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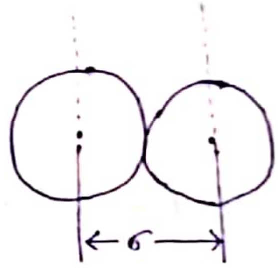
Collision Parameters :-

1). Collision diameter :-



When two non-reacting spherical molecules approaches each other, they can n't come closer together beyond a certain distance. The distance of closest approach between the centre of two molecules is known as Collision diameter. It is denoted by 'σ'.

So, for the collision between two molecules, 'σ' is the closest approach.

2). Collision Frequency :-

The number of collisions experinced by an individual molecule with other gas molecule per second (per unit time) is called Collision frequency.

Let us consider the molecule is rigid non-reacting sphere with diameter 'σ' & radius 'r'. The average velocity with which molecule moves is $\langle U_x \rangle$. This molecule Collides with other molecules with in a cylinder of radius 2r.

∴ The volume of the cylinder $= \pi \cdot (2r)^2 \langle U_x \rangle$

$$= \pi \sigma^2 \langle U_x \rangle \quad \text{—} (1)$$

If 'ρ' is the no. of molecules per cm^3 then –

Average no. of Collision per sec –

$$Z_1 = \pi \sigma^2 \langle U_x \rangle \rho \quad \text{—— (2)}$$

Where, Z_1 is the frequency with which a given molecule collides with the other.

Let, Z_{12} be the frequency of molecules of type-1 & type-2.

$$\therefore \quad Z_{12} = \pi \sigma^2 \langle U_x \rangle \rho \rho' \quad \text{—— (3)}$$

Where, ρ' is the density of molecule of type-2.

If the Collisions are between two like molecules –

$$Z_{11} = \pi \sigma^2 \langle U_x \rangle \rho^2 \quad \text{—— (4)}$$

Since,

$$\langle U_x \rangle_{rel} = \sqrt{2} \langle U_x \rangle \quad \text{—— (5)}$$

For co-relating eqⁿ – (2), (4) & (5) Correct value of Z_1 & Z_{11} are given as –

$$Z_1 = \sqrt{2} \pi \sigma^2 \langle U_x \rangle \rho$$

$$\& \quad Z_{11} = \sqrt{2} \pi \sigma^2 \langle U_x \rangle \rho^2$$

Since, each collision involves two molecule. So, Collision frequency –

$$Z_{11} = \frac{\sqrt{2} \pi \sigma^2 \langle U_x \rangle \rho^2}{2}$$

$$\boxed{Z_{11} = \frac{1}{\sqrt{2}} \pi \sigma^2 \langle U_x \rangle \rho^2}$$

But $\langle U_x \rangle = \left(\frac{8RT}{\pi M}\right)^{1/2}$

$$\therefore \quad Z_{11} = \frac{1}{\sqrt{2}} \pi \sigma^2 \sqrt{\frac{8RT}{\pi M}} \cdot \rho^2$$

$$\boxed{Z_{11} = 2\sigma^2 \rho^2 \sqrt{\frac{\pi RT}{M}}}$$

This is called Collision frequency.

③ Collision Number :-

a/c to kinetic consideration of gaseous molecule, the no. of molecule with which a single molecule will collide per unit time is given by —

$$Z_1 = \sqrt{2}\, \pi \sigma^2 \langle U_x \rangle \rho$$

Where, $\langle U_x \rangle$ is the average velocity.

ρ is the number density i.e. the no. of molecules per unit volume of the gas.

Thus, the number of collisions suffered by a single molecule per unit time per unit volume of the gas is called Collision number.

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