Phys 202 Exam
Wed 4/20

no office hour today

Finish §34

last time defined Poynting vector

$$\vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B}$$

 gives magnitude + direction of $\frac{\text{energy flow}}{\text{unit time}}$

time average of $|\vec{S}|$ = Intensity of radiation

$$I = \langle |\vec{S}| \rangle = \frac{E_{max}^2}{2c\mu_0} = \frac{E_{max} B_{max}}{2\mu_0}$$

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

energy density $= \frac{B_{max}^2}{2\mu_0}$

§34.4 momentum and radiation pressure

Maxwell showed that if a surface absorbs all radiation energy incident on it, then

→ Momentum transfered to surface has magnitude

$$\text{momentum } |\vec{p}| = \frac{U}{c}$$

$\frac{\text{force}}{\text{area}}$ on absorber (pressure)

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

$$= \frac{1}{A}\frac{d}{dt}\left(\frac{U}{c}\right) = \frac{1}{c}\underbrace{\left(\frac{dU/dt}{A}\right)}_{\text{magnitude of } S}$$

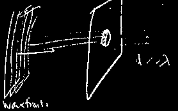
So radiation pressure P exerted on absorbing surface is

$$P = \frac{S}{c}$$

reflector vs absorber

→| $\Delta P = \frac{S}{c}$ absorber

⇄| $\Delta p = \frac{2S}{c}$ reflector



- reflection
- refraction

] geometric optics

- diffraction → wave nature

Smooth versus rough

Specular

rough ⇒ diffuse reflection

Retroreflection: 2 mirrors at 90° angle

reflects light back to source for many different source locations

§35.4 Reflection

$$\theta_i = \theta_r$$

§34.6 Electromagnetic spectrum

radio waves	wavelengths λ $>10^4 m$ to $\sim 0.1 m$
microwaves	$\sim 0.3 m - 10^{-4} m$
infrared waves	$10^{-3} m - 7\times10^{-7} m$
visible light	$7\times10^{-7} m - 4\times10^{-7} m$
ultraviolet	$4\times10^{-7} - 6\times10^{-10} m$
x-rays	$10^{-8} m - 10^{-12} m$
γ-rays	$10^{-10} m - 10^{-14} m$

Optics (study of light)

recall light is electromagnetic wave

speed of light $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = 3\times10^8 \frac{m}{s}$

visible light $\lambda \sim 0.5 \mu$

if scale at which you are looking $\gg \lambda$, then can use "geometric optics"

light moves in straight "rays", unless something "happens"

§35.5 Refraction

light in material (vs vacuum) moves <u>slower</u>

$$v = \frac{1}{\sqrt{\mu \varepsilon}}$$

typically for lens (glass, plastic)

$$\mu \approx \mu_0$$
$$\varepsilon > \varepsilon_0$$

so <u>almost always</u> $v < c$

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at boundary between
2 transparent media,
part of wave is reflected & part is refracted.