P-1 Date - 26/10/2024

MTC-SEM-III Unit-1

Topic :- Maxwell - Boltzmann speed Distribution law :-

The Maxwell - Boltzmann equation for distribution of energy among the molecules of an ideal gas is give by.

$$n(E)dE = \frac{2\pi N}{(\pi KT)^{3/2}} E^{\frac{1}{2}} e^{-E/KT} dE \quad -(1)$$

A classical ideal gas is defined as an assembly of non-interacting molecules, each distinguisable from one another. Therefore, the molecules has no internal degrees of freedom all the energy of the gas molecules is completely kinetic in nature. Thus,

$E = \frac{1}{2}mv^2$, Hence $dE = mvdv$

Substituting these values of E and dE in equation (1), the number of molecules $n(v)dv$ whose speeds lie between v and $(v+dv)$ is given by

$$n(v)dv = \frac{2\pi N}{(\pi KT)^{3/2}} \cdot \left(\frac{1}{2}mv^2\right)^{\frac{1}{2}} \cdot e^{\frac{-mv^2}{2KT}} \cdot mvdv$$

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$$= \frac{2\pi N}{(\pi KT)^{3/2}} \cdot 2\left(\frac{m}{2}\right)^{3/2} v^2 e^{\frac{-mv^2}{2KT}} dv.$$

$$\Rightarrow n(v)dv = 4\pi N \left(\frac{m}{2\pi KT}\right)^{3/2} v^2 e^{-mv^2/KT} dv$$

This equation is known as the Maxwell or Maxwell-Boltzmann law of distribution of speeds among the molecules of a gas. In this $n(v)$ is the number of molecules per unit speed range.

HW

Q. Define the maxwell law of distribution of speeds among the molecules of gas.