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* Degrees of Freedom and Maxwell's law of equipartition of Energy: —

A molecule in a gas can move along any of the three co-ordinates axis. It has three degrees of freedom. Degrees of freedom mean the number of independent variables that must be known to describe the state or the position of the body completely. A mono atomic gas molecule has three degrees of freedom. A diatomic gas molecule has three degrees of freedom of translation and two degrees of freedom of rotation. It has in all five degrees of freedom.

According to kinetic theory of gases, the mean kinetic energy of a molecule at a temperature T is given by

$$\frac{1}{2}mc^2 = \frac{3}{2}KT \quad \text{— (i)}$$

But, $c^2 = u^2 + v^2 + w^2$

As x, y and z are all equivalent, mean square velocities along the three axis are equal

$$\therefore u^2 = v^2 = w^2$$

$$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 = \frac{1}{2}mw^2$$

$$\frac{1}{2}mc^2 = 3\left[\frac{1}{2}mu^2\right] = 3\left[\frac{1}{2}mv^2\right] = 3\left[\frac{1}{2}mw^2\right]$$

$$= \frac{3}{2}KT$$

$$\therefore \frac{1}{2}mu^2 = \frac{1}{2}KT \quad \text{— (ii)}$$

$$\frac{1}{2}mv^2 = \frac{1}{2}KT \quad \text{— (iii)}$$

$$\frac{1}{2} m\omega^2 = \frac{1}{2} KT \quad \text{— (iv)}$$

Therefore, the average kinetic Energy associated with each degree of freedom = $\frac{1}{2}KT$

Thus the energy associated with each degree of freedom is $\frac{1}{2}KT$.

This represents the theorem of equipartition of energy.