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B.Sc II Physics Hons
Paper - 4

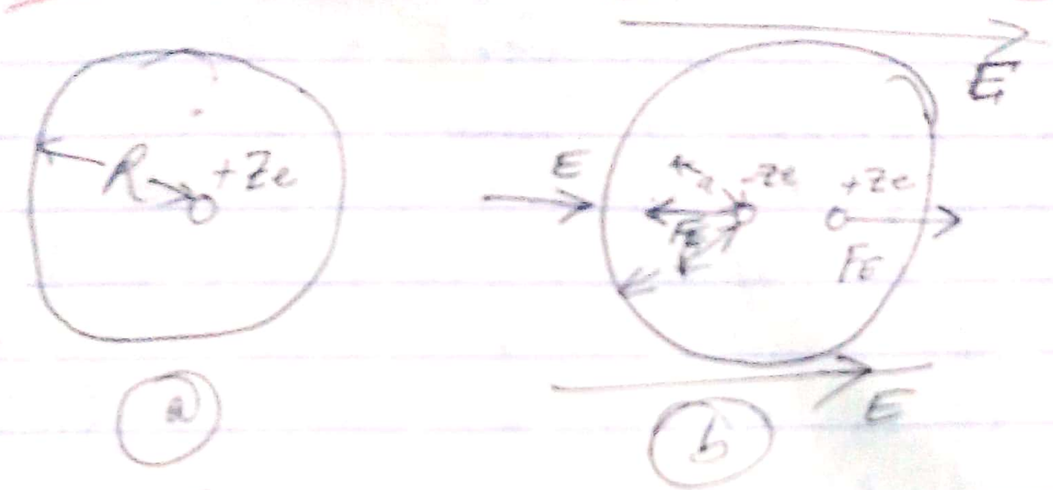

Fig ② An atom becomes an induced dipole when placed in an electric field.

Since an atom consists of a +ive nucleus with a 'cloud' of −ive charge around it, the total charge in the cloud equals the +ive charge on the nucleus. When an atom experiences an electric field E, the two charges tend to separate moving in opposite directions thus producing an induced electric dipole. If the charge on the nucleus is Ze, where Z = atomic number and e = electron charge, if a = distance between the nucleus and centre of the electron 'cloud', the dipole moment of the atom is $p = Zea$. If we assume that the −ive charge is uniformly distributed within a sphere of when the force on the nucleus and on the electron cloud equals the Coulomb attraction between the two parts of the atom.

Now inside a uniform spherical shell of charge, the intensity is zero, but outside the spherical shell the electric intensity is the same as if the charge is concentrated at the centre of the shell. Hence the nucleus will experience a Coulomb force due to the sphere of -ive charge of radius a, fig. 2(B). This -ive charge is a fraction a^3/R^3 of the total -ive charge $-Ze$.

$$\therefore \quad ZeE = \frac{(Ze)^2 \, a^3/R^3}{4\pi\epsilon_0 a^2} \quad \text{--- (1)}$$

$$= \frac{q}{\epsilon_0 A}.$$

where q is the induced charge and A = area of the surface of the dielectric; and the dipole moment $p_m = Zea = 4\pi\epsilon_0 R^3 E$, which shows that the induced dipole moment of an atom is proportional to the strength of the applied field.