ECE.305

Dielectrics Vs Insulators:

Dielectrics → store the Electric charge Capacitor.

Insulators → Block the Electric charge.

Dielectric material / Dielectrics

Polarisation of charge → P

↳ Polarizibility α

$P \propto E$

$P = \alpha E$

Electric dipole Moment When two equal & opposite small charges are placed at a small distance then electric dipole is formed.

Electric dipole moment is given by

$p = q \times d$

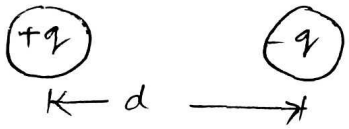
↓ Electric dipole Moment

↓ unite Coulomb-metre

↳ Another unite is

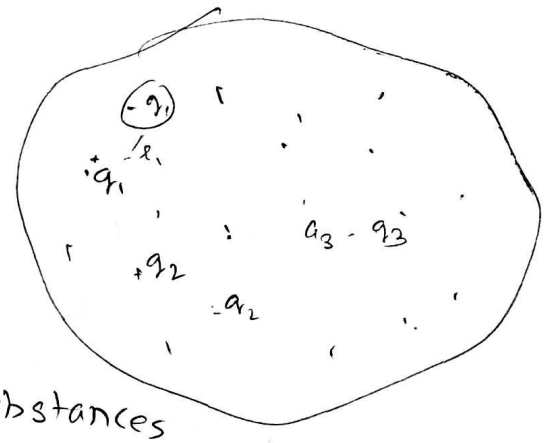
Debyee =

1 Debyee = 3.33×10^{-3} Coulomb-metre



Total polarisation

$$\vec{P} = \sum_{i=1}^{n} q_i' r_i'$$



Dielectrics Materials & Polarisation:-

"Dielectric materials are these materials or substances which does not have free electrons but their behavieris changed by application of electric field."

"Electric dipole moment per unit volume is called polarisation of dielectrics." Polarisation is represented by P and given by.

$$P = \frac{\vec{p}}{v}$$

$P = p/v =$

unit of polarisation is Coulomb/m^2 Polarisation is occure due to electric dipole moment.

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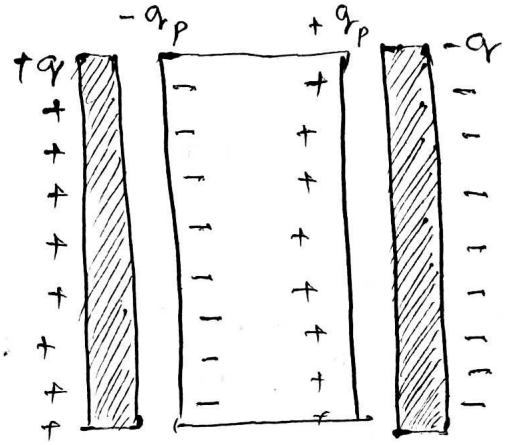
Dielectric Constant & displacement vector :- Let us consider a dielectric material is placed between plates of parallel plate capacitor. How the dielectric is polarised and net effect of presence of dielectric reduce the electric field.



The Resultant electric field given by

$$E = E_0 - E_p \quad \text{.....(i)}$$

E_0 = Electric field in the absence of dielectric

E_p = Electric field developed due to polarisation of dielectric

The dielectric constant also called relative permittivity and given as bellow-

$$\epsilon_r = \frac{\text{Field in Vacuume}}{\text{Field in dielectric}} = \frac{E_0}{E} = \frac{q/4\pi\epsilon_0 r^2}{q/4\pi\epsilon r^2}$$

$\epsilon_r = \frac{\epsilon}{\epsilon_0}$, Dielectric Constant is the ratio of permittivity of medium to Permittivity of Free Space. $\epsilon_r = 1 + \chi_e$

$$\epsilon = \epsilon_0 \epsilon_r \quad \text{.....(ii)}$$

ϵ_r is also given as $\epsilon_r = 1 + \chi_e$

$$\epsilon = \epsilon_0(1 + \chi_e)$$

Permittivity of material, χ_e = Electrical Susceptibility. The electric displacement vector $\vec{D}$ is defined as bellow:-

$$\vec{D} = \frac{1}{4\pi} \frac{q\vec{r}}{r^3} \quad \text{.....(iii)}$$

$$\vec{E} = \frac{1}{4\pi\epsilon} \frac{q\vec{r}}{r^3} \quad \text{.....(iv)}$$

Deviding (iii) by (iv) we get-

$$\frac{\vec{D}}{\vec{E}} = \epsilon$$

$$\vec{D} = \epsilon\vec{E}$$

$$= \epsilon_0 \epsilon_r \vec{E}$$

$$\vec{D} = \epsilon_0(1 + \chi_e)\vec{E}$$

$$= \epsilon_0 E + \epsilon_0 \chi_e E$$