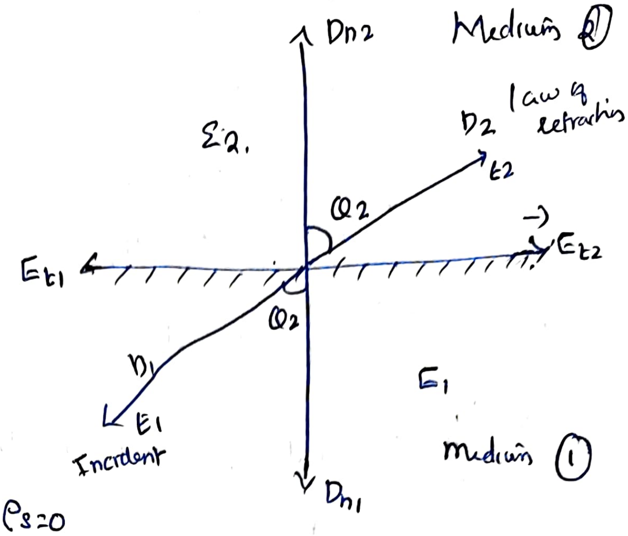
Reflection & Refraction at the Boundary:



→ The normal component of 'D'

$D_{n1} = D_1 \cos\theta_1$

$D_{n2} = D_2 \cos\theta_2$

→ tangential component of 'E'

$E_{t1} = E_1 \sin\theta_1$

$E_{t2} = E_2 \sin\theta_2$.

Apply boundary conditions with $\rho_s = 0$

$E_{t1} = E_{t2}$ & $D_{n1} = D_{n2}$

$E_1 \sin\theta_1 = E_2 \sin\theta_2 \rightarrow (1)$

$D_1 \cos\theta_1 = D_2 \cos\theta_2 \rightarrow (2)$

Eqn (1) ÷ (2).

$$\frac{E_1 \sin\theta_1}{D_1 \cos\theta_1} = \frac{E_2 \sin\theta_2}{D_2 \sin\theta_2}.$$

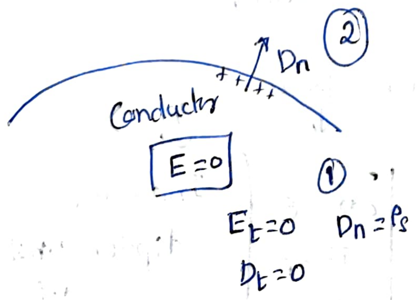
$D = \varepsilon_0 E_1$

$\varepsilon_0\varepsilon_1 = \varepsilon_0\varepsilon_2$

$$\frac{E_1}{\varepsilon_0\varepsilon_1 E_1}\tan\theta_1 \Rightarrow \frac{E_2}{\varepsilon_0\varepsilon_2 E_2}\tan\theta_2$$

$$\frac{\tan\theta_1 \text{ (Incident)}}{\tan\theta_2 \text{ (Refract)}} = \frac{\varepsilon_1}{\varepsilon_2}$$ law of refraction.

Conductor - Dielectric Boundary conditions:



Under static conditions.

(i) E = 0 inside the conductor

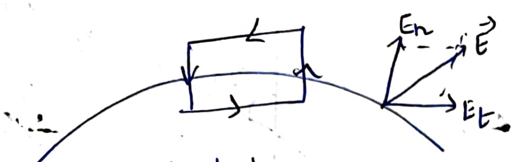
(ii) At the surface,

$D_t = 0$ & $D_n = \rho_s$

* Conductor – Free space boundary conditions:

$\varepsilon_r = 1$.

Free space. ②



Conductor

$E = 0$ ①

→ The tangential component of $\vec{E}$ is zero at the boundary

$E_t = 0$ & $D_t = 0$

$D_t = \varepsilon E_t$
$\downarrow \quad \downarrow$
$0 \quad\quad 0$

→ Only D_n and E_n exist at the boundary (i.e.) always in perpendicular direction

$D_n = \rho_s$

$E_n = \frac{\rho_s}{\varepsilon_0}$

if $\rho_s \neq 0$, $= 0$

$\varepsilon_r = 1$ for free space.

Dielectrics in Static Electric Field:

Dielectrics:

$\frac{\sigma}{\omega_E} \ll 1$

σ → conducting

ω_E → dielectric constant.

$\varepsilon \gg \sigma$

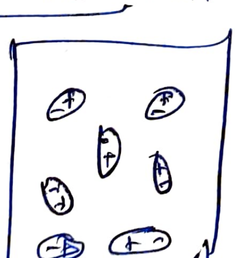
- → Do not contain free electrons.
- → The charges in a dielectric are tightly bounded.
- → Ex: Rubber, ceramic, wood, etc.
- → It can be polarized by an applied electric field.
- → When a dielectric material is placed in an electric field, charges shift from their positions.

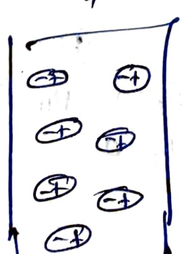
Structure of dielectric

→ Polar molecules

→ Non-polar.

Polar molecules.





(+). ⇒ Individual dipoles cancel each other.