* Distribution of velocities of gases :-

Maxwell distribution law of velocities :-

Gaseous molecules are colliding with themselves randomly their by changing the molecular velocity.

Let us consider a gas molecule of mass 'm' having a velocity component 'u'. Then, the Kinetic energy 'E' associated with this velocity component is $\frac{1}{2}mu^2$. The probability that this molecule has its velocity component between u and u+du is given by p(u). Boltzmann had shown that the probability for a molecule to have an energy 'E' was propotional to $e^{-E/KT}$.

$$p(u) \propto e^{-E/KT} \propto e^{-mu^2/2KT}$$

or $$p(u)\,du = A e^{-mu^2/2KT}\,du \qquad \text{--- (1)}$$

where, 'A' is the constant of proportionality. This constant can be evaluated by requiring that the total probability must be unity. Thus,

$$\int_{-\infty}^{+\infty} p(u)\,du = A\int_{-\infty}^{+\infty} e^{-mu^2/2KT}\,du = 1 \qquad \text{--- (2)}$$

The range of intigration $+\infty$ to $-\infty$ (velocity component u) has both magnitude and direction. This eqn – (2) is simplified as –
putting $m/2KT = a$.

$$\int_{-\infty}^{+\infty} e^{-au^2}\,du = (\pi/a)^{1/2} = \left(\frac{2\pi KT}{m}\right)^{1/2} \qquad \text{--- (3)}$$

from eqn – (2) & (3) we have
$$A(2\pi KT/m)^{1/2} = 1$$

So, $A = (m/2\pi KT)^{1/2}$ — (4)

Now substituting for A in eqn — (1) we get.

$$P(u)\,du = \left(\frac{m}{2\pi KT}\right)^{1/2} e^{-mu^2/2KT}\,du \quad \text{— (5)}$$

Eqn — (5) is called Maxwell distribution of molecular velocities in one dimension.

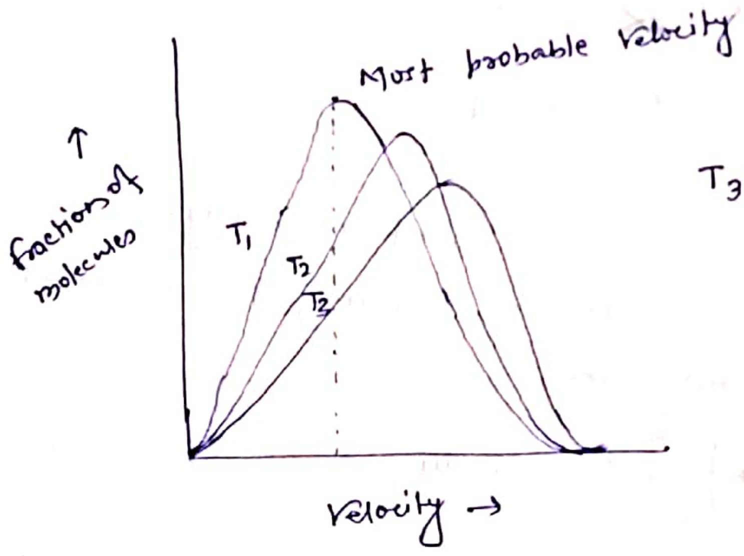
In three dimension, the eqn — (5) is written as —

$$P(c)\,dc = 4\pi\left(\frac{m}{2\pi KT}\right)^{3/2} c^2 \exp\left(-mc^2/2KT\right) dc \quad \text{— (6)}$$

or

$$\frac{dN_c}{N} = 4\pi\left(\frac{M}{2\pi RT}\right)^{3/2} c^2 \exp\left(-\frac{Mc^2}{2RT}\right) dc \quad \text{— (7)}$$

This may be plotted as:-



At higher temperature, the whole curve shifts to the right. This show that at higher temperature more molecules have higher velocity and fewer molecules have lower velocity.

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