Chapter 5

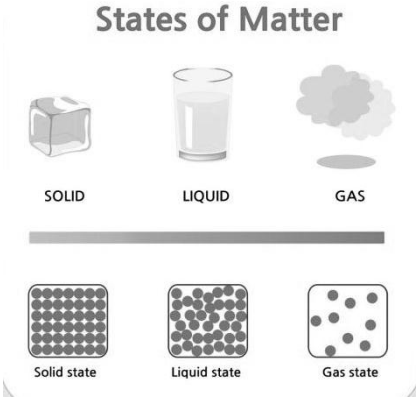
Gases and liquids

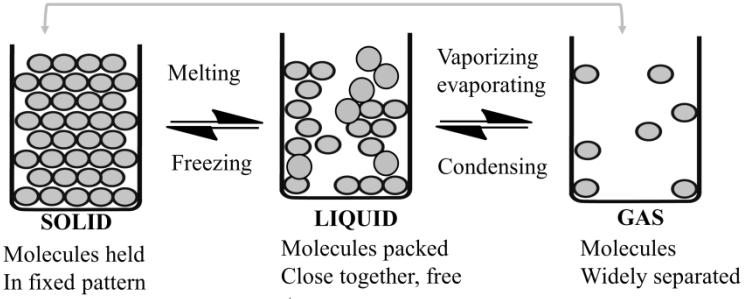
Day - 1

STATES OF MATTER

There are five known phases, or **states, of matter**: solids, liquids, gases, and plasma and Bose-Einstein condensates.

Here we will study only three. Solid, Liquid and Gas

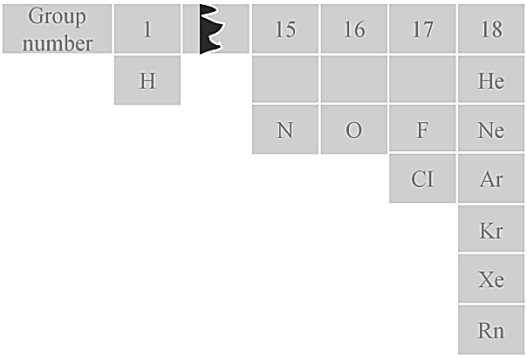




	Properties	Solids	Liquids	Gases
1	**Mass**	Definite	Definite	Definite
2	**Shape**	Definite	Acquires the shape Of the container	Acquires the shape of the container
3	**Volume**	Definite	Definite	Indefinite
4	**Compressibility**	Not possible	Almost Negligible	Highly Compressible
5	**Fluidity**	Not possible	Can flow	Can flow
6	**Rigidity**	Highly rigid	Less rigid	Not rigid
7	**Diffusion**	Slow	Fast	Very fast
8	**Space between particles**	Most closely packed	Less closely packed	Least closely packed
9	**Inter-particle force**	strongest	Slightly weaker than in solids	Negligible

GASEOUS STATE

Only eleven elements exist as gases under normal conditions



GASEOUS STATE

The gaseous state is characterized by the following physical properties.

- Gases are highly compressible.
- Gases exert pressure equally in all directions.
- Gases have much lower density than the solids and liquids.
- The volume and the shape of gases are not fixed. These assume volume and shape of the container.
- Gases mix evenly and completely in all proportions without any mechanical aid (Diffusion)

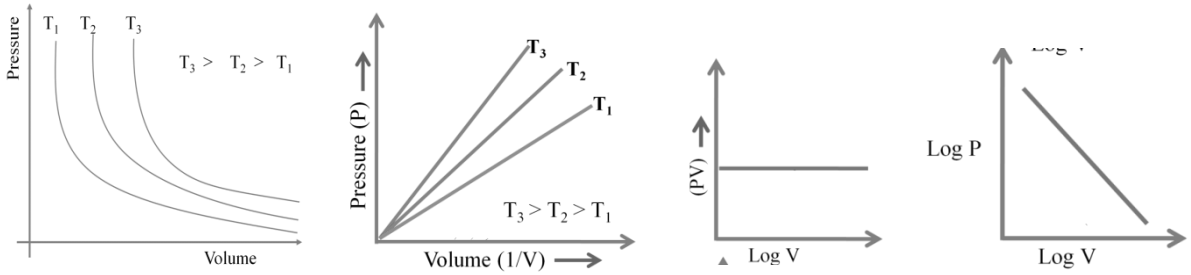
Gas Laws

1. **Boyle's** Law: At constant temperature

$P \propto \frac{1}{V}$

$PV = \text{constant}$

$P_1V_1 = P_2V_2 = P_3V_3 = \cdots = \text{constant}$



2. Charles Law: At constant pressure

$V \propto T$ or $\frac{V}{T} = \text{constant} = K$

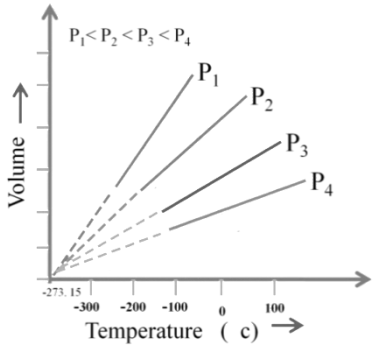
Here K is a constant that depends on the pressure of gas, the amount of gas and also unit of volume if V_1 and T_1 are the initial values of volume and temperature of a gas then,

$\frac{V_1}{T_1} = K$

Also, if the temperature is now changed to T_2 such that the volume change to V_2

We can write,

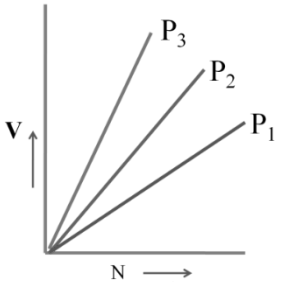
We can write, $\frac{V_2}{T_2} = K$ Or $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ or $V_1T_2 = V_2T_1$



Volume Vs Temperature graph (c)

3. Avogadro's Law: At constant pressure and temperature

$V \propto$ n (no. of moles)



4. Ideal gas equation

Ideal gas equation

$$\left.\begin{array}{l} V \propto \frac{1}{p} \\ V \propto T \\ V \propto n \end{array}\right\}$$

$$V \propto \frac{nT}{p}$$

$$V = \frac{nRT}{p}$$ R = gas constant

$$P = \frac{n}{V}RT = \rho RT$$ w = mass of gas ρ = density

$$P = \frac{\frac{w}{M}}{V}RT$$ M = Mol weight of gas R = gas constant

5. Modified gas equation

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ If moles are constant

$P_1V_1 = P_2V_2$ If n & T, are constant

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$ If n & V, are constant

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ If n & P, are constant

Gas Constant 'R'

$R = \frac{PV}{nT}$

= 0.0821 lit atm/ K. mole

= 8.314x 10^7 erg/k. mole

= 8.314 J/k. mole

= 1.987 cal/k. mole

Units and conversion

	SI	cgs	Common
V	m^3	cm^3	Liter
p	N/m^2	Dy/cm^2	Atm. and mm Hg
T	K	K	˚C
n	moles	moles	moles

Conversion

Volume $\Rightarrow$ $1m^3=10^6\ cm^3=10^3$ lit

Pressure $\Rightarrow$ 1atm = 760 mm Hg = 101.3kPa

= $1.013x\ 10^5$ Pa = 14.7 Psi

1 bar = 10^5 Pa = 10^6 dy/cm^2 = 750 torr

Temperature $\Rightarrow$ K = ˚C + 273.15