

Relation between E, P and D

$$E = \text{Electric field intensity} = \frac{F}{q}$$

$$P = \text{Polarization vector} = \frac{q'}{A}$$

$$D = \text{Displacement vector} = \frac{q}{A}$$

According to Gauss law in dielectrics

$$\oint \vec{E} \cdot d\vec{s} = \frac{q - q'}{\epsilon_0} \quad \left| \quad \phi = \frac{q}{\epsilon_0}$$

$$\epsilon_0 E A = q - q'$$

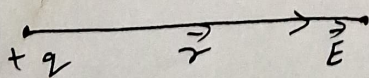
$$\epsilon_0 E = \frac{q}{A} - \frac{q'}{A}$$

$$\epsilon_0 E = D - P$$

$$\therefore D = P + \epsilon_0 E$$

Electric Displacement vector

Electric displacement vector is a new electric field vector that depends only on charge distribution & does not depend on medium



A horizontal line with a dot at the left end labeled '+q'. An arrow labeled 'r' points to the right from the dot. Further to the right, another arrow labeled 'E' points to the right.

$$\vec{E} = \frac{1}{4\pi\epsilon_0} k \frac{q}{r^2} \hat{r}$$

$$\epsilon_0 = \text{Permittivity of free space} \\ = 8.85 \times 10^{-12} \text{ N m}^2/\text{C}^2$$

$K =$ Dielectric constant

$$\vec{E} = \frac{1}{4\pi\epsilon} \frac{q}{r^2} \hat{r} \quad \text{--- (1)}$$

$\epsilon \Rightarrow$ Permittivity of medium

Air $K = 1$

$$\epsilon \vec{E} = \frac{1}{4\pi} \frac{q}{r^2} \cdot \hat{r} = \vec{D}$$

Displacement vector