Relation between E, P and D

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

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

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

According to Gauss law in dielectrics

$$\oint \vec{E} \cdot \vec{ds} = \frac{q - q'}{\varepsilon_0} \qquad \Big| \; \phi = \frac{q}{\varepsilon_0}$$

$$\varepsilon_0 E A = q - q'$$

$$\varepsilon_0 E = \frac{q}{A} - \frac{q'}{A}$$

$$\varepsilon_0 E = D - P$$

$$\boxed{\therefore D = P + \varepsilon_0 E}$$

Electric Displacement vetor

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

$$+q \xrightarrow{\vec{r}} \vec{E}$$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0 k} \frac{q}{r^2} \hat{r}$$

ε_0 = Permittivity of free space

$= 8.85 \times 10^{-12}\ Nm^2/C^2$

K = Dielectric constant

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

$\varepsilon \rightarrow$ Permittivity of medium

Air $K = 1$

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

Displacement vector