

Physics 5B: Light I

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- Sound Waves \Rightarrow light waves

Longitudinal vs transverse

Sound Waves require a medium to travel to (air, water, metal, etc)

Electric (E) fields and Magnetic (B) fields do not require a medium to propagate!

Depends on permittivity(ϵ) and permeability(μ) of free space

- Speed of EM wave in a vacuum

$$c = \frac{1}{\sqrt{\epsilon_0 \mu_0}} = \frac{1}{\sqrt{\left(8.85 \times 10^{-12} \frac{C^2}{Nm^2}\right) \left(4\pi \times 10^{-7} \frac{Tm}{A}\right)}} = 2.9979 \times 10^8 \frac{m}{s}$$

How far does light travel in 1 nano second?

$$D = vt = \left(3.00 \times 10^8 \frac{m}{s}\right) (1 \times 10^{-9} s) = .3m$$

In other materials, speed of light

$$v = \frac{1}{\sqrt{\epsilon \mu}} < c$$

As Always, $c = \lambda f$ or $v = \lambda f$

- Light is apart of the EM wave

Light is a small fraction of EM spectrum

$$\text{"red light"} \Rightarrow \lambda = 7.5 \times 10^{-7} m = 750nm$$

$$\text{"violet"} \Rightarrow 4 \times 10^{-7} m = 400nm$$

- Frequencies

$$f = \frac{c}{\lambda} = \frac{3.00 \times 10^8 \frac{m}{s}}{7.5 \times 10^{-7} m} = 4.0 \times 10^{14} Hz \Rightarrow 400THz$$

- Now, we will treat light as as a series of rays that travel in straight line. Known as "ray models"

- Geometric Optics

Vertical angles - same angles across

Supplementary angles - 180°

Alternate interior angles- same size angles on opposite sides and ends

- Reflection: The $\theta_{\text{incident}} = \theta_{\text{reflection}}$

$$\theta_i + \theta_A = \theta_r + \theta_B$$

$$\theta_A = \theta_B \quad \text{If } \theta_i = \theta_r$$

- The actual light rays do not pass through the image \Rightarrow virtual images.
- Example:

Two mirrors make an angle of 135° . Light comes in at an angle 38° and reflects to another mirror at angle X_2 and reflects off.

$$\Theta_{i1} = 90 - \Theta \Rightarrow 90 - 38 = 52$$

$$\Theta_{r1} = \Theta_{i1} = 52$$

$$\Theta_A = 90 - \Theta_{r1} = 38 \quad \Theta_B = 180 - 135 - \Theta_A = 7$$

$$\phi = 7$$