Class : 11th Physics
Chapter- 13 : Kinetic Theory

Kinetic Theory

Degree of freedom

For monoatomic gas: f = 3 For diatomic gas:

(i) at room temperature, f = 5

(ii) at high temperature, f = 7

For polyatomic gas:

(i)at room temperature, f = 6

(ii)at high temperature, f = 8

Assumption of kinetic Theory of Gases

- All the molecules of a gas are identical.
- The molecules of different gases are different.
- The molecules of gases are in a state of random motion.
- The collisions of gases molecules are perfectly elastic.

Average Speed

$$v_{av} = \frac{v_1 + v_2 + v_3 + ... + v_N}{N}$$

$$v_{av} = \sqrt{\frac{8RT}{\pi M}} = \left(\sqrt{\frac{8}{3\pi}}\right) v_{rms} = 0.92\ v_{rms}$$

Pressure exerted by gas

$$P = \frac{1}{3}\rho v_{rms}^2$$

Root mean square speed

$$v_{rms} = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3P}{\rho}} = \sqrt{\frac{3RT}{M}}$$

Mean Free Path

$$\lambda = \frac{1}{\sqrt{2}\pi n d^2} = \frac{k_B T}{\sqrt{2}\pi d^2 P}$$

Most probable speed

$$v_{mp} = \sqrt{\frac{2RT}{M}} = \left(\sqrt{\frac{2}{3}}\right) v_{rms} = 0.816\ v_{rms}$$

Relation between pressure (p) and Kinetic Energy (E)

$$E = \frac{3}{2} PV$$

Behaviour of Gases

Specific Heat Capacity

Specific Heat Capacity for an ideal gas, $C_p - C_v = R$

for monoatomic $\frac{C_p}{C_v} = \gamma = \frac{5}{3}$

for diatomic $\frac{C_p}{C_v} = \gamma = \frac{7}{5}$

for polyatomic gases, $\frac{C_p}{C_v} = \gamma = \frac{(4+f)}{(3+f)}$

Hence, f is the degree of freedom

An ideal gas satisfies equation $PV = nRT$ all pressure and temperature n = no. of moles, $R = N_A k_B$ universal gas constant

Law of Equipartition Energy

Energy associated with each degree of freedom per molecule = $\frac{1}{2}kT$

Charles's s Law

$V \propto T$ (If P = constant)

$\frac{V}{T}$ = constant

or $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Avogadro's law

Under the same condition of temperature and pressure equal volumes of all gases contain equal no. of molecules.

i.e. $N_1 = N_2$

Boyles's Law

$P \propto \frac{1}{V}$ (If T = constant)

PV = constant

or $P_1V_1 = P_2V_2$

Guy Lussac's Law

$P \propto T$ (If V = constant)

$\frac{P}{T}$ = constant

or $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Dalton's Law of partial pressure

Total pressure of a mixture of non - reacting gases,

$P = P_1 + P_2 + ... + P_n$