Dr. Sanjeet Kumar
Asstt Prof.
Deptt of Physics
HSJC, VKSU, Ara
Bihar - 802301

B. Sc. II Physics Hons.

Paper - 4.

Permittivity of a gas. Variation with temperature.

When an electric field is applied to a dielectric, since the electric charges of the atoms or molecules are slightly displaced from their positions in each individual atom, an electric moment will be induced. Hence the dielectric polarisation, and with it the dielectric constant, should depend only on the number of displaced charges, i.e, on the density of the material. If the temperature of the dielectric is changed, it should result in the change in density only of the material. However, the dependence of dielectric constant on the temperature cannot be accounted for on the density changes only.

Debye suggested that many substances have permanent dipoles in which, in the absence of an external field, the axes of their molecules are oriented at random. When a field is applied these dipoles, like elementary magnets, line up in the direction of the field. This produces a polarisation in the dielectric.

If p' = electric dipole moment of each molecules of a gaseous dielectric, E = electric field applied, then

$$p' \propto E \quad \text{or} \quad p' = lE$$

where l is a constant depending on the dielectric.

If there are n molecules per unit volume, and P = polarisation. Then

$$np' = P = nlE. \quad \text{---} \quad (6)$$

According to Debye, since a polar molecule has a definite electric moment even before the application of E, the action of E is

(a) to align the molecules along E.

(b) to cause displacement of the electrons in each atom relative to the molecules and suggested that

$$l = l_1 + l_2.$$

where l_1 is the contribution of the induced dipoles caused by E, and l_2 the contribution due to orientation due to orientation of permanent electric moments of the molecules. Debye said that l_2 depends on the temperature of the dielectric, on account of the thermal agitation of the molecules; the polarisation and hence K becomes smaller with the increase in temperature; for as temperature rises, the molecules will be less liable to orientation. For non-polar compounds K is constant.