Important Definitions

Chapter: - Solutions

1. Mole fraction-The mole fraction of a component is the ratio of the number of moles of component to the total number of moles of all the components present in the solution.

   $$\text{Mole fraction of component} = \frac{\text{Number of moles of component}}{\text{Total number of moles of all component}}$$

   For a binary solution, mole fraction of component A

   $$x_A = \frac{n_A}{n_A + n_B}$$

   Similarly,

   For B, $x_B = \frac{n_B}{n_A + n_B}$ and $x_A + x_B = 1$

2. Henry's law- It states that the partial pressure of the gas in vapour state (P) is directly proportional to the mole fraction of the gas (x) in the solution.

   $$P = k_H . x$$

   Here,

   K_H = Henry's law constant

   Different gases have different K_H (henry's law constant) value at the same temperature.

3. Molality: - It is defined as the number of moles of solute per kilogram of the solvent. It is represented by m

   $$\text{Molality}(m) = \frac{\text{Number of moles of solute} \times 1000}{\text{Mass of solvent } (\text{in } g)}$$

   It does not change with change in temperature.

4. Molarity- It is defined as the number of moles of solute dissolved in one liter or one cubic decimeter of the solution.

$$Molarity(M) = \frac{Number\ of\ moles\ of\ solute \times 1000}{Volume\ of\ solutions(\ in\ ml)}$$

It decreases with increase in temperature (as $V \propto T$)

5. <u>Raoult's law for volatile solute</u>

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

For Component 1,

$P_1 \propto x_1$ or, $P_1 = P_1^\circ x_1$

For Component 2,

$P_2 = P_2^\circ x_2$;

$$P_{total} = P_1 + P_2 = P_1^\circ x_1 + P_2^\circ x_2$$

$$P_{total} = (1 - x_2)P_1^\circ + x_2 P_2^\circ \quad \text{as } (x_1 + x_2 = 1)$$

$$P_{total} = P_1^\circ + (P_2^\circ - P_1^\circ) + x_2$$

Here, P_1° and P_2° are the vapour pressures of pure component 1 and 2 respectively.

If y_1 and y_2 are the mole fractions of the component 1 &2 respectively in vapour phase then,

$P_1 = y_1 \times P_{total}$

Similarly,

$P_2 = y_2 \times P_{total}$

6. <u>Ideal solutions</u>

The solutions which obey raoult's law over the entire range of concentration are known as ideal solutions.

For ideal solutions -

$\Delta H(mixing) = 0$

$\Delta V(mixing) = 0$

e.g- solutions of n-hexane and n- heptane, bromoethane and chloroethane, etc.

Or In these solutions (binary solution),
A-B type (i.e solute-solvent) interactions are nearly equal to the A-A (solute-solute) and B-B type (solvent- solvent) interactions.

7. Non- Ideal solutions - The solutions which do not obey raoult's law over range of concentration are known as non- ideal solutions.
   $\Delta H(mixing) \neq 0$
   $\Delta V(mixing) \neq 0$
   To such solution, the vapour pressure is either higher (+ve deviation from Raoult's law) or lower(-ve deviation from raoult' law) than the predicted by raoult's law.

8. Azeotropes - The binary mixtures (solution) that have the same composition in liquid and vapour phase and boil at constant temprature like a pure liquid are called as azeotropes or azeotropic mixtures.

   The solution which shows large negative deviation from raoult's law, forms maximum boiling azeotropes, e.g. Nitric acid-water mixture and the solution which shows large positive deviation from raoult's law, forms minimum boiling azeotropes, e.g. ethanol-water mixture.

9. Osmotic pressure- It is the extra pressure which is applied on the solution just to prevent the flow of solvent into the solution through a semipermeable membrane.

10. Abnormal molar mass- molar mass that is either lower or higher than the expected or normal value is called abnormal molar mass,e.g

all the molecules of ethanoic acid associate in benzene , then ΔT_b or ΔT_f for ethanoic acid will be half of the normal value.

11. Van't Hoff factor- It is defined as ratio of the experimental value of colligative property to the calculated value of the colligative property and is used to find out the extent of dissociation or association. Mathematically, it is represented as:

$$i = \frac{observed\ colligative\ property}{Calculated\ colligative\ property}$$

12. Isotonic solution- Two solutions having the same osmotic pressure at a given temperature are called isotonic solutions.

13. Colligative property-The properties of solution which depends only on the number of solute particles, irrespective of their nature relative to the total number of particles present in the solution. There are four important colligative properties-

    i) Relative lowering of vapour pressure
    ii) Elevation of boiling point
    iii) Depression of freezing point
    iv) Osmosis and osmotic pressure