## Types

**Gaseous**
- Gas-Gas → Mixture of $O_2$ and $N_2$
- Liquid-Gas → Chloroform with $N_2$
- Solid-Gas → Camphor in $N_2$

**Liquid**
- Gas-Liquid → $O_2$ dissolved in water
- Liquid-Liquid → Ethanol dissolved in water
- Solid-Liquid → Glucose dissolved in water

**Solid**
- Gas-Solid → $O_2$ in Pd
- Liquid-Solid → Amalgam of Hg with Na
- Solid-Solid → Cu dissolved in gold

## Expressing Concentration of solutions

- **Mass by volume percentage (w/v)** → $\frac{\text{Mass of solute}}{\text{Volume of solution}} \times 100$
- **Mass percentage (w/w)** → $\frac{\text{Mass of component in solution}}{\text{Total mass of solution}} \times 100$
- **Volume percentage (v/v)** → $\frac{\text{Volume of component}}{\text{Total volume of solution}} \times 100$
- **Parts per million : For trace quantities** → $\frac{\text{No. of parts of components} \times 10^6}{\text{Total no. parts of components of solution}}$
- **Mole fraction** → $\frac{\text{No. of moles of component}}{\text{Total No. of moles of all components}}$
- **Normality:** Number of gram equivalents of the solute dissolved in one litre of solution → $\frac{\text{No. of gram equivalent of solute} \times 100}{\text{Volume of solution (in L)}}$
  - Gram Equivalents of solute $= \frac{\text{Mass of solute}}{\text{Equivalent weight}}$
  - Equivalent weight $= \frac{\text{Molecular mass}}{\text{valency}}$
- **Molality:** Number of moles of solute per kilogram of the solvent → $\frac{\text{No. of moles of solute} \times 1000}{\text{Mass of solvent (in g)}}$
- **Molarity :** Number of moles of solute in 1L solution → $\frac{\text{No. of moles of solute} \times 100}{\text{Volume of solution (in L)}}$

# SOLUTIONS

### Colligative properties

Osmotic pressure → $\pi = CRT$

Depression in freezing point → $\Delta T_f = \frac{K_f \times W_2 \times 1000}{M_2 \times W_1}$

Elevation of boiling point → $\Delta T_b = \frac{K_b \times 1000 \times W_2}{M_2 \times W_1}$

Relative lowering of vapour pressure (for dilute solutions) → $\frac{W_2 \times M_1}{M_2 \times W_1} = \frac{P^\circ_1 - P_1}{P^\circ_1}$

### Abnormal molecular mass

**Molecular mass different from expected value**

Van't Hoff factor (i) $= \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$

### Effect of temperature

- Solid in liquid
  - Endothermic $\Delta_{sol} H > 0$, Solubility Increases at high temp.
  - Exothermic $\Delta_{sol} H < 0$, Solubility decreases at high temp.
  - Effect of Pressure → Not significant
- **Solubility**
- Gas in liquid
  - Effect of temperature → Increases with decrease in temperature
  - Effect of Pressure → Increases with increase in Pressure

### Henry's Law

Partial pressure of gas in vapour phase is proportional to the mole fraction of gas in the solution.

$p = K_H x$

### Raoult's Law

For any solution, the partial vapour pressure of each volatile component is directly proportional to its mole fraction in solution phase

**Obey raoult's law**

Ideal solution → $\Delta H_{mix} = \Delta V_{mix} = 0$
eg: n-hexane and n-heptane
Ethyl bromide + Ethyl chloride,
Chlorobenzene + Bromobenzene, etc.

**Do not Obey raoult's law**

Non-Ideal solution → $\Delta H_{mix}$ or $\Delta V_{mix} \neq 0$

- **Positive Deviation**
  - $\Delta H_{mix} > 0$
  - $\Delta V_{mix} > 0$
  - eg: Acetone + Ethyl alcohol, Water + Ethyl alcohol, Carbon tetrachloride + Chloroform, Chloroform + Ethanol, Acetone + Carbon disulphide, Acetone + Benzene, etc.
- **Negative Deviation**
  - $\Delta H_{mix} < 0$
  - $\Delta V_{mix} < 0$
  - eg: Acetone + Aniline, HCl + $H_2O$, $HNO_3$ + $H_2O$, $H_2SO_4$ + $H_2O$, Acetone + Chloroform, $HNO_3$ + Chloroform, Benzene + Chloroform, Pyridine + Glacial acetic acid, etc.

### Azeotropes:

The mixtures of liquids which boil at constant temperature like a pure liquid and possess same composition of components in liquid as well as vapour phase are called constant boiling mixtures or azeotropic mixtures.

**Minimum boiling azeotropes:**
They are formed by those liquid pairs which show positive deviations from ideal behaviour. eg: ethanol-water mixture.

**Maximum boiling azeotropes:**
They are formed by those liquid pairs which show negative deviations from ideal behaviour e.g nitric acid-water mixture.

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