

LIGHT

I. Properties of Light- What we already know:

II. Speed of light (c)

A. Galileo (early 1500's)

- 1. Tried to measure time light took to travel to a hill 1.5 km away and back.**
- 2. Time and distance = too short.**

B. Roemer (1676)

- 1. Measured the orbit of Jupiter's moon Io. When traveling away from Jupiter, the orbit of Io took 22 minutes longer than when earth was traveling towards Jupiter.**
- 2. Correct technique, but man's knowledge of solar system measurements were incorrect.**
- 3. Less than 100 years later, these measurements were corrected and the speed of light was calculated correctly.**

C. Fizeau (1848) and Michelson (1918)

1. Octagonal mirror experiment

2. First device to measure speed of light within the confines of the Earth

D. Accepted value of the speed of light

$$c = 3 \times 10^8 \text{ m/s}$$

III. Wave Properties of Light

A. Emitted by vibrating electrical charges in atoms

B. Travel in a wave that is partly electric and partly magnetic (electromagnetic wave)

1. Visible light is only one member of the broad family of electromagnetic waves called the electromagnetic spectrum

2. The different kinds of waves in this spectrum are distinguished by their frequency (f) and their wavelength(λ)

3. Electromagnetic Spectrum (from longest to shortest λ)

- **Radio waves**
- **Microwaves**
- **Infrared waves**
- **Visible light**
- **Ultraviolet light**
- **X-rays**
- **Gamma rays**

C. All electromagnetic (EM) waves travel at the same speed $c = 3 \times 10^8$ m/s

D. Wave equation for EM waves

Speed of light = Frequency \times wavelength

$$c = f\lambda$$

$$3 \times 10^8 \text{ m/s} = f\lambda$$

IV. What is Light?

A. Sources

- 1. Chemical**
- 2. Electrical**
- 3. All production of light involves the giving off of energy from vibrating electrons.**

B. Composition

- 1. 5th Century BC debate:**
 - a. Socrates and Plato -we see by streamers/ filaments emitted by the eye**
 - b. Pythagoreans- light travels to the eye in tiny particles**
 - c. Empedocles- light travels in waves**

2. 17th century debate:

- a. Newton- particle theory b/c light seemed to travel in straight lines instead of spreading out (light v. sound coming through a small hole)**
- b. Huygens - said light is a wave b/c through a prism, light spreads out**

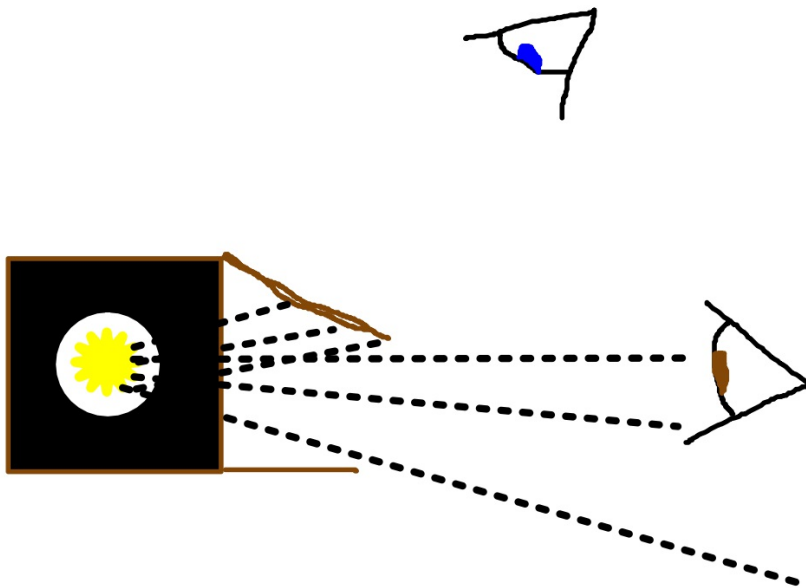
3. 19th century-Young- established the wave nature of light through his double-slit experiment

4. 20th century-Einstein- in 1905 published the Photoelectric Effect analyzing an experiment which establishes light as massless bundles of electromagnetic energy called photons

Scientists Conclusion = Wave-particle Duality (light is both!)

I. Particle Model of light: Light travels in a straight line from one point to another.

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I. Brightness of light

- A. The brightness increases or decreases exponentially as you move closer or further from the source.
- B. If moving further away, the relative brightness is calculated as a fraction of the original brightness:

$$\frac{1}{(x)^2}$$

where x is the multiplier of distance (1x, 2x, 3x further away, etc.)

- C. If moving closer to a light source, the relative brightness is calculated as a multiple of the original brightness:

$$(x)^2$$

where x is still the multiplier of distance (1x, 2x, 3x closer, etc.)