$$\oint B \cdot d\vec{s} = \mu_0 I$$ (Ampere's Law)

↓ constant electic field

Maxwell ⇒ $\oint B \cdot d\vec{s} = \mu_0 (I + I_d)$ → displacement current

↳ due to non uniform $\vec{E}$

$$I_d = \epsilon_0 \frac{d\Phi_E}{dt}$$

Ampere's Law: $\oint B \cdot d\vec{s} = \mu_0 I + \mu_0 \epsilon_0 \frac{d\Phi_E}{dt}$ ⇒ Maxwell's Equations I

↳ Ampere's Maxwell Law

Electric flux: $\Phi_E = \oint E \cdot d\vec{A} = \frac{q}{\epsilon_0}$ Gauss's Law — " " II

Magnetic Flux: $\Phi_B = \oint B \cdot d\vec{A} = 0$ Gauss's Law in magnetism — " " III

$\text{emf} = \oint E \cdot d\vec{s} = -N \cdot \frac{d\Phi_B}{dt}$ Faraday's Law — " " IV

$\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$ Lorentz's Law

Basis of electro magne-tism

Properties of Electromagnetic wave

1. c (speed of light) $= \frac{1}{\sqrt{\epsilon_0 \mu_0}} \approx 3 \times 10^8$ m/s
2. Transverse Wave ⇒ $\vec{E}$ $\vec{B}$ direction of propogation are all ⊥ to each other

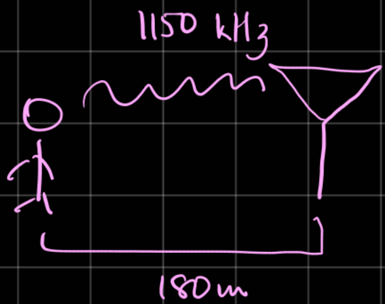
3 $c = \frac{\vec{E}}{\vec{B}}$; Wavelength $\lambda = \frac{c}{f}$ (m)

f ↳ frequency

f = no. of cycles / sec

Example

$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{1150 \times 10^3}$



wavelengths $= \frac{180}{\lambda}$

Poynting Vector $\vec{S}$

$$\vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B} \quad (W/m^2)$$

↳ direction

same as direction of propogation

(W/m²)

Intensity $= S_{avg} = \frac{E_{max} B_{max}}{2\mu_0} = \frac{B_{max}^2 c}{2\mu_0} = \frac{E_{max}^2}{2\mu_0 c}$

Energy Density

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

Total Energy Density in em wave

$u_E + u_B$

$= \frac{1}{2}\epsilon_0 E^2 + \frac{B^2}{2\mu_0}$

For electromagnetic wave

$u_E = u_B$

1/2 here 1/2 here

Total energy density

$= 2u_E = 2u_B$

$= \epsilon_0 E^2 = \frac{B^2}{\mu_0}$

Total

Avg Energy Density

$= u_{avg} = \frac{1}{2}\epsilon_0 E_{max}^2 = \frac{B_{max}^2}{2\mu_0}$

$\text{Intensity} = \frac{E_{max} B_{max}}{2\mu_0} = \frac{B_{max}^2 c}{2\mu_0}$

$= c \cdot u_{avg}$

$P = \frac{F}{A} = \frac{1}{A}\frac{dp}{dt}$ → momentum

$= \frac{1}{A}\boxed{\frac{d}{dt}\left(T_{ER} / dt\right)}$

Time derivative of the rate of energy transferred to the surface

$$= \frac{1}{A}\left[\frac{dT_{ER}/dt}{c}\right] \qquad \frac{\text{Power}}{\text{Area}} = \text{Intensity}$$

$$= S_{avg}/c$$

$$= I/c$$ (perfectly absorbing surface)

perfectly reflecting surface

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