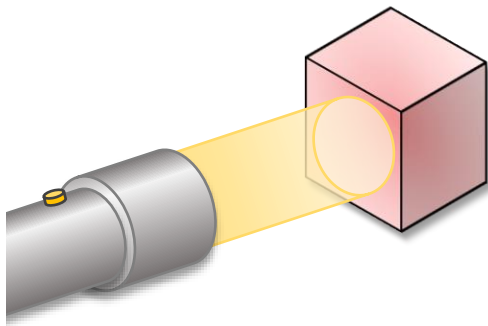


CONCEPT: RADIATION PRESSURE

- Remember: Like all waves, EM waves carry energy. Additionally, EM waves also have _____.
- When light “hits” an object, it _____ its momentum and “_____” objects with a Force!

ABSORBED LIGHT



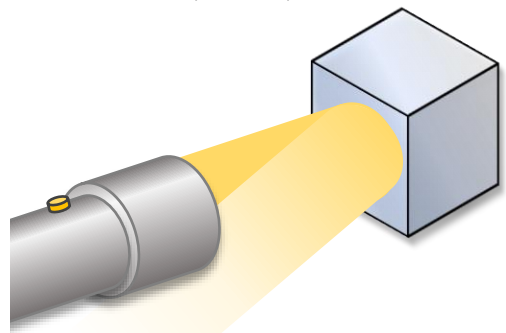
- Similar to a(n) _____ collision

$$F_{abs} = \text{_____}$$

$$p_{abs} = \frac{F}{A} = \text{_____}$$

REFLECTED LIGHT

(e.g. mirror)



- Similar to a(n) _____ collision

$$F_{ref} = \text{_____}$$

$$p_{ref} = \frac{F}{A} = \text{_____}$$

EXAMPLE: You shine a laser pointer onto your hand. The laser pointer has an average power output of 5mW and the beam focuses onto a $1.0 \times 10^{-6} \text{ m}^2$ area on the palm of your hand. If your hand completely absorbs the incoming light, calculate the **a)** radiation pressure and **b)** force exerted on your hand.

PROBLEM: A radio transmits a wave with intensity 27.0 W/m^2 towards a flat surface (perfectly reflecting) with area 2m^2 . Calculate the force and radiation pressure on the surface.

E.M. WAVES EQUATIONS	
$I = \frac{P}{A} = \frac{1}{2} c \epsilon_0 E_{max}^2 = \frac{1}{2} \frac{c}{\mu_0} B_{max}^2$	
$E_{rms} = \frac{E_{max}}{\sqrt{2}} \quad ; \quad B_{rms} = \frac{B_{max}}{\sqrt{2}}$	
$E_{max} = c B_{max}$	
$F_{abs} = \frac{IA}{c} \quad ; \quad F_{ref} = \frac{2IA}{c}$	
$p_{abs} = \frac{F}{A} = \frac{I}{c} \quad ; \quad p_{ref} = \frac{F}{A} = \frac{2I}{c}$	
CONSTANTS	
$c = 3.0 \times 10^8 \frac{m}{s}$	
$\mu_0 = 1.26 \times 10^{-6} \frac{N}{A^2}$	
$\epsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{N \cdot m^2}$	

PROBLEM: You wish to use a laser beam to make an object float in the air. The laser points straight upwards and exerts radiation pressure on a horizontal disc of mass 7.80g and radius 100mm . If the disc, which completely absorbs light, is 2.75 m from the laser, and the radius of the beam is 50mm , what must the laser's power be to balance the disc?

E.M. WAVES EQUATIONS	
$I = \frac{P}{A} = \frac{1}{2} c \epsilon_0 E_{max}^2 = \frac{1}{2} \frac{c}{\mu_0} B_{max}^2$	
$E_{rms} = \frac{E_{max}}{\sqrt{2}} \quad ; \quad B_{rms} = \frac{B_{max}}{\sqrt{2}}$	
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PROBLEM: A spacecraft with a reflective “sail” to capture sunlight may eventually be used for low-cost space travel. A 400-kg satellite near Earth is equipped with two completely reflective sails, each with an area of 5000m². If the intensity of sunlight is approximately 1350 W/m², **a)** calculate the force exerted on the satellite. **b)** Assuming the satellite starts from rest, how fast is it moving after 1 year?

E.M. WAVES EQUATIONS

$$I = \frac{P}{A} = \frac{1}{2} c \epsilon_0 E_{max}^2 = \frac{1}{2} \frac{c}{\mu_0} B_{max}^2$$

$$E_{rms} = \frac{E_{max}}{\sqrt{2}} \quad ; \quad B_{rms} = \frac{B_{max}}{\sqrt{2}}$$

$$E_{max} = c B_{max}$$

$$F_{abs} = \frac{IA}{c} \quad ; \quad F_{ref} = \frac{2IA}{c}$$

$$p_{abs} = \frac{F}{A} = \frac{I}{c} \quad ; \quad p_{ref} = \frac{F}{A} = \frac{2I}{c}$$

CONSTANTS

$$c = 3.0 \times 10^8 \frac{m}{s}$$

$$\mu_0 = 1.26 \times 10^{-6} \frac{N}{A^2}$$

$$\epsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{N \cdot m^2}$$