Physics

Cartesian Coordinate (x, y, z)

$dl = x\,dx + y\,dy + z\,dz$

$dA_x = dy\,dz$, $dA_y = dx\,dz$, $dA_z = dx\,dy$

$dV = dx\,dy\,dz$

Cylindrical Coordinate (r, ϕ, z)

$dl = r\,dr + \phi\, r\,d\phi + z\,dz$

$\cancel{dA_r =}\; dS_r = dl_\phi\, dl_z$, $dS_\phi = dr\,dz$

$dS_z = r\,dr\,d\phi$

$dV = r\,dr\,d\phi\,dz$ $\qquad 0 < r < \infty$, $0 < \phi < 2\pi$, $0 < z < \infty$

Spherical Coordinate (r, θ, ϕ)

$\cancel{dl = r\,dl + \theta\,dl_\theta +}$

$0 < r < \infty$

$0 < \theta < \pi$

$0 < \phi < 2\pi$

$dl = r\,dr + \theta\, r\,d\theta + (r\sin\theta)\,\phi\,d\phi$

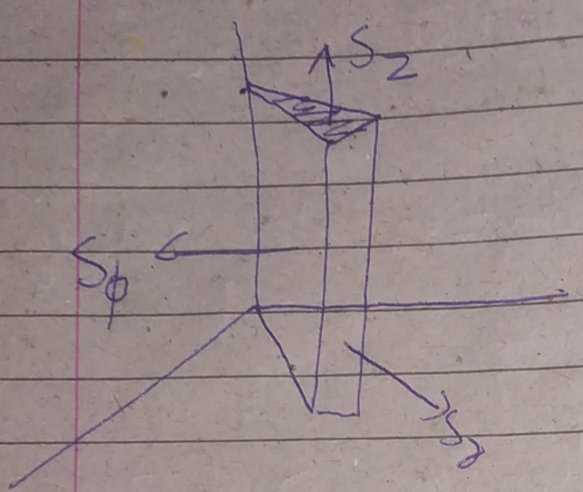
$dS_r = r^2 \sin\theta\,d\theta\,d\phi$

$dS_\theta = r\sin\theta\,dr\,d\phi$

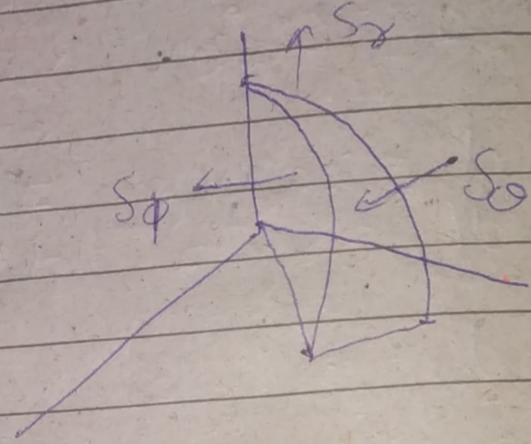
$dS_\phi = r\,dr\,d\theta$

$dV = r^2 \sin\theta\,dr\,d\theta\,d\phi$

Cylinder



Sphere



Interdependence of Electric & Magnetic

A moving electric charge produces magnetic fields

Changing magnetic fields move electric charges

Electromagnetism: A fundamental interaction between the magnetic field & the presence & motion of an electric charge

Gradient, Divergence & Curl

Coordinate System

Gradient: $\nabla = \frac{\partial}{\partial x} + \frac{\partial}{\partial y} + \frac{\partial}{d z}\hat{k}$

Divergence:

$$\nabla \cdot V = \frac{\partial V_z}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z}$$

Curl: $\nabla \times V = \left(\frac{\partial V_z}{\partial y} - \frac{\partial V_y}{\partial z}\right)\hat{i} + \left(\frac{\partial V_x}{\partial d z} + \frac{\partial V_z}{\partial V_x}\right)\hat{j}$

$$+ \left(\frac{\partial V_y}{\partial x} - \frac{\partial V_x}{\partial y}\right)\hat{k}$$

Cylindrical Coordinate

Gradient $=$ ~~V_r~~ $\frac{\partial}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial}{\partial \phi}\hat{\phi} + \frac{\partial}{\partial z}\hat{z}$

Divergence $= \frac{1}{r}\frac{\partial}{\partial r}(\partial V_r) + \frac{1}{r}\frac{\partial V_\phi}{\partial \phi} + \frac{\partial V_z}{\partial z}$

Curl $= \left(\frac{1}{r}\frac{\partial V_z}{\partial \phi} - \frac{\partial V_\phi}{\partial z}\right)\hat{r} + \left(\frac{\partial V_r}{\partial z} - \frac{\partial V_z}{\partial r}\right)\phi$

$$+ \frac{1}{r}\left(\frac{\partial}{\partial r}(\partial V_\phi) - \frac{\partial V_r}{\partial \phi}\right)\hat{z}$$

Spherical

Gradent $\Rightarrow \frac{\partial}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial}{\partial \theta}\hat{\theta} + \frac{1}{r\sin\theta}\frac{\partial}{\partial \phi}\hat{\phi}$

Divergence $= \frac{1}{r^2}\left(\frac{\partial(r^2 V_r)}{\partial r}\right) + \frac{1}{r\sin\theta}\frac{\partial(\sin\theta V_\theta)}{\partial \theta} + \frac{1}{r\sin\theta}\frac{\partial V_\phi}{\partial \phi}$

Curl $\Rightarrow \frac{1}{r\sin\theta}\left(\frac{\partial}{\partial \theta}(\sin\theta V_\phi) - \frac{\partial V_\theta}{\partial \phi}\right)\hat{r} + \frac{1}{r}\left(\frac{1}{\sin\theta}\frac{\partial V_r}{\partial \phi} - \frac{\partial(rV_\phi)}{\partial r}\right)\hat{\theta}$

$+ \frac{1}{r}\left(\frac{\partial}{\partial r}(rV_\theta) - \frac{\partial V_r}{\partial \theta}\right)\hat{\phi}$

Gauss Divergence Theorem : $\int_V \overline{\nabla}\cdot V\, dV = \oint V\cdot ds$

Stokes Curl Theorem $\int_S (\overline{\nabla}\times V)\cdot ds = \oint_l V\cdot dl$

Electrostats

$$F = \frac{kq_1q_2}{r^2}$$

$$\boxed{\begin{aligned} k &= 9\times10^9 \\ k &= \frac{1}{4\pi\epsilon_0} \end{aligned}}$$

Electric flux

=> No of electric field lines through a surface

$$\phi = E.A\cos\theta$$

Gauss's law

$$\phi_{net} = \oint E\cdot dA = \frac{Q_{enc}}{\epsilon_0}$$ (Integral form

$$\boxed{\nabla\cdot\vec{E} = \frac{\rho}{\epsilon_0} \quad \& \quad \nabla\cdot\vec{D} = \rho}$$

Derivation of gauss law by Coloumb's law

↳ pg-34

Conducting Sphere

At Surface $E_S = \frac{1}{4\pi\epsilon_0} \times \frac{q}{R^2}$

At Inside $E_i = 0$

At Outside

$E_0 = \frac{1}{4\pi\epsilon_0} \times \frac{q}{r^2}$

where r = distance from centre

Non-Conducting Sphere

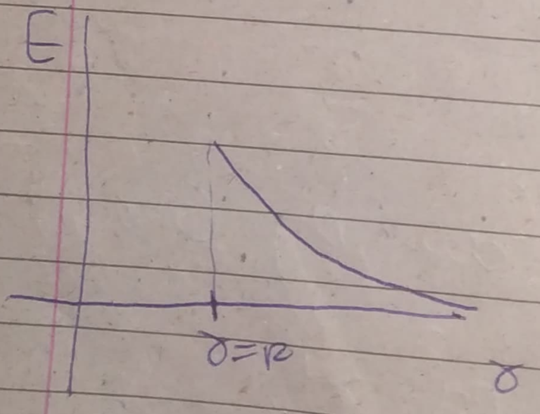
$E_0 = \frac{1}{4\pi\epsilon_0} \times \frac{q}{r^2}$

$E_S = \frac{1}{4\pi\epsilon_0} \times \frac{q}{R^2}$

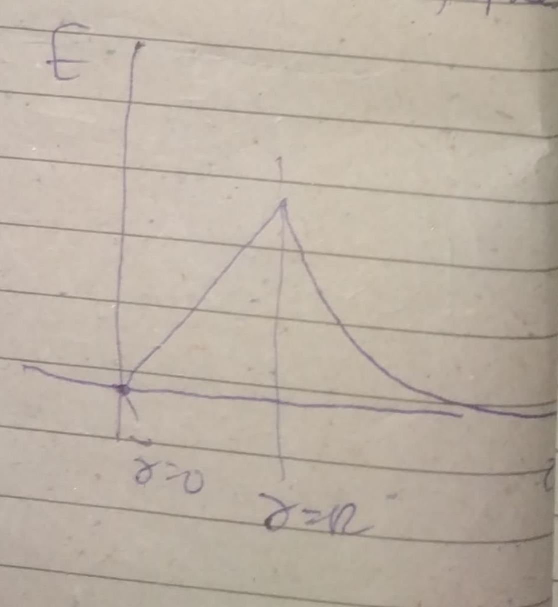
$E_i = \frac{q}{4\pi\epsilon_0} \times \frac{r}{R^3}$

Graph

Conducting Sphere



Non-Conducting Sphere



Solid Sphere

$$E_0 = \frac{KR}{\epsilon_0 r_0^2}\hat{r}$$

$$E_s = \frac{K}{\epsilon_0 R}\hat{r}$$

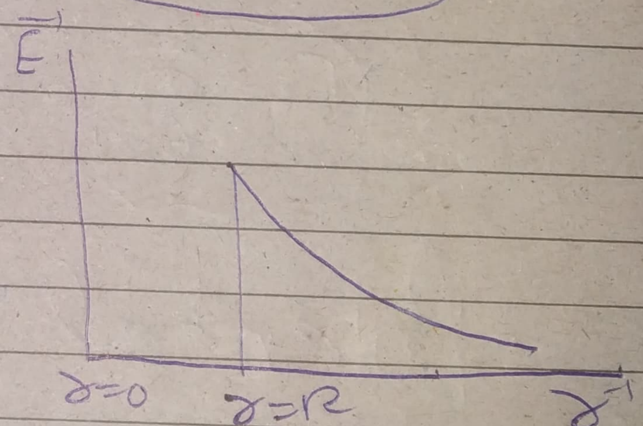
$$E_i = \frac{K}{\epsilon_0 r_i}\hat{r}$$

Conducting Cylinder

$$E_0 = \frac{1}{2\pi\epsilon_0} \times \frac{q}{r \times l}\hat{r}$$

$$\boxed{E_i = 0}$$

$$E_s = \frac{1}{2\pi\epsilon_0} \times \frac{q}{R \times l}$$



Non-Conducting Cylinder

$$E_0 = \frac{1}{2\pi\epsilon_0} \times \frac{q}{r \cdot l}$$

$$E_i = \frac{q}{2\pi\epsilon_0 l} \times \frac{r}{R^2}\hat{r}$$

$$E_s = \frac{1}{2\pi\epsilon_0} \times \frac{q}{R \times l}$$

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Infinite long charge density (λ)

$$E = \frac{\lambda}{2\pi r \epsilon_0}$$

Infinite plane sheet of charge

$$E = \frac{\sigma}{2\epsilon_0}$$

Electric field just outside the surface of charged conductor

$$\boxed{E = \frac{\sigma}{\epsilon_0}}$$

Potential

$\vec{E} = -\vec{\nabla} V$ $\left(V = -\int_a^b E \cdot dl\right)$

$\oint E \cdot dl = 0$ (only in Electrostatic condition (No magnetic field)

↳ So, using Stokes law

$\oint E\, dl = \vec{\nabla} \times \vec{E} = 0$ Only static charges

Note:

$\oint E \cdot dl = 0 \Rightarrow$ only when static charge is there & No magnetic field is there

Poisson's equation

$$\nabla^2 V = -\frac{\rho}{\epsilon_0}$$

Proof

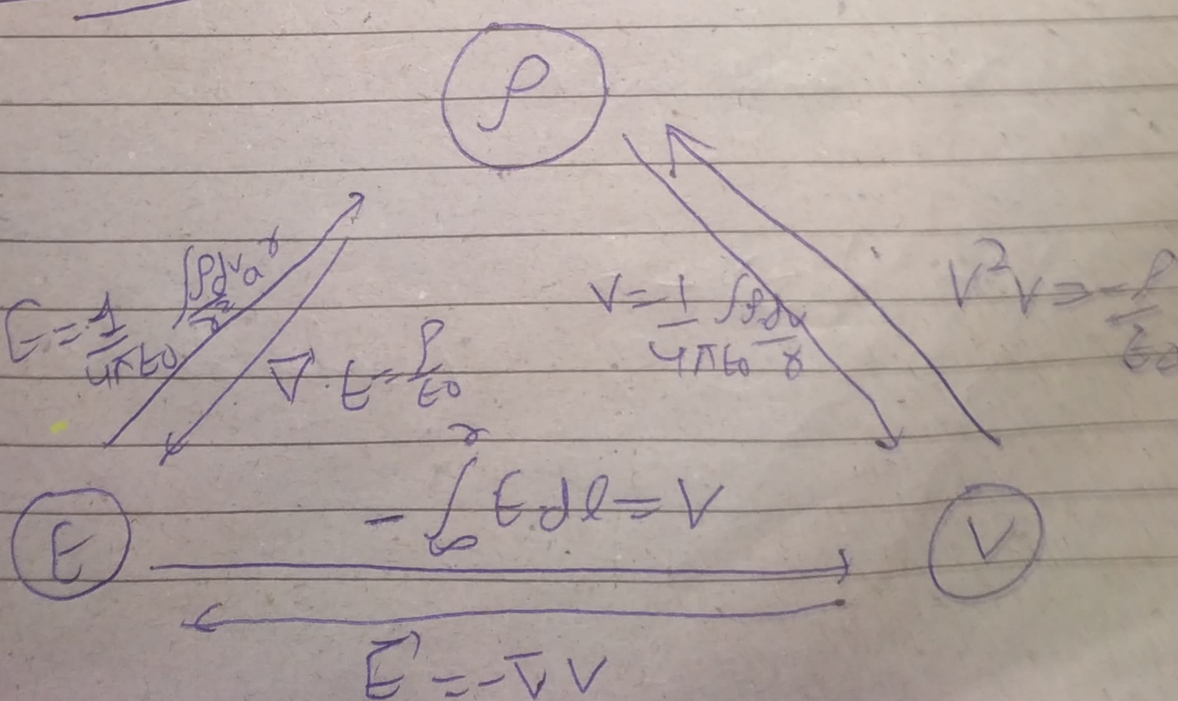
$$\nabla \cdot E = \frac{\rho}{\epsilon_0}, \quad E = -\nabla V$$

$$\nabla \cdot (-\nabla V) = \frac{\rho}{\epsilon_0}$$

Laplace Equation

In charge free region $\Rightarrow$ $\nabla^2 V = 0$

Conversion



Laplace Operator

Coordinate System

$$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$$

Cylinderical

$$\nabla^2 = \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2}{\partial \phi^2} + \frac{\partial^2}{\partial z^2}$$

Spherical

$$\nabla^2 = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial}{\partial r}\right) + \frac{1}{r^2 \sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\frac{\partial}{\partial \theta}\right) + \frac{1}{r^2 \sin^2\theta}\frac{\partial^2}{\partial \phi^2}$$

Application

Coordinate system

$V = A(z) + B$

↳ If 'V' only depends on 'z'

Cylindrical

If 'V' is dependent on r

$$V = A \ln r + B \quad -(1)$$

If V is a function of ϕ

$$V = A\phi + B$$

Spherical

If 'V' is depend on 'r'

$$V = -\frac{A}{r} + B$$

'θ' dependent

$$V = A \ln\left(\tan\frac{\theta}{2}\right) + B$$

Electrostatic Boundary Condition

↳ At surface / Boundary of object

$$\oint E \cdot ds = \frac{Q_{enc}}{\epsilon_0} = \frac{\sigma A}{\epsilon_0}$$

$$E^{\perp}_{above}\cancel{A} - E_{below}^{\perp}\cancel{A} = \frac{\sigma \cancel{A}}{\epsilon_0}$$

For $E^{\parallel}$

$$\oint \vec{E} \cdot d\vec{l} = 0$$

$$E^{\parallel}_{above}\, l - E^{\parallel}_{below}\, l = 0$$

$$E^{\parallel}_{above} = E^{\parallel}_{below}$$

Pressure on Surface

At external field 'E'

$$P = \sigma E$$

At surface

$$P = \frac{1}{2}\sigma\left(E_{above} + E_{below}\right)$$

—×—×—×—×—×—×—

Biot-Savart Law

$$dB = \frac{\mu_0 I dl}{4\pi r^2} \times \hat{r}$$

Magnetic flux

$$\phi = \int_S B \cdot d\vec{s} = 0 \Rightarrow \nabla \cdot B = 0$$

Ampere's law

$$\oint_C B \cdot dl = \mu_0 I_{enclosed}$$

current density

$$I_{enclosed} = \int J \, ds$$

$$\nabla \times B = \mu_0 J \qquad \nabla \times H = J \neq 0$$

Non conservative

Faraday's law

$$\oint E \cdot dl = -\frac{\partial \phi_B}{\partial t}$$

If magnetic field is there otherwise '0'

$$\Downarrow$$

$$\vec{\nabla} \cdot E = -\frac{\partial B}{\partial t} \Rightarrow$$ Differential form

Modified Ampere Circuit law

$$\boxed{\oint B \cdot dl = \mu_0 i_{enc} + \mu_0 \epsilon_0 \frac{d\phi_E}{dt}} = \mu_0 i_{enc} + \mu_0 \epsilon_0 \frac{d\phi_E}{dt}$$

$\mu_0 \epsilon_0 \frac{d\phi_E}{dt}$ → I_d → displacement current

↓

Because unlike change in Magnetic field produces electric field

Old Ampere law was not justifying that change in electric field also produces Magnetic field

So Maxwell modified Ampere's law so that

Change in electric field produces Magnetic field significance ~~can be~~ can be proved

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→ Very Important

→ Assymetry in above law

Continuity Equation

$$I_{out} = \oint J \cdot ds = -\frac{dQ_{in}}{dt}$$

Outward curr

$Q_{in} \Rightarrow$ Total charge inclosed in closed ~~Surfa~~ Surface

$$\oint J \cdot ds = \int_V \nabla \cdot J \, dV$$ (Divergence theorem)

$$\int \nabla \cdot J \, dv = -\frac{dQ_{in}}{dt} = -\frac{d}{dt}\int_V \rho_v \, dV$$

$$\nabla \cdot J = -\frac{\partial \rho_v}{\partial t}$$

$\hookrightarrow$ There can be no accumulation of charge at any point

$$J = \frac{dt}{dt}$$

Steady Current

$$\frac{\partial \rho_v}{\partial t} = 0$$

$\hookrightarrow$ $\nabla \cdot J = 0$

$$\nabla \times B = \mu_0 (J + J_d)$$ $\hookrightarrow$ Modified Ampere's law

Maxwell equation in Material Medium

$\vec{D} = \epsilon_0 E + P$ → electric dipole moment per unit volume

$H = \frac{1}{\mu_0} \vec{B} - m$ → magnetic dipole moment per unit vole

$P = \chi_E E \quad \vec{m} = \chi_m H$

$D = \epsilon E \quad \& \quad \vec{H} = \frac{1}{\mu} B$

→ where $\epsilon = \epsilon_0 (1+\chi_e) \quad \mu = \mu_0 (1+\chi_m)$

In perfect Dielectric Medium

$\vec{\nabla} \cdot D = 0$

$\vec{\nabla} \cdot B = 0 \qquad \nabla \times H = \frac{dD}{dt}$

$\nabla \times E = -\frac{dB}{dt}$

When $D = \epsilon E$, $H = \frac{1}{\mu} B$

Also

$\nabla \cdot \vec{E} = 0$, $\vec{\nabla} \cdot B = 0 \quad \nabla \times E = -\frac{\partial B}{\partial t}$

$\nabla \times B = \mu\epsilon \, \partial E$

EM Waves

~~Usi maxwell equation~~ we get

$$\nabla^2 E = \mu_0 \epsilon_0 \frac{\partial^2 E}{\partial t^2}$$

$$\nabla^2 B = \mu_0 \epsilon_0 \frac{\partial^2 B}{\partial t^2}$$

These equat look simila to standard wave equat ie.

$$\nabla^2 y = \frac{1}{v^2} \frac{\partial^2 y}{\partial t^2}$$

So, $\frac{1}{v^2} = \mu_0 \epsilon_0$

& $v = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$

$$n = \frac{c}{v} = \sqrt{\mu_r \epsilon_r}$$

$\left(\begin{array}{l} \mu = \mu_0 \times \mu_r \\ \epsilon = \epsilon_0 \times \epsilon_r \end{array} \right)$

$$E = E_0 e^{i(kr - \omega t)}$$

$$B = B_0 e^{i(kr - \omega t)}$$

$\longrightarrow$ Electric field & Magnetic field equ

Some Results

$K \cdot E = K \cdot B = 0$

$\vec{K} \times \vec{E} = \omega B = \frac{\nabla \times E}{i}$

$K \times \vec{B} = -\epsilon_0 \mu_0 \omega \vec{E} = \frac{\vec{\nabla} \times B}{i}$

Show that E & B of plane wave are in same phase at anytime in space

↳ $\boxed{\text{pg} - 120}$

⇒ EM waves are called linearly polarised

⇒ EM waves are Transverse waves

Energy in EM waves

$$\vec{S} = \vec{E} \times \vec{H} = \frac{1}{\mu_0} \vec{E} \times \vec{B}$$

The Rate of flow energy through a unit Surface Area perpendicular to direction of wave propogation

S ⟹ Power per unit Area

Direction ⟹ Same as direction of propogat

Can be said
S ⟹ Power density of the wave at that point

For EM waves

$$S = \frac{1}{\mu_0} \vec{E} \times \vec{B} = \frac{EB}{\mu_0} \sin 90^\circ$$

As $\vec{E}$ & $\vec{B}$ are 90° for EM wave

$$S = \frac{E^2}{\mu_0 c} = \frac{cB^2}{\mu_0}$$

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$$B = \frac{E}{c}$$

Avere of S = ~~Intens~~ Wave Intensity

$$I = \langle S \rangle = \frac{E_0 B_0}{2\mu_0} = \frac{E_0^2}{2\mu_0 c} = \frac{cB_0^2}{2\mu_0}$$

Energy Density

$$u_E = \frac{1}{2}\epsilon_0 E^2 \qquad u_B = \frac{1}{2}\frac{B^2}{\mu_0}$$

&

$$u_E = u_B$$

Total Energy density = (U)

$$U = u_0 + u_B = \epsilon_0 E^2 = \frac{B^2}{\mu_0}$$

Avere

$$\langle U \rangle = \frac{1}{2}\epsilon_0 E_{max}^2 = \frac{1}{2}\frac{B_{max}^2}{\mu_0}$$

$$\langle S \rangle = c\langle U \rangle$$

Relation ~~we~~ betwe
S & U

As $\langle S \rangle$ = Wave Intensity (I)

So, Intensity of EM wave equals average energy density multiplied by speed of light

$$\boxed{E = U = pc}$$

Radiation pressure $= \frac{1}{cA}\left(\frac{dU}{dt}\right)$

Energy of EM wave ≠ Not Energy dens.

Radiation press $= \frac{1}{c} S$

Total Absorption

$$F = \frac{IA}{c}$$

$$(I = \langle S \rangle)$$

$$P = \frac{I}{c}$$

Total Reflection

$$F = 2\frac{IA}{c}$$

$$P = \frac{2I}{c}$$

Poynting Theorem

$$\int (E \cdot J)\, dv = -\frac{\partial}{\partial t} \int \left(\frac{1}{2} \epsilon E^2 + \frac{1}{2} \mu H^2 \right) dv - \oint (E \times H)$$

Differential

$$\nabla \cdot S = -\frac{\partial}{\partial t} \left(u_{mech} + u_{EM} \right)$$

Boundary Conditions

1) $\epsilon_1 E_1^{\perp} = \epsilon_2 E_2^{\perp}$

2) $B_1^{\perp} = B_2^{\perp}$

3) $E_1^{\parallel} = E_2^{\parallel}$

4) $\dfrac{B_1^{\parallel}}{\mu_1} = \dfrac{B_2^{\parallel}}{\mu_2}$

Reflection & Transmission

At Normal Incidence

Incident wave

$$E_i(x,t) = E_{0i}\, e^{i(k_1 x - \omega t))}$$

$$\cancel{E_{00}}\; B_i(x,t) = \frac{1}{v_1} E_{0i}\, e^{i(k_1 x - \omega t)}$$

Reflected wave

$$E_R(x,t) = E_{0R}\, e^{(i(-k_1 x - \omega t))}$$

$$B_R(x,t) = -\frac{1}{v_1} E_{0R}\, e^{(i(-k_1 x - \omega t))}$$

Transmitted wave

$$E_T(x,t) = E_{0T}\, e^{(i(k_2 x - \omega t))}$$

$$B_T(x,t) - \frac{1}{v_2} E_{0T}\, e^{(i(k_2 x - \omega t))\hat{z}}$$

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$$\boxed{\begin{array}{c} E_i + E_R = E_T \\ B_i + B_R = B_T \end{array}}$$

used in Oosha

$$\boxed{\begin{array}{c} n_1 \sin\theta_i = n_2 \sin\theta_T \\ \theta_i = \theta_R \end{array}}$$

$$E_{0R} + E_{0I} = E_{0T}$$

$$E_{0I} - E_{0R} = \beta E_{0T}$$

$$\beta = \frac{\mu_1 v_1}{\mu_2 v_2} = \frac{\mu_1 n_2}{\mu_2 n_1} = \sqrt{\frac{\mu_1 \epsilon_2}{\mu_2 \epsilon_1}}$$

$$E_{0R} = \left(\frac{1-\beta}{1+\beta}\right) E_{0I} \qquad E_{0T} = \left(\frac{2v_2}{v_2+v_1}\right) E_{0I}$$

$$E_{0R} = \left(\frac{n_1-n_2}{n_1+n_2}\right) E_{0I} \qquad E_{0T} = \left(\frac{2n_1}{n_2+n_1}\right) E_{0I}$$

E_0

For Non Magnetic Material

$\mu_1 = \mu_2$

$\beta = \frac{v_1}{v_2}$

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Wave Intensity

$$I = \langle S \rangle = \frac{1}{2} \frac{B_0 E_0}{\mu}$$

If $\mu_1 = \mu_2 = \mu_0$

then $R = \frac{I_R}{I_1} = \left(\frac{E_{0R}}{E_{0I}}\right)^2 = \left(\frac{n_1 - n_2}{n_1 + n_2}\right)^2$

& $T = \frac{I_T}{I_1} = \frac{\epsilon_2 v_1}{\epsilon v_1} \left(\frac{E_{0T}}{E_{0I}}\right)^2$

$$= \frac{n_2}{n_1}\left(\frac{2n_1}{n_1+n_2}\right)^2 \Rightarrow \frac{4n_1 n_2}{(n_1+n_2)^2}$$

$R + T = 1$

θ

$$T = \frac{n_2 \cos\theta_2}{n_1 \cos\theta_1} |t_1|^2$$

Oblique Incidence

→ P polarisation

Case 1: E parallel to the plane of incidence

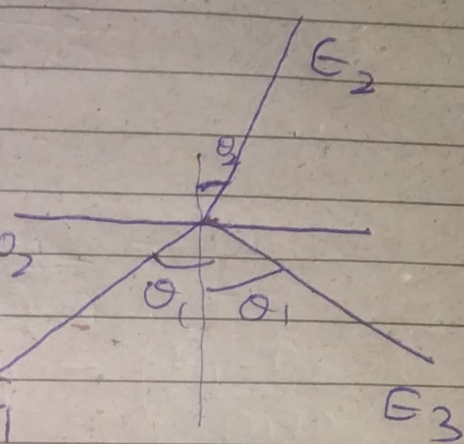
$E_i = E_{0i}\, e^{i(k \cdot r - \omega t)}$ (Incident Ray)

~~E_R = Same like EM wave Reflection & Transmission at Normal Incidence Solved like that only~~

$r_{\parallel}$, $t_{\parallel}$ are used ⇒ Formula written on next page s-polarized

Case II: E perpendicular to the plane of Incidence

$$E_{10} + E_{30} = E_{20}$$



$$H_{10}\cos\theta_1 - H_{30}\cos\theta_1 = H_{20}\cos\theta_2$$

$$\frac{k_1}{\omega\mu_1}(E_{10} - E_{30})\cos\theta_1 = \frac{k_2}{\omega\mu_2}E_{20}\cos\theta_2$$

$$r_{\parallel} = \frac{n_2\cos\theta_1 - n_1\cos\theta_2}{n_2\cos\theta_1 + n_1\cos\theta_1}$$

$$= \frac{(n_2/n_1)^2\cos\theta_1 - \sqrt{(n_2/n_1)^2 - \sin^2\theta_1}}{(n_2/n_1)^2\cos\theta_1 + \sqrt{(n_2/n_1)^2 - \sin^2\theta_1}}$$

$$= \frac{\tan(\theta_1 - \theta_2)}{\tan(\theta_1 + \theta_2)}$$

$$r_{\perp} = \frac{n_1\cos\theta_1 - n_2\cos\theta_2}{n_1\cos\theta_1 + n_2\cos\theta_2}$$

$$= \frac{\cos\theta_1 - \sqrt{(n_2/n_1)^2 - \sin^2\theta_1}}{\cos\theta_1 + \sqrt{(n_2/n_1)^2 - \sin^2\theta_1}}$$

$$= \frac{\sin(\theta_1 - \theta_2)}{\sin(\theta_1 + \theta_2)}$$

$$t_{\parallel} = \frac{2n_1\cos\theta_1}{n_2\cos\theta_1 + n_1\cos\theta_2}$$

$$= \frac{2\cos\theta_1 \sin\theta_2}{\sin\theta_1\cos\theta_1 + \sin\theta_2\cos\theta_2}$$

$$t_{\perp} = \frac{2n_1\cos\theta_1}{n_1\cos\theta_1 + n_2\cos\theta_2} = \frac{2\cos\theta_1\sin\theta_2}{\sin(\theta_1+\theta_2)}$$

$$I = \langle S \rangle = \frac{1}{2}\epsilon v E_0^2 \cos\theta$$

$$R = \frac{I_R}{I_I} = \left(\frac{E_{0R}}{E_{0I}}\right)^2 = \left(\frac{E_{03}}{E_0}\right)^2 = \left[\frac{n_1\cos\theta_2 - n_2\cos\theta}{n_1\cos\theta_2 + n_2\cos\theta}\right]^2$$

$$T = \frac{I_T}{I_I} = \frac{\epsilon_2 v_2 \cos\theta_2}{\epsilon_1 v_1 \cos\theta_1}\left(\frac{E_{0T}}{E_{0I}}\right)^2 = \frac{n_2\cos\theta_2}{n_1\cos\theta}\left(\frac{E_{0T}}{E_{0I}}\right)^2$$

$$T = \frac{n_2\cos\theta_2}{n_1\cos\theta_1}\left[\frac{2n_1\cos\theta_1}{n_1\cos\theta_3 + n_2\cos\theta_1}\right]^2$$

$$T = \frac{4n_1n_2\cos\theta_1\cos\theta_2}{(n_1\cos\theta_2 + n_2\cos\theta_1)^2}$$

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$R + T = 1$

$I_T + I_R = I_I$

Also, $R = |r''|^2$ = ~~$|r_{0}''|^2$~~

$T = \frac{n_2 \cos\theta_2}{n_1 \cos\theta_1} |t''|^2$ = ~~$\frac{n_2 \cos\theta_2}{n_1 \cos\theta_1}|t''|^2$~~

↳ Remember

Relation

Non-magnetic material
then $\mu_2 = \mu_1$

↳ so, $\beta = \frac{v_1}{v_2}$

$\epsilon v = nc$

$D = \sigma = \epsilon E$

As
$E \cdot A = \sigma \times \frac{A}{\epsilon_0}$

$D = \sigma$

For Cone

$$V = A \ln \frac{\theta}{2} + B$$

$\boxed{\text{Polarised Direction means} \to \text{Electric field direction}}$

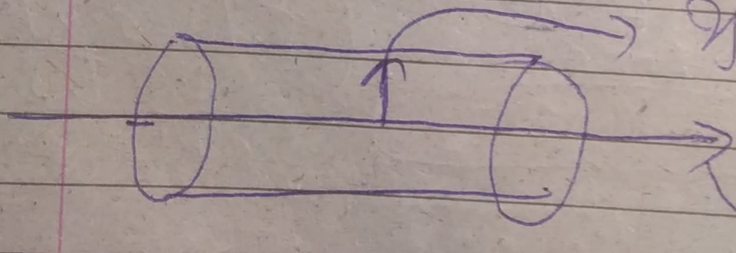
Note
Always write 'E' & B direction
while solving Poynting vector

For cylinder

$\vec{E}$ — $\hat{r}$
— $\hat{z}$

& $\boxed{B \to \hat{\phi}}$ → fix dir

If E is along radius of the shape ⇒ r else take 'z' dir



→ If 'E' in this direct then 'r' direct of 'E'

→ If Electric field is this dir then $E \to \hat{z}$

Some NOTES of Boundary Condition

If Two surface Meets Region is charge free

then $\hookrightarrow \sigma = 0$

$D_1^{\perp} - D_2^{\perp} = \sigma = 0$

$D_1^{\perp} = D_2^{\perp}$

~~else~~ If $\sigma \neq 0$ (Not charge free)

$D_1^{\perp} - D_2^{\perp} = \sigma$

$\tan\theta = \frac{E_1^{\perp}}{E_2^{\parallel}}$

$\hookrightarrow$ To find Electric field Angle at Boundary Condition

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Important Note

To find $\vec{B}$

Use $B.\pi$

$$\boxed{\oint_C B \cdot dl = \mu_0 I + \mu_0 I_d}$$

To find Electric field in ~~capacitor~~ & ~~conductor~~

$$E = \frac{\sigma}{\epsilon_0}$$

Capacitor & Conductor

~~for~~ one plate

$\hookrightarrow E = \frac{\sigma}{2\epsilon_0}$

Always Remember

Poynting Vector is always perpendicular

So, dU_x (dA) ⇒ of the always perpendicular vector

For Cylinder

$B \rightarrow \hat{\phi}$

$E \rightarrow \hat{r}$ or $\hat{z}$ → like for Normal case

↳ If perpendicular find out → then $\hat{r}$

↳ If along (like capacitor) $\Rightarrow \hat{z}$

$$\oint_C B \cdot dl = \mu_0 I + \mu_0 \epsilon_0 \frac{dE}{dt} \times A$$

↳ J_d

I_d

$\cancel{n_1 = \sqrt{\epsilon_1}}$ $\cancel{n_2 = \sqrt{\epsilon_2}}$

$n_1 = \epsilon$

↳ If $\mu_0 \cdot \mu_1$

$$\frac{\mu_1 n_2}{\mu_2 n_1} = \sqrt{\frac{\mu_1 \epsilon_2}{\mu_2 \epsilon_1}}$$

$$\sqrt{\frac{\mu_1}{\mu_2}} \frac{n_2}{n_1} = \sqrt{\frac{\epsilon_2}{\epsilon_1}}$$ → Remember

$$\frac{n_2}{n_1} = \sqrt{\frac{\mu_2 \epsilon_2}{\mu_1 \epsilon_1}}$$

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$\mu_0 = 4\pi \times 10^{-7}$

$\epsilon_0 = 8.85 \times 10^{-12}$

$$\nabla^2 \psi = \frac{1}{c^2}\frac{\partial^2 \psi}{\partial t^2}$$

$\epsilon_0 E^2 = \frac{\text{Energy}}{\text{Volume}}$ Rev

~~Intensity~~ = Power → Energy per second

S ⇒ Power per unit area
= Energy per second per unit Area

S → Power density at a point

Intensity = Average Power

$6 \cdot c$

$\frac{\mu_0 c}{2} \quad 4\pi \times 3 \times 10^{8}$

Remember

$$E = E_{max} \cos (\quad)$$

& $$I = \frac{1}{2} \frac{E_{max} B_{max}}{\mu_0}$$

using E value we can find only Intensity

& ~~Form~~ Total energy density $= \frac{1}{2} \epsilon_0 E_{max}^2$

This Energy can be find using this one

$$\boxed{\frac{\epsilon_2 v_2}{\epsilon_1 v_1} = \frac{n_2}{n_1}}$$

$\epsilon \propto n^2$

$$n = \sqrt{\mu_r \epsilon_r}$$

$$\boxed{\epsilon \propto n^2}$$

Important

eV

Cone

$$V = A \ln \frac{\theta}{2} + B$$

~~Semivertical Angle~~ $= \tan^{-1}\left(\frac{y}{\theta/2}\right), \tan^{-1}\left(\frac{x}{y}\right)$ $y/z = 0$

$y/x = 0$ $\tan^{-1}\left(\frac{x}{z}\right)$

$y/y = 0$

not Logic

If Charge density is there σ_f &
current density K_f

then

$$D_1^{\perp} - D_2^{\perp} = \sigma_f$$
$$E_1^{\parallel} = E_2^{\parallel}$$
$$B_1^{\perp} = B_2^{\perp}$$
$$\frac{B_1^{\parallel}}{\mu_1} - \frac{B_2^{\parallel}}{\mu_2} = K_f \times \hat{n}$$

$\boxed{\text{Always Remember } D^{\perp} = \sigma}$

Energy ⇒ Juoles

Poynting vector → Juoles sec^{-1} × m^{-1}

Power → Juoles sec^{-1} (watt)

Electric field ⇒ N/C = V/m
(volts per meter)

Vol Potential ⇒ V ⇒ Juoles/coloumb