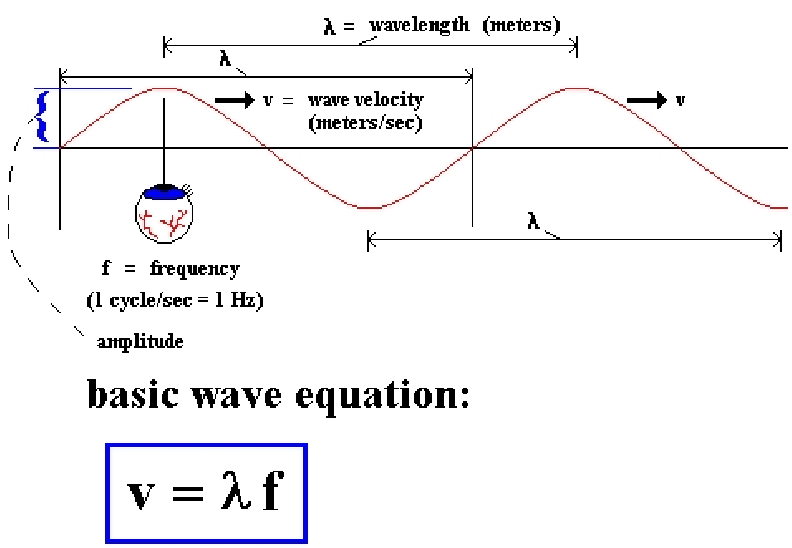
Basic Wave Properties:



Waves carry or transmit energy; energy transmitted in proportional to the square of the amplitude

Wave exhibit interference phenomena

Light:

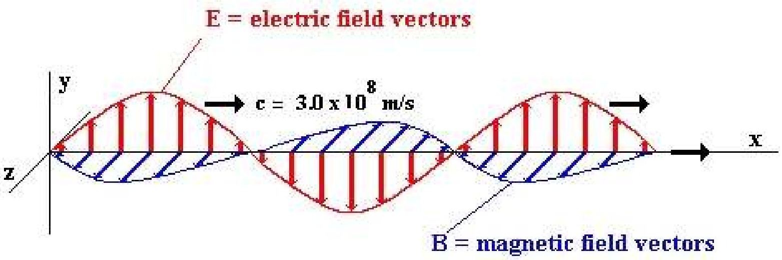
Newton: "corpuscular theory" - light as particles (used to explain refraction, and dispersion

interference phenomena observed for light - light as waves

Maxwell (1862) - linear field theory of light - light as transverse electro-magnetic waves

Einstein (1905) - photoelectric effect explaination - light as particles (photons)

Electro-magnetic waves:



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

$$\frac{\partial^2 \Psi}{\partial x^2} + \frac{\partial^2 \Psi}{\partial y^2} + \frac{\partial^2 \Psi}{\partial z^2} = \frac{1}{v^2}\frac{\partial^2 \Psi}{\partial t^2}$$

where $V = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$

v for E&M waves was calculated and shown to be equal to the measured speed of light

light = transverse E&M waves

$$E_y(x,t) = E_{0y} \cos\left[\omega\left(t - \frac{x}{c}\right) + \varepsilon\right]$$

$$E_y = c B_z$$

Poynting Vector: magnitude = power/area crossing a surface whose normal is parallel to $\vec{S}$ direction, $\vec{S}$ direction is the direction of propagation

$$\vec{S} = c^2 \epsilon_0 \vec{E} \times \vec{B}$$

Irradiance = Intensity = Flux Density

I = the time average of power/area (the time average of the Poynting Vector)

time average for harmonic waves:

(note: $|\vec{r}|$ = magnitude of $\vec{r}$)

$$\frac{1}{\tau}\int_0^{\tau} \cos^2\theta \, d\tau = \frac{1}{2}$$

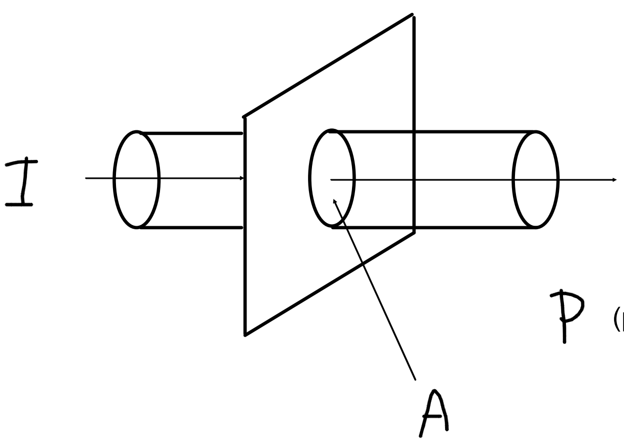
for $\tau >>$ period of oscillation

$$\langle S\rangle_\tau = c^2\epsilon_0|\vec{E}_0\times\vec{B}_0|\langle\cos^2(\vec{k}\cdot\vec{r}-\omega t)\rangle$$

$\rightarrow \frac{1}{2}$ see above

$$\langle S\rangle_\tau = \frac{c^2\epsilon_0}{2}|\vec{E}_0\times\vec{B}_0| \qquad E_0 = cB_0$$

$$I \equiv \langle S\rangle_\tau = \frac{c^2\epsilon_0}{2}\left(E_0\times\frac{E_0}{c}\right) = \boxed{\frac{c\epsilon_0}{2}E_0^2}$$



radiant flux:

$$P = IA$$

P (power passing through surface area "A")

Inverse square law for intensity: