CONCEPT MAP

STATES OF MATTER : GASES AND LIQUIDS

Gases

It is the state of matter which occupies the whole of the container irrespective of its quantity.

Characteristics of gases

- Gases neither have definite shape nor definite volume.
- Gases can be compressed by application of external pressure.
- Gases are homogeneous in nature.
- Gases exert pressure equally in all directions.
- Gases can be liquefied by cooling or by applying pressure.

Measurable properties of gases

- Mass
- Volume
- Pressure
- Temperature

Kinetic molecular theory of gases

- All gases are made up of a very large number of minute particles, atoms or molecules.
- The molecules are in continuous random motion in all directions.
- Molecular collisions are perfectly elastic.
- The intermolecular forces of attraction are negligible.
- The average kinetic energy of a gas molecule is directly proportional to the absolute temperature.

Gas laws

- **Boyle's law :** It states "at a constant temperature (T), the pressure (P) of a given mass of any gas varies inversely with its volume (V)". *i.e.* $P \propto (1/V)$. PV = constant.
- **Charles' law :** It states "at constant pressure (P), the volume (V) of a fixed mass of a gas is directly proportional to its absolute temperature (T)".
  i.e, $V \propto T$ or (V/T) = constant.
- **Avogadro's law :** It states "at a given temperature (T) and pressure (P), the volume (V) of a gas is directly proportional to the number of moles (n) of a gas". *i.e*, $V \propto n$ or (V/n) = constant
- **Gay Lussac's law :** It states "at constant volume (V), the pressure (P) of a given mass of gas is directly proportional to the absolute temperature (T) of the gas". *i.e.*, $P \propto T$ or (P/T) = constant.
- **Dalton's law of partial pressure :** It states "at a given temperature, the total pressure (P_{total}) exerted by two or more non-reacting gases occupying a definite volume is equal to the sum of partial pressures of the component gases".
  $P_{total} = P_1 + P_2 + P_3 + ...$ (where P_1, P_2, P_3 are partial pressures of component gases)

Ideal gas equation

$PV = nRT$ [R = gas constant]

Ideal gas equation is a relation between four variables and it describes the state of any gas. For this reason it is also called equation of state.

Ideal and Real gases

- A gas which obeys ideal gas equation and other gas laws at all temperatures and pressures is called ideal gas or perfect gas.
- A gas which does not obey general gas equation and other gas laws at all temperatures and pressures is called real gas or non-ideal gas.

van der Waal's equation for real gases

$$\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$

where a = constant (related to interaction of molecules)
b = constant (the excluded volume of gaseous molecules)

Liquids

Liquids have a fixed volume but take the shape of the container.

Kinetic molecular model for liquids

- Liquids are composed of molecules.
- The molecules of liquids are held together by appreciable intermolecular forces.
- The molecules of liquid are in constant random motion.
- The average kinetic energy of molecules of a liquid is directly proportional to their absolute temperature.

Properties of liquids

- **Volume :** Liquids have definite volume because the molecules are closely packed due to strong intermolecular forces of attraction.
- **Density :** Liquids have high density as compared to gases but have less density than solids.
- **Compressibility :** As compared to gases liquids are less compressible, because the molecules of liquid are held by such a strong cohesive force that the volume of any liquid decreases very little with increased pressure.
- **Diffusion :** It is defined as the process of intermixing of the molecules of two or more liquids to form homogeneous mixture.
- **Evaporation :** It is the process of conversion of a liquid into its vapours at room temperature.
- **Vapour pressure :** It is the pressure exerted by the vapours in equilibrium with its liquid at a given temperature. It increases with the increase in temperature.
- **Surface tension :** It is the tangential force acting along the surface of a liquid at right angle to a line of one unit length drawn on the surface of the liquid. It decreases with the increase in temperature.
- **Viscosity :** The ease with which a liquid can flow is determined by its property, called viscosity. It arises due to the internal friction between layers of fluids.