Poynting Vector.

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad \text{---} \quad (1)$$

$$\vec{\nabla} \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t} \quad \text{---} \quad (2)$$

Eqn (1).

$$\vec{H} \cdot (\vec{\nabla} \times \vec{E}) = -\vec{H} \cdot \frac{\partial \vec{B}}{\partial t} \quad \text{---} \quad (3)$$

Eqn (2)

$$\vec{E} \cdot (\vec{\nabla} \times \vec{H}) = \vec{E} \cdot \left(\vec{J} + \frac{\partial \vec{D}}{\partial t}\right) \quad -(4)$$

Substract (3) to (4)

$$\underline{\vec{H} \cdot (\vec{\nabla} \times \vec{E})} - \underline{\vec{E} \cdot (\vec{\nabla} \times \vec{H})} = -\vec{H} \cdot \frac{\partial \vec{B}}{\partial t} - \vec{E} \cdot \left(\vec{J} + \frac{\partial \vec{D}}{\partial t}\right)$$

H E

$$\vec{\nabla} \cdot (\vec{A} \times \vec{B}) = \vec{B} \cdot (\vec{\nabla} \times \vec{A}) - \vec{A} \cdot (\vec{\nabla} \times \vec{B})$$

$$\vec{\nabla} \cdot (\vec{E} \times \vec{H}) = -\vec{H} \cdot \frac{\partial \vec{B}}{\partial t} - \vec{E} \cdot \left(\vec{J} + \frac{\partial \vec{D}}{\partial t}\right)$$

$$= -\vec{H} \cdot \mu \frac{\partial \vec{H}}{\partial t} - \vec{E} \cdot \vec{J} - \underline{\vec{E} \cdot \frac{\partial \vec{D}}{\partial t}}$$

$$\underline{-\mu \vec{H} \cdot \frac{\partial \vec{H}}{\partial t}} = -\frac{\mu}{2} \frac{\partial H^2}{\partial t}$$

$$\frac{\partial H^2}{\partial t} = \frac{\partial}{\partial t}(\vec{H} \cdot \vec{H}) = \underline{2\vec{H} \cdot \frac{\partial \vec{H}}{\partial t}}$$

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

$$\vec{S} = \vec{E} \times \vec{H}$$

Electromagnetic wave Eqn

1) $\vec{\nabla} \cdot \vec{E} = 0$ ✓ $\quad \rho$

2) $\vec{\nabla} \cdot \vec{B} = 0$

3) $\vec{\nabla} \times \vec{E} = -\dfrac{\partial \vec{B}}{\partial t}$

4) $\vec{\nabla} \times \vec{B} = \mu_0 \dfrac{\partial \vec{D}}{\partial t} = \mu_0 \epsilon_0 \dfrac{\partial \vec{E}}{\partial t}$

$$\vec{\nabla} \times (\vec{\nabla} \times \vec{E}) = -\vec{\nabla} \times \frac{\partial \vec{B}}{\partial t} = -\frac{\partial}{\partial t}(\vec{\nabla} \times \vec{B})$$

$$= -\frac{\partial}{\partial t}\left(\mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}\right)$$

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

$$\vec{A} \times (\vec{B} \times \vec{C}) = \vec{A}(\vec{B} \cdot \vec{C}) - (\vec{A} \cdot \vec{B})\vec{C}$$

$$\vec{\nabla} \times (\vec{\nabla} \times \vec{E}) = \vec{\nabla}\,\cancelto{0}{(\vec{\nabla} \cdot \vec{E})} - \nabla^2 \vec{E}$$

$$= -\nabla^2 \vec{E}$$

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

$$\boxed{\frac{\partial^2 \vec{E}}{\partial t^2} = \frac{1}{\mu_0 \epsilon_0} \nabla^2 \vec{E}}$$

$$\frac{1}{\mu_0 \epsilon_0} = c^2$$

3×10^8 m/s

$c \Rightarrow$ light of speed