From equations (1) and (2)

$$2.54 \times 10^{24}\,\alpha = \frac{D_0 - 1}{3} \times 22400$$

$$\therefore \qquad \alpha = 2.94 \times 10^{-21}(D_0 - 1) \qquad \text{... (3)}$$

Again if a conducting sphere of radius r be placed in an electric field of intensity χ, the induced electric moment (induced dipole moment) would be

$$\mu_i = r^3 \cdot \chi$$

Since $\qquad \mu_i = \alpha \cdot \chi$

Hence $\qquad \alpha \cdot \chi = r^3 \chi$

$$\therefore \qquad \alpha = r^3 \qquad \text{... (4)}$$

From equations (3) and (4), we get

$$r^3 = 2.94 \times 10^{-21}\,(D_0 - 1)$$

$$\therefore \qquad r = [2.94 \times 10^{-21}\,(D_0 - 1)]^{1/3}\ \text{cm}$$

$$= [2.94\,(D_0 - 1)]^{1/3} \times 10^{-7}\ \text{cm}$$

It is thus easy to obtain radius of a spherical molecule from polarizability or dielectric constant. The result will however be approximate in view of liberal assumptions made. Thus, for hydrogen molecule from dielectric constant relation, the radius comes to be 0.92 Å, while from viscosity measurements it is 1.09 Å.

6. APPLICATIONS OF DIPOLE MOMENT

The following are the main application of dipole moment :

(*i*) **Determination of Molecular Structure.** Dipole moment gives the following valuable informations regarding molecular structure of the compounds :

(*a*) Percentage of ionic character in the bond.

(*b*) Geometry of molecules, especially the bond angles and symmetry of the molecules.

(*a*) **Calculation of Percentage of Ionic Character in the Bond.** Chemical bonding between two atoms is necessarily associated with an electrical moment arising out of the difference in the electronegativity of the two atoms. This means that every bond carries with it an electrical moment called the *bond moment* or *bond dipole*. The dipole moment of a molecule is vectorial sum of individual bond moments present in the molecule. The bond dipole moment gives information regarding the extent to which bond is permanently polarized, *i.e., the extent of ionic character in the bond.* How the bonding electrons are located and shared between the two atoms can be somewhat assessed from the calculations of dipole moment. This can be illustrated by taking following examples :

1. HCl has dipole moment 1.07 D and bond length 1.275 Å. If we suppose that HCl is completely ionized *i.e.*, the pair of bonding electrons is completely held by chlorine atom, then H will carry a charge of + 1 electron unit and Cl atom will have a charge of – 1 electron unit.

Now 1 electron unit charge $= 4.8 \times 10^{-10}$ esu

Distance between positive and negative charge centres $= 1.275$ Å

$= 1.275 \times 10^{-8}$ cm

Expected (calculated) dipole moment $= (4.8 \times 10^{-10})\,(1.275 \times 10^{-8})$ esu-cm

$= 6.05 \times 10^{-8}$ esu-cm

$= 6.05$ debye

But, observed dipole moment $= 1.07$ debye