Star Light

1. Properties of Light

A. Light - radiant energy that can travel thru space (even empty space - vacuum)

(1) speed of light (c) in a vacuum

3.00×10^8 m/s — fastest speed any object can move

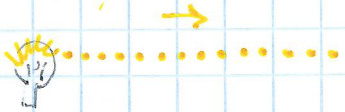
(2) colored light travels @ slightly different speeds thru materials, like air in our atmosphere or a prism.

Ex) blue light travels slower than red light.

2. Light is both a wave and particle at the same time!

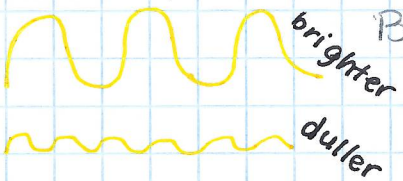
wave theory

particle theory



stream of energy particles, called photons that move in a straight line

height of the wave (amplitude) — Intensity or Brightness



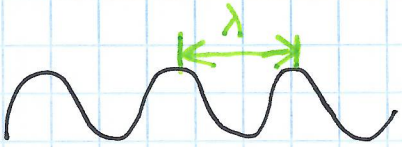
brighter light has more photons than dimmer light

Wave theory

color

each color is determined by its WAVELENGTH λ

spacing between 2 crests on a wave



- measured in nanometers (nm)
  1nm = 1/1,000,000,000 m

ex) red light λ = 700nm
violet light λ = 400nm

white light - mixture of all the colors of the rainbow!

Particle Theory

amount of energy the photons have is dependent on its wavelength.

- Each color of light has its own wavelength & energy

$$E = \frac{hc}{\lambda}$$

E = energy
h = Planck's constant
c = speed of light
λ = wavelength

The larger the wavelength is, the more energy the photons have

3. Beyond visible Light - the Electromagnetic Spectrum

A. Infrared Radiation (IR) - heat radiation
   - use IR cameras/telescopes to detect IR photons & waves to detect an object's warmth

B. Ultraviolet Radiation (UV)
   - causes you to tan or burn

C. Microwaves
λ is between 1mm → 1m
- use to cook food
- astronomers use microwave telescopes to study the molecules inside inter-stellar gas clouds & to study the light from the universe when it was young

D. Radiowaves
λ of 1m or more
- used in communication & radar
- astronomers use radio-telescopes to "view" stars forming or dying (exploding), active galaxies, & interstellar gas clouds

E. X-rays
λ between .01nm → 10nm
- used by dentists & doctors
- astronomers use X-ray telescopes to find x-rays given off by hot gases near black holes

F. Gamma rays
- shortest λ known
- associated w/ violent super nova explosions
- gamma ray telescopes are put on satellites in space because our ozone layer blocks gamma rays

4. Waves have a <u>frequency</u> (ν)

↓

= # waves that pass a given point per second
- measured in hertz (Hz)
= # waves/second

frequency & wavelength are related thru the speed of light

$$c = \lambda \cdot \nu$$

- c: speed of light, 3.00×10^8 m/s
- λ: wavelength
- ν: frequency

smaller λ
higher ν

larger λ
lower ν