IDEAL GASES

A gas which obeys the gas laws and the equation of state (PV = nRT) at all temperature, pressure and volume is called an **ideal gas**.

THE GENERAL GAS EQUATION (EQUATION OF STATE)

From Boyle's law,

$$PV = \text{Constant}$$

From Charles' law,

$$V/T = \text{Constant}$$

Combining these two equations,

$$\frac{pV}{T} = \text{Constant}$$

For two cases,

$$\boxed{\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}}$$

For 'n' mole of gas, the equation becomes:

$$\boxed{pV = nRT} \text{ --------------------- } (1)$$

For 1 mole of gas, the constant is known as the **molar gas constant (R).**

Therefore,

$$pV = RT$$

Now the volume of **one mole** (n =1) of an ideal gas at **S**tandard **T**emperature and **P**ressure (**STP**) is 0.0224 m^3.

Therefore,

$$R = \frac{PV}{T} = \frac{1.014 \times 10^5 \times 0.0224}{273.15} = 8.314\, JK^{-1}mol^{-1}$$

NOTE:

If ‘M’ is the mass of one mole of a gas, then the total mass of the gas ‘m’ is given by:

$$m = nM \quad \text{or} \quad n = \frac{m}{M} = \frac{mass\ of\ gas}{Molar\ mass} \quad \text{-----------} \ (2)$$

Also, if ‘N_A’ is the Avogadro’s constant in one mole, then the total number of molecules ‘N’ in the gas is given by:

$$N = nN_A \quad \text{or} \quad n = \frac{N}{N_A} = \frac{No\ of\ molecules}{Avogadro's\ Number} \quad \text{------} \ (3)$$

Putting equation (2) and (3) into equation (1), we have:

$$pV = \frac{m}{M}RT \quad \text{or} \quad pV = \frac{N}{N_A}RT$$

But,

$$\frac{R}{N_A} = k$$

Therefore,

$$\boxed{pV = NkT}$$

where,

P = Pressure

V = Volume

T = Absolute temperature/Thermodynamic temperature

n = No of moles

N = No of molecules

N_A = Avogadro’s Number

k = Boltzman’s constant (1.38 x 10^{-23} J/K)

m = mass of gas

M = Molar mass

KINETIC THEORY OF GASES

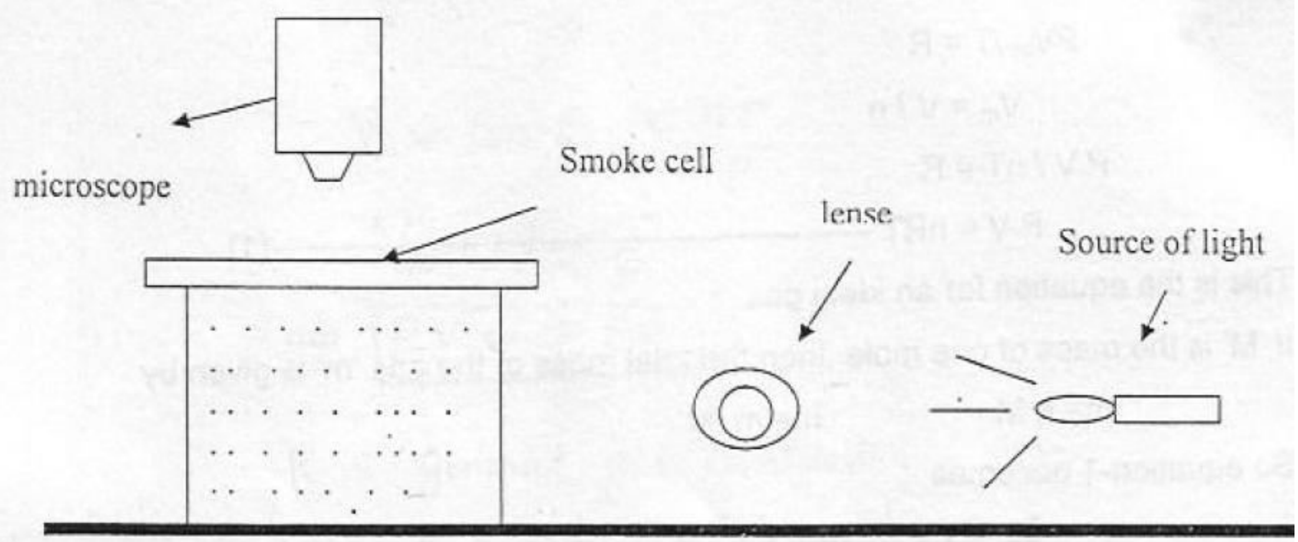
KINETIC THEORY OF GASES

This theory explains the behaviour of gases at macroscopic level.
The following are the basic assumptions of the theory:

1. A gas consists of a large number of molecules.
2. The gas molecules are constantly in rapid and free random motion.
3. The collisions between the molecules and with the walls are elastic.
4. There are no intermolecular forces except during collision.
5. The volume of a gas molecule is negligible as compared to the whole volume of the gas.
6. The duration of collision is negligible compared to the time interval between collisions.

BROWNIAN MOTION

The gas molecules move on a random path. This motion is called Brownian motion.



The above apparatus is used to demonstrate Brownian motion.
It is an evidence that gas molecules are always in continuous motion. The smoke particle moves here and there after colliding with air molecules.The air molecules bump into the smoke particles and push them into different directions. It means the molecules in gases are always keep on colliding and pushing each other in different directions. This is cause of zigzag movement of the molecules and this random movement of molecules is called Brownian motion.

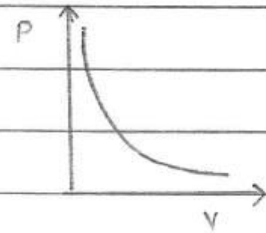
What is Boyle's Law?

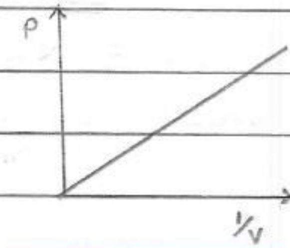
The pressure exerted by a fixed mass of gas is inversely proportional to its volume, provided the temperature remains constant.

$$P \propto \frac{1}{V} \quad \text{at a constant } T$$

$P_1V_1 = P_2V_2$

$PV = \text{constant}$





TEMPERATURE

CHAPTER 12 TEMPERATURE - NOTES

12.1 THERMAL EQUILIBRIUM

1. Temperature tells us about the hotness and coldness of a body with respect to some standard.

2. Temperature is average kinetic energy of molecules in a matter.

3. What is meant by temperature?

Physical properties of material (body) to determine in which direction heat is transferred from one object to another due to a temperature differences between the two objects.

4. A thermometer is a common instrument used to measure temperature.

5. Two bodies in contact with each other are said to be in thermal equilibrium when the two bodies have the same temperature.

6. When two bodies are not in same temperature, are put in contact, then thermal energy (heat energy) flows from the hotter to the cooler body until thermal equilibrium is established.

7. Ex.

8. During the process of reaching thermal equilibrium between two bodies, there will be net thermal energy flow.

9. The hotter body loses internal energy while the cooler body gains in internal energy.

What is absolute zero?

Absolute zero is the temperature at which the internal energy of a gas is minimum and no energy can be taken out of the gas.

It's the lowest possible temperature ($-273°C$ or $0K$)

What are the assumptions of the kinetic theory of gases?

The molecules of gas are in random motion, colliding with each other and the walls of the container. These collisions are perfectly elastic; no k.e. is lost.

↳ ∴ no change in temperature or internal energy.

The volume of the particles is negligible compared to the volume occupied by the gas.

The forces of attraction between the molecules (intermolecular forces) are negligible, except during collisions.

↳ ∴ $PE = 0$ and $du = k.e.$

The time of collision is negligible compared with the time between collisions.

Between collisions, the molecules travel in a straight line at a constant velocity.