

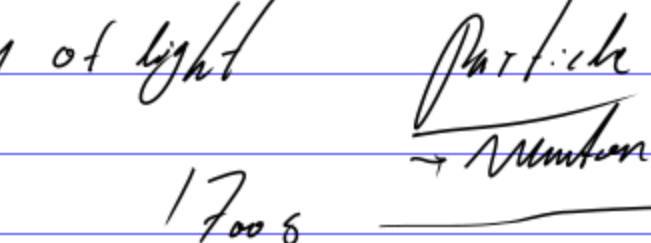
Optics class one 9-3-2020

Homeworks due at 5:00 P.M

What is light? Particle & Wave

Mostly treat as wave in Optics

Emission



History of light

Particle

Wave

1700s

→ Newton

→ Huygens

1800s

→ Young - Double slit

→ Maxwell - EM waves

→ Michelson & Morley - Speed of light

→ Fresnel - No medium

Ether not real.

1900s

Planck → Quantum

Einstein → Special

Theory of Relativity

$$E = h \nu$$

↑ Frequency (Hz)

$$h = 6.63 \times 10^{-34} \text{ Js}$$

Planck's Constant

Einstein → Photoelectric effect

Bohr → Emission spectrum

Compton → Compton Scattering

Heisenberg → Uncertainty principle

Light energies

De Broglie wavelength → $\lambda = \frac{h}{p}$

$p = mv$

Momentum

"Review" of special Relativity (for a short)

$$\beta = \frac{v}{c}, \quad \gamma = \frac{1}{\sqrt{1-\beta^2}}$$

$v \geq 0.1c$ For special relativity $v = c$ (obviously)

$$E_0 = mc^2$$

$$E_K = mc^2(\gamma - 1) \text{ Kinetic}$$

Total energy E_{tot} or just $E \rightarrow E = E_0 + E_K$

$$1. \lambda = ?$$

$$v = ?$$

$$p = ?$$

$$E_0 = E, \quad E_K = E_0, \quad p = mv, \quad c^2$$

$$E_K = (1.67 \times 10^{-27} \text{ kg}) (3 \times 10^8 \text{ m/s})^2$$

$$\lambda = \frac{h}{p} \xrightarrow{p = \frac{mv}{c}} \lambda = \frac{h}{\frac{mv}{c}}$$

$$\lambda = \frac{6.63 \times 10^{-34} \text{ Js}}{(1.67 \times 10^{-27} \text{ kg}) (3 \times 10^8 \text{ m/s})}$$

$$\lambda = \frac{6.63 \times 10^{-34} \text{ Js}}{(1.67 \times 10^{-27} \text{ kg}) (3 \times 10^8 \text{ m/s})}$$

$$\lambda = 1.32 \times 10^{-15} \text{ m} \text{ Gamma Ray}$$

$$v = \frac{c}{\lambda} = \frac{3 \times 10^8 \text{ m/s}}{1.32 \times 10^{-15} \text{ m}} = 2.27 \times 10^{23} \text{ Hz}$$

$$p = \frac{E_K}{c} = \frac{mv^2}{c} = \frac{mv}{c} = (1.67 \times 10^{-27} \text{ kg}) (3 \times 10^8 \text{ m/s})$$

$$p = 5.01 \times 10^{-19} \text{ kg m/s}$$

$$2. E^2 = (pc)^2 + (mc^2)^2 \text{ Photons have zero rest mass.}$$

Can a photon come to rest?

$$E^2 = (pc)^2 + (0)^2$$

$$E^2 = (pc)^2$$

$$p^2 = \frac{E^2}{c^2}$$

$$p = \frac{E}{c}$$

$$v = \frac{p c^2}{E} \text{ (6.9)}$$

$$v = \left(\frac{E}{c} \right) \frac{c^2}{E} = c$$

$$v = c$$

No photon cannot come to rest. $v = c$ ALWAYS