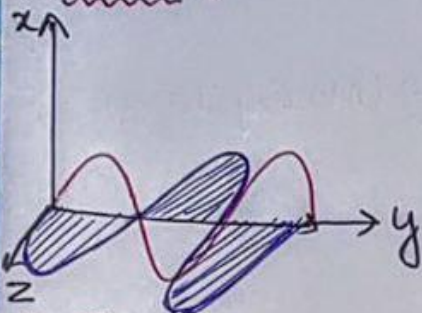


EM WAVES

* WAVES :



* Direction :-

$$\vec{E} = E_0 \sin(kx - \omega t)$$

$$\vec{B} = B_0 \sin(kx - \omega t)$$

(ϕ) Phase = 0

→ Angle between plane of $\vec{E}$ and $\vec{B}$ are 90°

* Direction of waves :-

$\vec{E}$, $\vec{B}$ and waves are mutually perpendicular

$$\hat{C} = \frac{\vec{E} \times \vec{B}}{|\vec{E} \times \vec{B}|}$$

Tells the direction of wave.

unit vector

short trick;



always clockwise

$\hat{i} \times \hat{j} = +\hat{k}$ (No kuchalra)

$\hat{j} \times \hat{i} = -\hat{k}$ (kuchalra)

B_0 = Peak value of $\vec{B}$

E_0 = Peak value of $\vec{E}$

$$B_0 = \frac{E_0}{C}$$

$$C = 3 \times 10^8 \text{ m/s}$$

Speed of light;

$$C_{vac} = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$

$$C_{med} = \frac{1}{\sqrt{\mu_0 \mu_r \epsilon_0 \epsilon_r}}$$

refractive index (η) :- $\frac{C_v}{C_{med}}$

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

$$\omega \text{ (angular frequency)} = 2\pi f$$

$$\text{Wavelength} (\lambda) = \frac{C}{f} \quad T = \frac{2\pi}{\omega}$$

angular wave $\Rightarrow (k) = \frac{2\pi}{\lambda}$ number

$$\text{velocity of wave } (C) = \frac{\omega}{k}$$

$$\vec{E} = \hat{i} 40 \cos(kz - 6 \times 10^8 t)$$

$\hat{i} = \vec{E}$ direction

$z = \vec{B}$ direction

$$6 \times 10^8 = \omega$$

* Tip for question;

$\omega t + kx \rightarrow -ve$ x dir'n of wave

$\omega t - kx \rightarrow +ve$ x dir'n

$-\omega t - kx \rightarrow -ve$ x dir'n

Intensity of EM wave :-

$$I = \frac{EB}{\mu_0}$$

$$I = \epsilon_0 \sin(kx - \omega t) [B_0 \sin(kx - \omega t)]$$

$$I = \frac{\epsilon_0 B_0 \sin^2(kx - \omega t)}{\mu_0}$$

Average of $\sin^2(kx - \omega t)$ is $1/2$

$$I_{avg} = \frac{\epsilon_0 B_0}{\mu_0} \frac{1}{2}$$

→ In EM wave

$$(\text{Energy})_{\vec{E}} = (\text{Energy})_{\vec{B}}$$

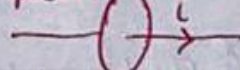
Faraday's law :-

$$\mathcal{E} = -\frac{d\phi}{dt}$$

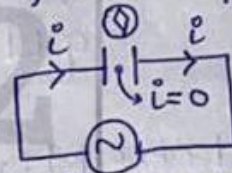
bulb glow

i induced due to change in magnetic flux in the coil.

Ampere law :-

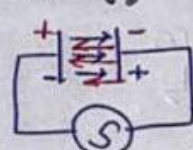


$$\oint \vec{B} \cdot d\vec{l} = \mu_0 i_{enclosed}$$



capacitor k upar nhi deflect nhi hona chahiye but actually

But why? -



$\vec{E}$ variable $\rightarrow$ also tend

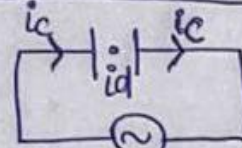
$\vec{B}$ variable

Maxwell law

i_d = displacement current

$$i_c = i_d$$

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 (i_c + i_d)$$



i_c = conductor current

$$i_d = \epsilon_0 \frac{d\phi_E}{dt}$$

$$i_c = \mu_0 i_c$$

Maxwell equation :

1° Gauss law = $\oint \vec{E} \cdot d\vec{A} = \frac{q}{\epsilon_0}$ (Electrostat)

2° Gauss law for magnet. $\oint \vec{B} \cdot d\vec{A} = 0$ (NO monopole exist) (Moving charge)

3° $\oint \vec{E} \cdot d\vec{l} = -\frac{d\phi_B}{dt}$ Faraday law (EMI)

4° $\oint \vec{B} \cdot d\vec{l} = \mu_0 (i_c + i_d)$ (EM wave)

$\left\{ i_d = \epsilon \frac{d\phi_E}{dt} \right\}$

Electro Magnetic spectrum :

→ Gamma	X Ray	UV Ray	Visible	Infra	Mag icuo	Radio wave
10^{-14}	10^{-12}	10^{-10}	10^{-8}	10^{-6}	10^{-4}	10^{-2}