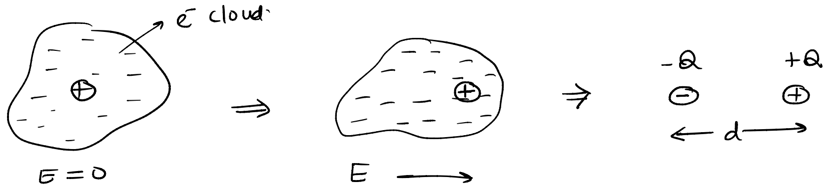
Lecture - 10

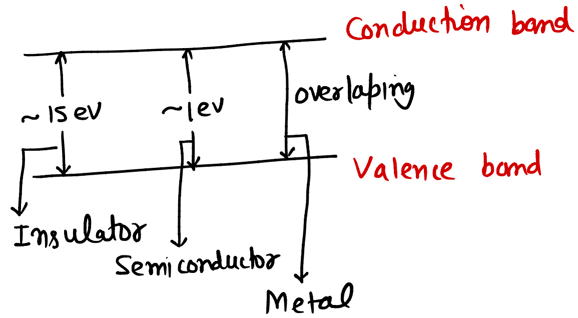
24/08/2023.

Insulator ⇒ The atoms of insulator have titely bound electrons which can not move radily.

Ex ⇒ glass, rubber etc



Effect of external Electric field.



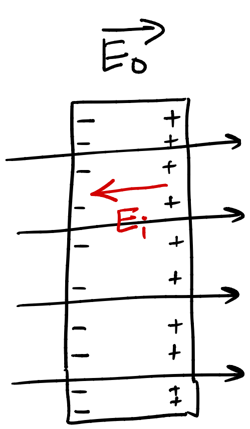
* Conductor (Metallic) ⇒ They have one or more free electrons per atom that can move freely through the material.

Ex ⇒ Copper, Aluminum, Gold etc.

* A perfect conductor should contain unlimited supply of free electrons.

Properties of conductor ⇒

(1) ⇒ Inside a conductor $\overline{E} = 0$ [Static Equilibrium]



* When we apply external electric field, the free $\bar{e}$ move in the opposite direction.
* The charges pile up, these induced charges produce their own field E_i, which is in the opposite direction to E_0.
* The field of induced charges tends to cancel the origional field.
* The charge continue to flow until this cancellation is complete.

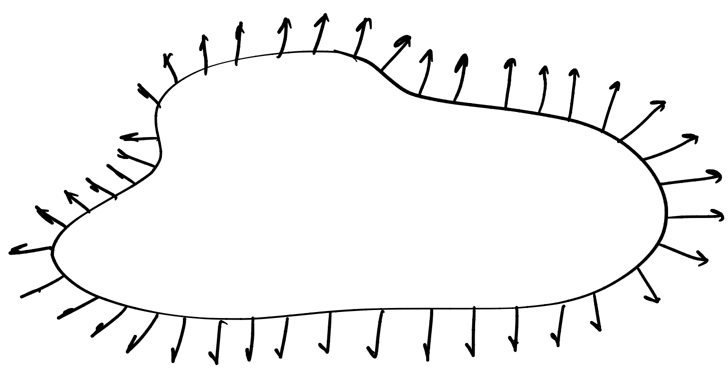
* The resultant field therefore inside the consuctor is preciely zero.

(ii) → <u>Inside a conductor</u> ⇒ $\nabla \cdot E = \rho/\varepsilon_0$, $\rho = 0$.

Net charge density in the interior is zero.

(iii) ⇒ <u>The surface of conductor is equipotential</u> ⇒ If there are some pot. difference b/w two points of conductor, then charges will flow within conductor to make the pot. same.

(iv) ⇒ <u>$\bar{E}$ is $\perp^{ar}$ to the surface</u> ⇒



<u>Boundary Conditions</u> ⇒

The conditions that the field must satisfy at the interface seperating two media.

(i) Dielectric (ε_1) & dielectric (ε_2)

(ii) Conductor & dielectric.

(iii) Conductor & free space.

* We need to use the following Maxwell eqn -

① $\oint E \cdot dl = 0$ &

$\nabla \times E = 0$

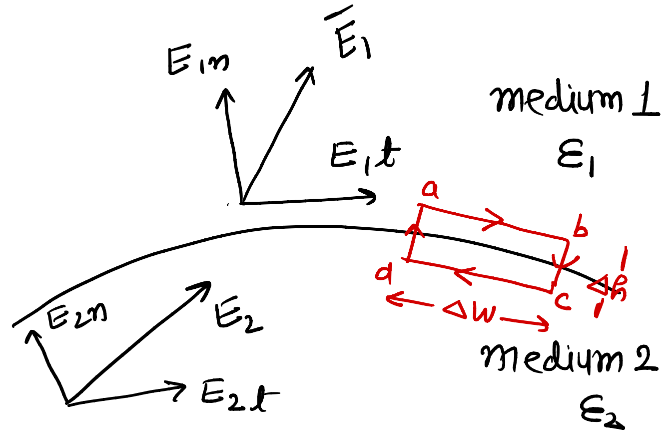
② $\oint D \cdot ds = Q_{enclosed}$.

$\nabla \cdot D = \rho$

(i) ⇒ Dielectric – Dielectric B.C ⇒

* Consider the $\bar{E}$ field existing in a region that consists of two dielectric media.

* How do the electric field change from one dielectric to other?



$$\oint E \cdot dl = 0$$

$$E_{1t}\Delta w - E_{1n}\cancel{\frac{\Delta h}{2}} - E_{2n}\cancel{\frac{\Delta h}{2}} - E_{2t}\Delta W + E_{2n}\cancel{\frac{\Delta h}{2}} + E_{1n}\cancel{\frac{\Delta h}{2}} = 0$$

$$E_{1t}\cancel{\Delta w} = E_{2t}\cancel{\Delta w}$$

$$\boxed{E_{1t} = E_{2t}}$$

Tangential component of Electric field are continuous across the interface.

* $D = \epsilon E \Rightarrow E = \frac{D}{\epsilon}$

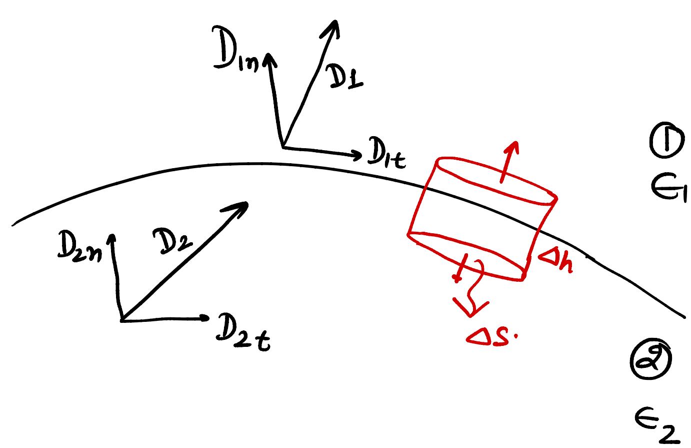
$$\frac{D_{1t}}{\epsilon_1} = \frac{D_{2t}}{\epsilon_2}$$

Tangential component of D is Discontinuous across the interface.

* $\oint D \cdot d\bar{s} = q_{enclosed}$

$$D_{1n}\Delta S - D_{2n}\Delta S = \sigma \Delta S$$

$$\therefore D_{1n} - D_{2n} = \sigma$$



§ If no free charges exist at the interface i.e. charges are not deliberately place, $\sigma = 0$

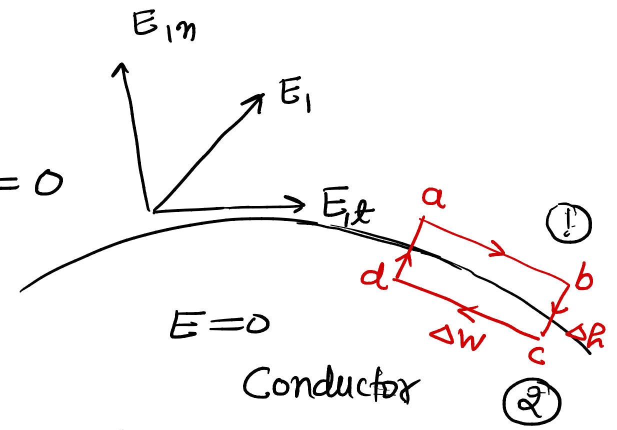
$$\therefore \boxed{D_{1n} = D_{2n}}$$

Thus normal component of D is continious across the interface.

* $D = \epsilon E \Rightarrow \epsilon_1 E_{1n} = \epsilon_2 E_{2n}$

Normal component of E is discontinious at the boundary.

(ii) ⇒ Conductor - Dielelectric B.C :→



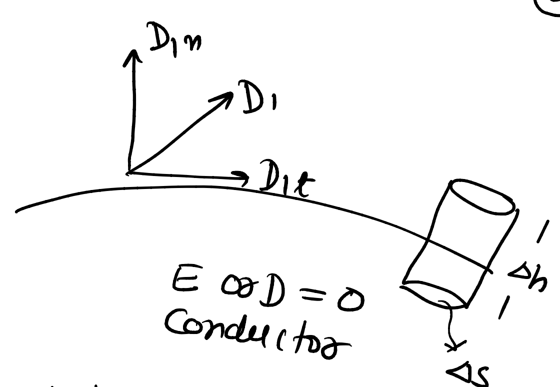
$$\oint E \cdot dl = 0$$

$$E_{1t} \Delta W - \cancel{E_{1n} \frac{\Delta h}{2}} + 0 + 0 + 0 + \cancel{E_{1n} \frac{\Delta h}{2}} = 0$$

$$E_{1t} = 0$$

$$E_t = 0$$

$$\oint D \cdot ds = q_{enclosed}.$$



$$D_{1n} \Delta S = \sigma \Delta S$$

$$D_{1n} = \sigma = \epsilon E_{1n}$$

(iii) ⇒ Conductor - Free space B.C :→

This is special case of conductor - dielectric.

$$E_t = 0$$

$$D_n = \sigma = \epsilon_0 E_n$$