Measuring Light

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How Fast is Light?

- Speed of light (c)
  - 3.00 x 10^8 m/s (3E8 in your calculator)
- How long does it take light to travel…
  - One mile = 5.3 x 10^{-6} seconds
  - New York to Los Angles = 0.016 seconds
  - Around the earth = 0.133 seconds
  - Moon to Earth = 1.29 seconds
  - Sun to Earth = 8 minutes
  - Alpha Centuri (closest star) = 4 years

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Radiant Energy

- Radiant energy is emitted by electromagnetic waves in the environment.
- The amount of radiant energy emitted depends on the frequency of the electromagnetic waves.
- Radiant energy can be found using the following equation:

$$E_R = hf$$

h = Planck's constant = 6.63×10^{-34} J·s or 6.63E-34

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Example Problem

- How much radiant energy is produced from green light (λ = 510 nm)?

Conversion: 1 nm = 10^{-9} m

$v = \lambda f$

$3.00 \times 10^{8} = (510 \times 10^{-9}) f$

$f = 5.88 \times 10^{14}$ Hz

$E_R = hf$

$E_R = 6.63 \times 10^{-34}(5.88 \times 10^{14})$

$E_R = 3.9 \times 10^{-19}$ J

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First Source of Light

- Candela(cd)
  - SI unit of luminous intensity (I)
  - 1 candela = luminous intensity of one candle

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Important Terms for Light

- Luminous - emits light
- Illuminated - reflects light
- Luminous Flux (F) - rate at which light is emitted
- Lumen (lm) - unit of measure for luminous flux
- Luminous Intensity (I) - the (F) that falls on a 1 m^2 surface 1m away $I = F/(4\pi)$ (measured in candelas)
- Illuminance - illumination of a surface measured in lm/m^2 or lux (E)

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I can see you!

- Transparent
  - Light passes through readily.
- Translucent
  - Light passes through but is diffused such that objects cannot be identified.
- Opaque
  - Light does not pass through.

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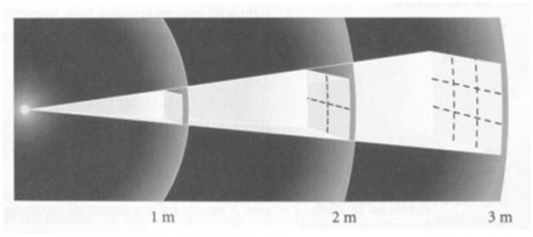
How Bright is that Light ?

- The farther we are from a light, the less bright it looks



Distance	1x	2x	3x
Brightness	Original	1/4 of original	1/9 of original

Inverse square relationship

$E \propto \frac{1}{d^2}$

$E = \frac{1}{1^2} = 1$

$E = \frac{1}{3^2} = \frac{1}{9}$

$E = \frac{1}{4^2} = \frac{1}{16}$

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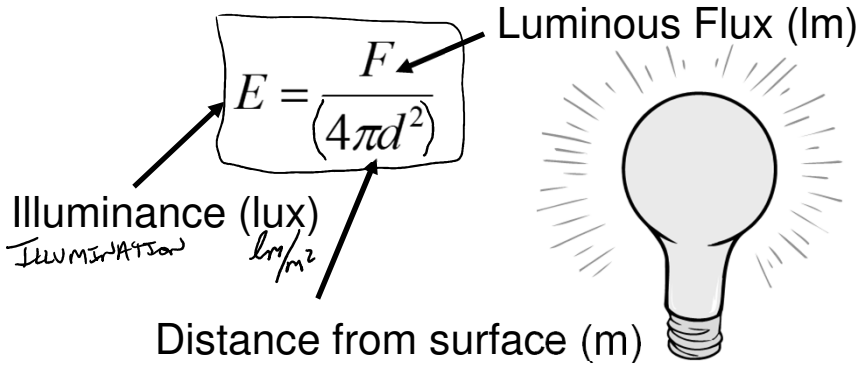
How Bright is that Light ?

- The farther we are from a light, the less bright it looks
- To find the Illuminance



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Illumination Sample Problem

- A 500 lm light source is projected on a wall 0.5 meters away. What is the illumination on the wall?

$E = \frac{F}{4\pi d^2} = \frac{500}{[4\pi(.5)^2]}$

$= 159.2 \text{ lm/m}^2 \text{ or lux}$

Answer: 159 lm/m^2 or lux

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Illumination Sample Problem

- A light is shown on desk. The illumination on the desk is 230 lm/m^2. The light is 35 cm away from the desk. What is the luminous flux of the light? It's luminous intensity?

$E = \frac{F}{(4\pi d^2)} \Rightarrow 230 = \frac{F}{[4\pi(.35)^2]}$

$F = 230[4\pi(.35)^2] = 354.1 \text{ lm}$

$I = \frac{F}{(4\pi)} = \frac{354.1}{(4\pi)} = 28.2 \text{ cd}$

Answer: 354 lm, 28.2 cd

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