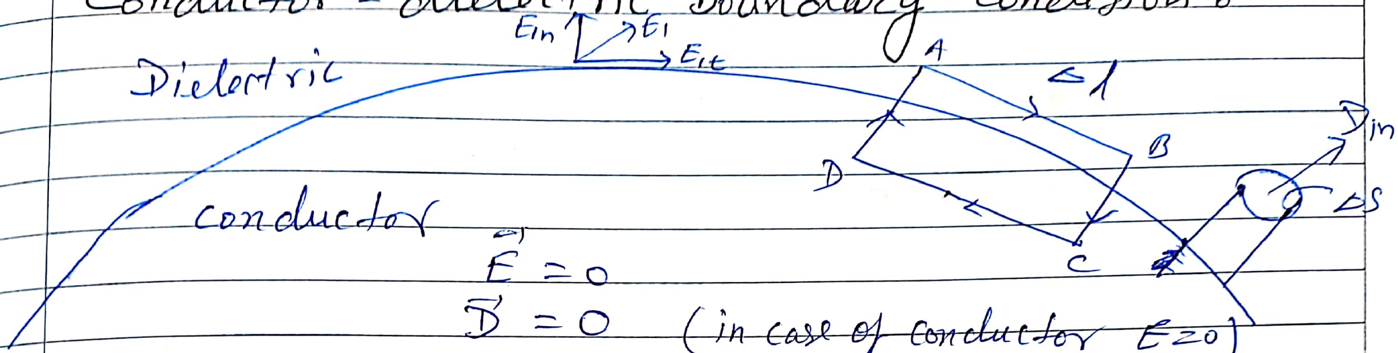
Conductor - dielectric boundary condition :→



$\vec{E} = 0$

$\vec{D} = 0$ (in case of conductor $E = 0$)

$$\oint \vec{E} \cdot \vec{dl} = 0$$

$$\int_A^B \vec{E} \cdot \vec{dl} + \int_B^C \vec{E} \cdot \vec{dl} + \int_C^D \vec{E} \cdot \vec{dl} + \int_D^A \vec{E} \cdot \vec{dl} = 0$$

$$E_{1t}\,\Delta l - \cancel{E_{in}\frac{\Delta h}{2}} + 0 + 0 + 0 + \cancel{E_{in}\frac{\Delta h}{2}} = 0$$

$$E_{1t}\,\Delta l = 0.$$

$E_{1t} = 0$ tangential component is zero.

$D_{1t} = 0$ tangential component of D is zero.

$E_{2t} = 0$

$D_{2t} = 0$

$$\int \vec{D} \cdot \vec{dS} = Q$$

$$D_{in}\,\Delta S = \sigma\,\Delta S$$

$D_{in} = \sigma$ Discontinuous.

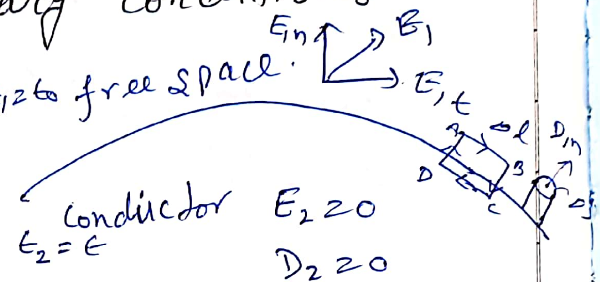
$$\epsilon E_{in} = \sigma$$

$$E_{in} = \frac{\sigma}{\epsilon}$$

Conductor free space boundary condition:

$E_{2t} = 0$, $D_{2t} = 0$

$E_{2n} = 0$, $D_{2n} = 0$



$D_{1n} = \sigma$

$D_{1n} = \sigma$

$\epsilon_0 E_{1n} = \sigma$

$$\boxed{E_{1n} = \frac{\sigma}{\epsilon_0}}$$

$$\boxed{E_{1t} = 0}$$

$$\boxed{D_{1t} = 0}$$

$$\int_A^B \vec{E}\cdot d\vec{l} + \int_B^C \vec{E}\cdot d\vec{l} + \int_C^D \vec{E}\cdot d\vec{l} + \int_D^A \vec{E}\cdot d\vec{l} = 0$$

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

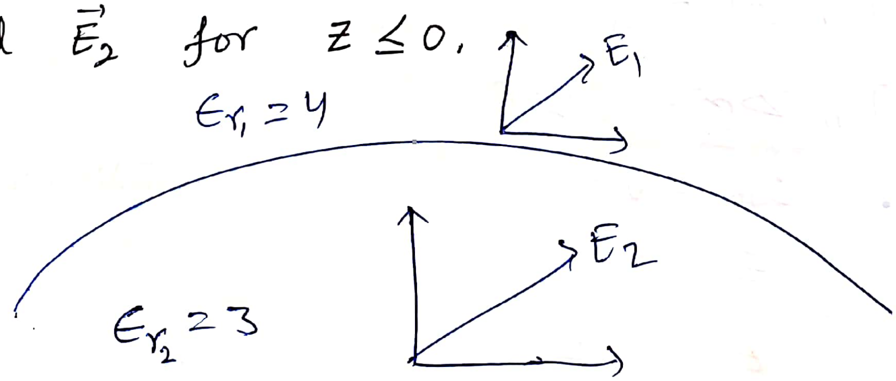
$E_{1t}\,\Delta l = 0$

$E_{1t} = 0$.

Q. Two extensive homogeneous dielectric metal on the plane $Z \geq 0$, $\epsilon_{r_1} = 4$ and for $Z \leq 0$ $\epsilon_{r_2} = 3$, A uniform electric field is given as

$\vec{E_1} = 5\,\hat{a}_x - 2\,\hat{a}_y + 3\,\hat{a}_z \ \frac{KV}{m}$ exist for $z \geq 0$

Find $\vec{E_2}$ for $z \leq 0$.



$\vec{E_1} = 5\hat{a}_x - 2\hat{a}_y + 3\hat{a}_z$

$\vec{E_1} = \vec{E}_{1n} + \vec{E}_{1t}$

$\vec{E}_{1n} = (E_1 \cdot \hat{a}_z) \cdot \hat{a}_z$

$\vec{E}_{1n} = 3\hat{a}_z$

$\vec{E}_{1t} = \vec{E_1} - \vec{E}_{1n}$

$\vec{E}_{1t} = 5\hat{a}_x - 2\hat{a}_y + \cancel{3\hat{a}_z} - \cancel{3\hat{a}_z}$

$\vec{E}_{1t} = 5\hat{a}_x - 2\hat{a}_y$

we know $\vec{E}_{1t} = \vec{E}_{2t}$

So $\vec{E}_{2t} = 5\hat{a}_x - 2\hat{a}_y$

$D_{1n} = D_{2n} \Rightarrow \epsilon_1 \vec{E}_{1n} = \epsilon_2 \vec{E}_{2n}$

$\epsilon_1 = \epsilon_0 \epsilon_{r_1}$

$\epsilon_2 = \epsilon_0 \epsilon_{r_2}$

$\cancel{\epsilon_0} \epsilon_{r_1} \vec{E}_{1n} = \cancel{\epsilon_0} \epsilon_{r_2} \vec{E}_{2n}$

$4\vec{E}_{1n} = 3\vec{E}_{2n}$

$\vec{E}_{2n} = \frac{4}{3}\vec{E}_{1n}$

$\vec{E}_{2n} = \frac{4}{\cancel{3}}(\cancel{3}\hat{a}_z)$

$\boxed{\vec{E}_{2n} = 4\hat{a}_z}$

$\vec{E_2} = \vec{E}_{2n} + \vec{E}_{2t}$

$\vec{E_2} = 4\hat{a}_z + 5\hat{a}_x - 2\hat{a}_y$

$\boxed{\vec{E_2} = 5\hat{a}_x - 2\hat{a}_y + 4\hat{a}_z}$

Ans.