Transport phenomena:—

According to Maxwell's law of distribution of velocity

$$dN = 4\pi N A^3 e^{-bc^2} c^2 \cdot dc \quad \text{— (i)}$$

But $4\pi c^2 \cdot dc = du \cdot dv \cdot dw$

$$\therefore dN = NA^3 e^{-bc^2} du \cdot dv \cdot dw \quad \text{— (ii)}$$

Also $c^2 = u^2 + v^2 + w^2$

$$\therefore dN = NA^3 e^{-b(u^2+v^2+w^2)} du \cdot dv \cdot dw \quad \text{— (iii)}$$

Eqn. (iii) has been modified in case of the gas as a whole possesses mass motion.

Let u_0, v_0 and w_0 be the components of the mass velocity. Therefore, the actual velocity of a molecule consists of two parts

(i) the mass velocity components u_0, v_0 and w_0

(ii) the random thermal velocity components $u - u_0$, $v - v_0$ and $w - w_0$

Corresponding to the thermal motion without mass motion, similar quantities with mass motion are

$$U = u - u_0$$
$$V = v - v_0$$
$$W = w - w_0$$

From eqn. (iii), Maxwell's law of distribution of velocity can be written as

$$dN = NA^3 e^{-b(U^2+V^2+W^2)} dU \cdot dV \cdot dW \quad \text{—(iv)}$$

Eqn (iv) holds good only if u_0, v_0 and w_0, T & N are constant through out the gas.

If the gas is not in an equilibrium state, there are three possibilities occuring singly or ~~jointing~~ jointly.

(i) The components of velocity u_0, v_0 and w_0 may not have the same value in all parts of the gas. This will result in relative motion of the gas layers with respect to one another.

There is relative velocity between different layers of the gas. This gives to rise the phenomena of viscosity.

(ii) The tempr. of the gas may not be the same through out. This results in the transference of thermal energy from regions of higher to lower temperature. This gives rise to the phenomenon of conduction.

(iii) The no. of molecules per c.c. i.e. N, may not be the same throught the volume of the gas. This results in the movement of molecules from regions of higher value of N to lower value of N. This gives rise to the phenomenon of diffusion.

From the above discussion it is clear that the transport of momentum, energy and mass ~~respect~~ represent viscosity, conduction and diffusion respectively. These are called transport phenomena. From the thermodynamic point to view, the trasport phenomena are irreversible.

The transport phenomena occur due to the thermal agitation of the molecules. The molecules in a particular layer are associated with certain values of velocity components, tempr. and molecular density. They tend to minimise the differences in u_0, v_0 and w_0, T & N. The molecules actually possess large velocities whereas these phenomena of viscosity conduction and diffusion are comparatively slow. This anomaly is explained on the fact that the molecules frequently collide. Therefore the transport phenomena are basically governed by the mean free path λ is actually transferring momentum, energy and mass through a distance λ.

The transport phenomena occur only in the non-equilibrium state of a gas.