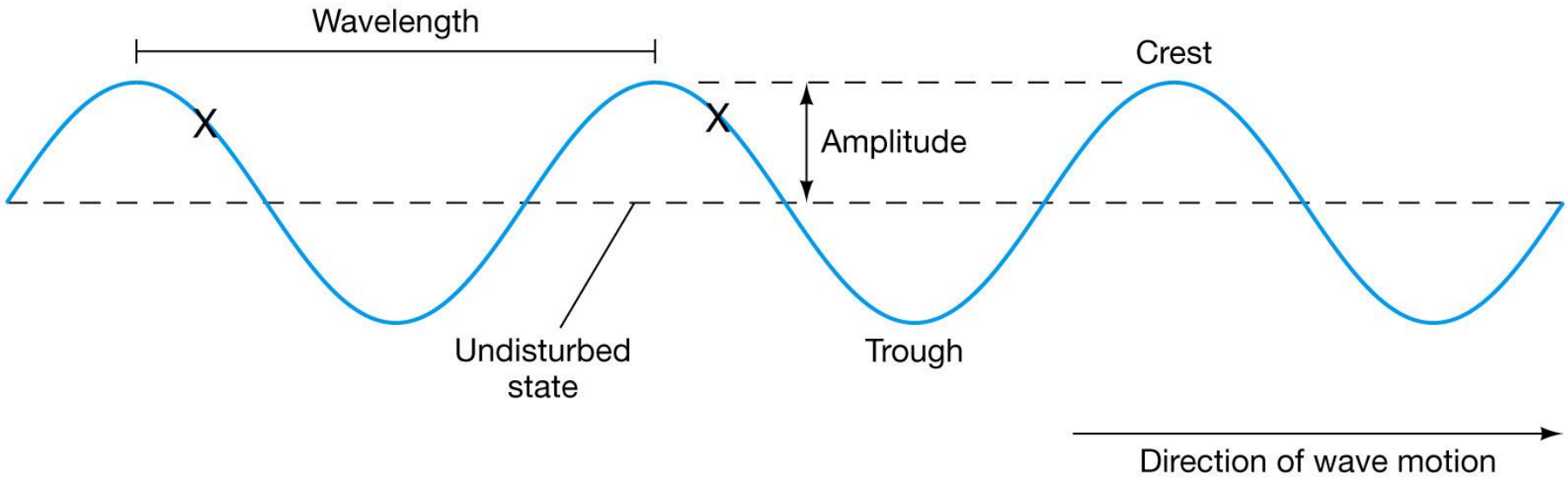
Electromagnetic Radiation

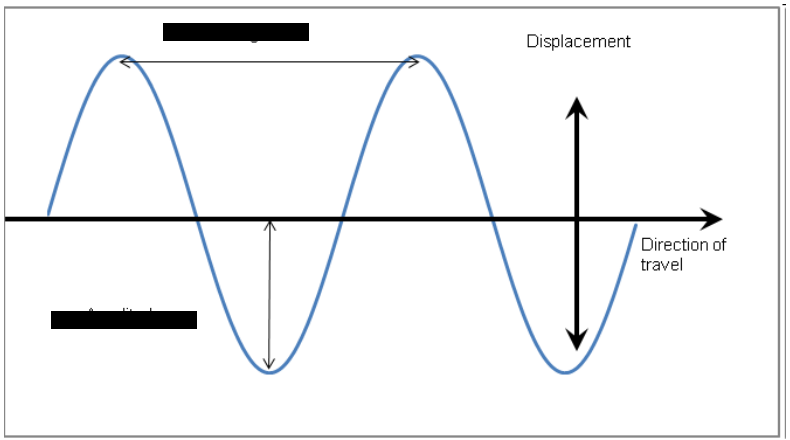
Wave Terminology

- ***Wavelength*** - distance between two like points on the wave
- ***Amplitude*** - the height of the wave compared to undisturbed state
- ***Period*** - the amount of time required for one wavelength to pass
- ***Frequency*** - the number of waves passing in a given amount of time



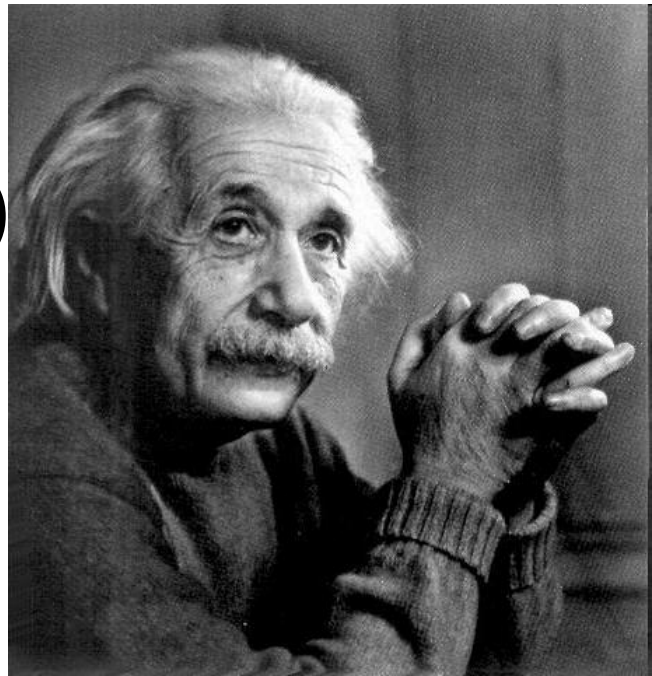
Waves… a review

- Most waves are either longitudinal or transverse.
- Sound waves are longitudinal.
- But all electromagnetic waves are transverse…



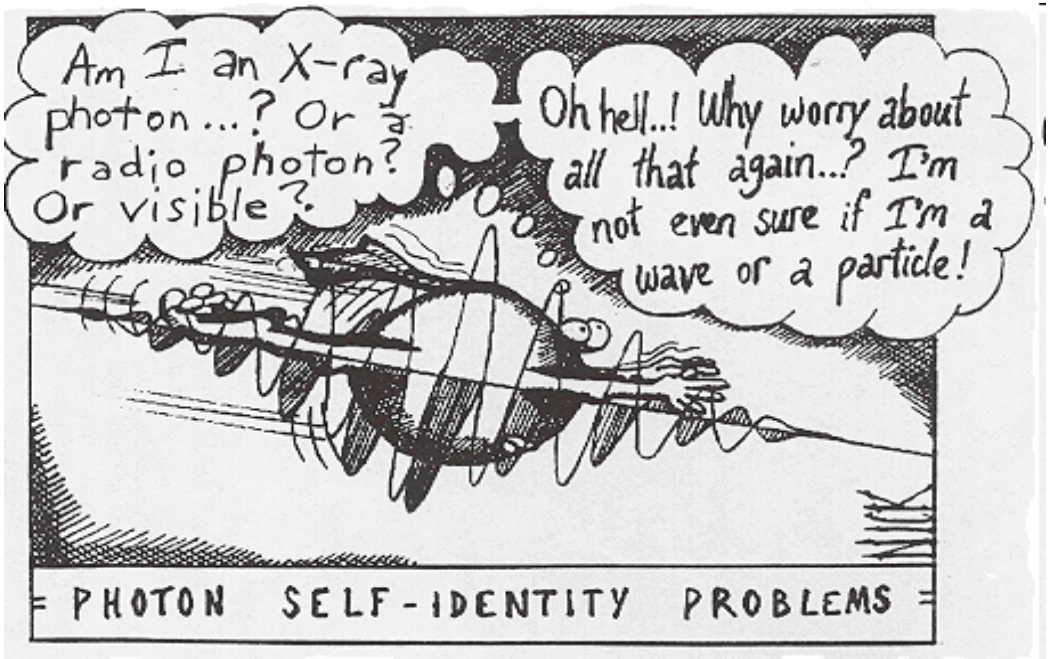
Electromagnetic waves

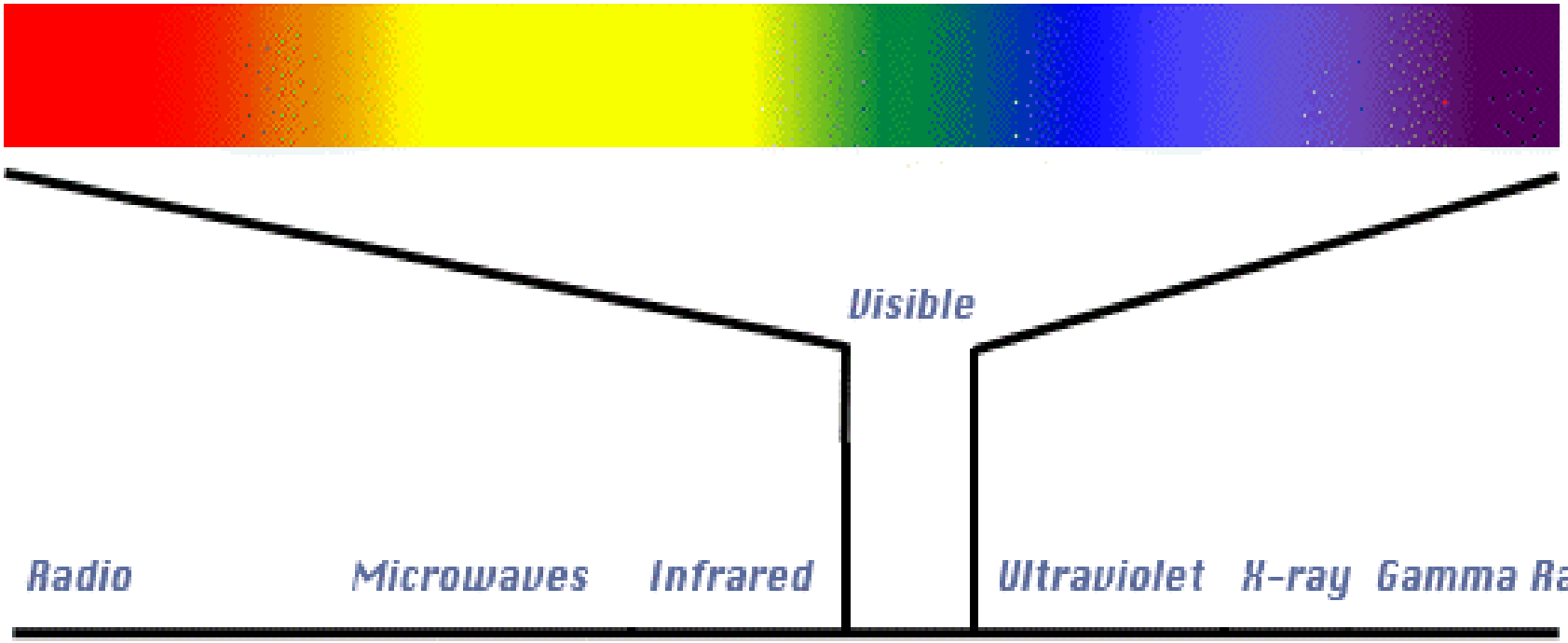
- Produced by the movement of electrically charged particles
- Can travel in a "vacuum" (they do NOT need a medium)
- Travel at the speed of light(300,000km/second)
- Also known as EM waves



Wave-particle Duality

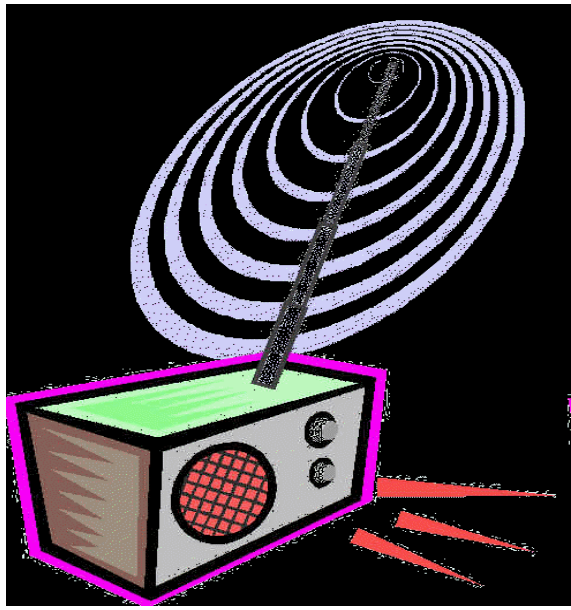
- Light can behave like a wave or like a particle
- A "particle" of light is called a photon
- These photons travel in streams of particles like a wave




Visible
Radio
Microwaves
Infrared
Ultraviolet
X-ray
Gamma Ray
Low Frequency
High Frequency
Long Wavelength
Short Wavelength

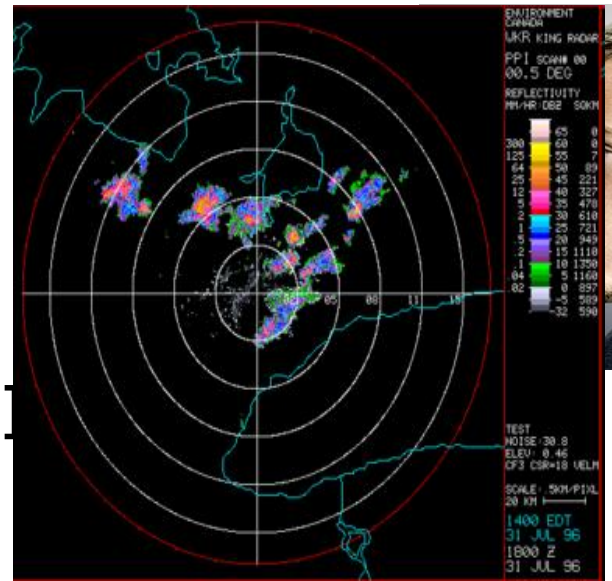
Radio waves

- Longest wavelength EM waves these waves include both TV and radio waves. Signals are transmitted and devices with antennas can receive the signals.
- Uses:
  - TV broadcasting
  - AM and FM broadcast radio
  - Avalanche beacons
  - Heart rate monitors
  - Cell phone communication



Microwaves

- Higher frequency and shorter wavelength than radio. As these waves pass through food, it causes the particles to vibrate resulting in the heating of the food. Microwaves are also used in communication.
- Uses:
  - Microwave ovens
  - Bluetooth headsets
  - Broadband Wireless I
  - Radar

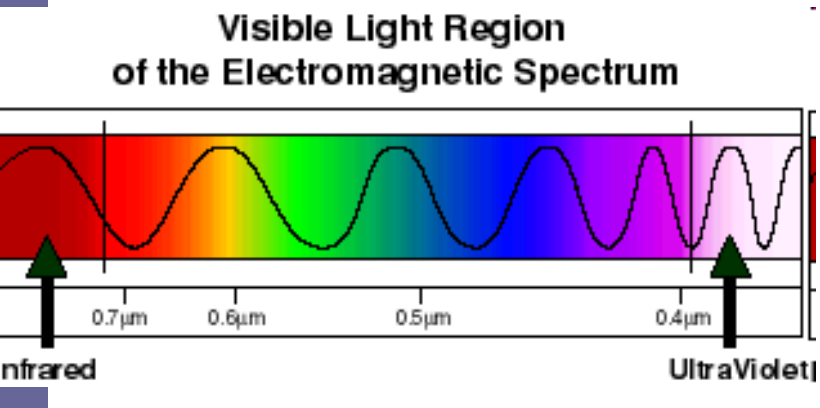


Infrared Radiation

- These waves are <u>responsible for the heat we feel</u>. Heat seeking missiles detect infrared sources such as tanks or aircraft.
- Uses:
  - Night vision goggles
  - Remote controls
  - Heat-seeking missiles

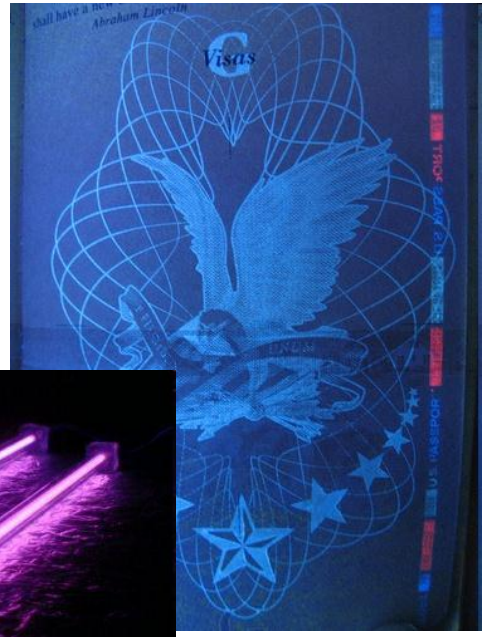
Visible light

- Only type of EM wave able to be detected by the human eye
- Violet is the highest frequency light
- Red light is the lowest frequency light



Ultraviolet

- These cause our skin to darken (tan) and can even damage our skin. The ozone layer protects us from most UV radiation from the sun.
- Uses:
  - Black lights
  - Sterilizing medical equipment
  - Water disinfection
  - Security images on money



X-rays

- Tiny wavelength, high energy waves these EM waves pass through many forms of matter
- Uses:
  - Medical imaging
  - Airport security
  - Inspecting industrial welds

Gamma Rays

- Smallest wavelengths, highest energy EM waves these EM waves are very penetrating and can severely damage cells.

- Uses
  - Food irradiation
  - Cancer treatment
  - Treating wood flooring

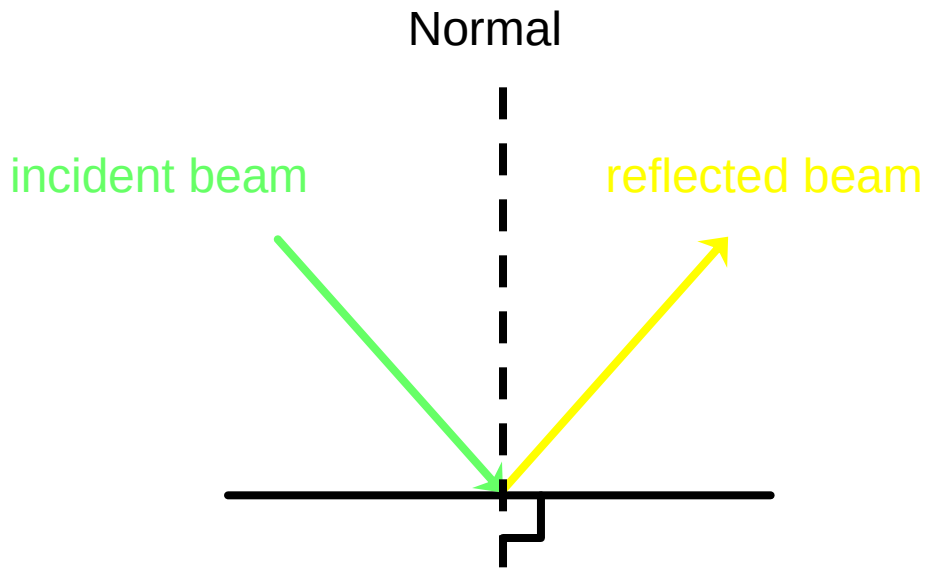
“Just Passing Through:”

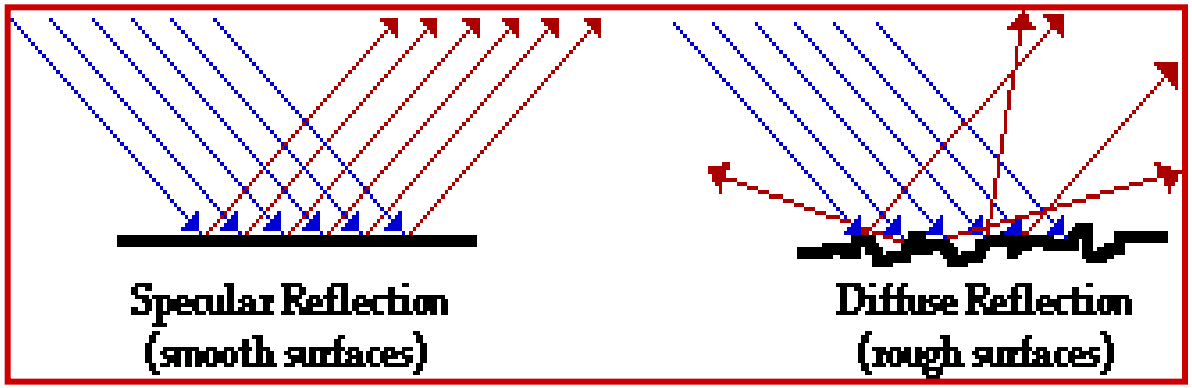
What happens when light strikes glass? Or waxed paper? Or a book?

- If light travels through an object it is transparent
- If light is blocked by an object and a dark shadow is cast it is opaque.
- If some light passes through but not all and a light shadow is present it is translucent.

Reflection

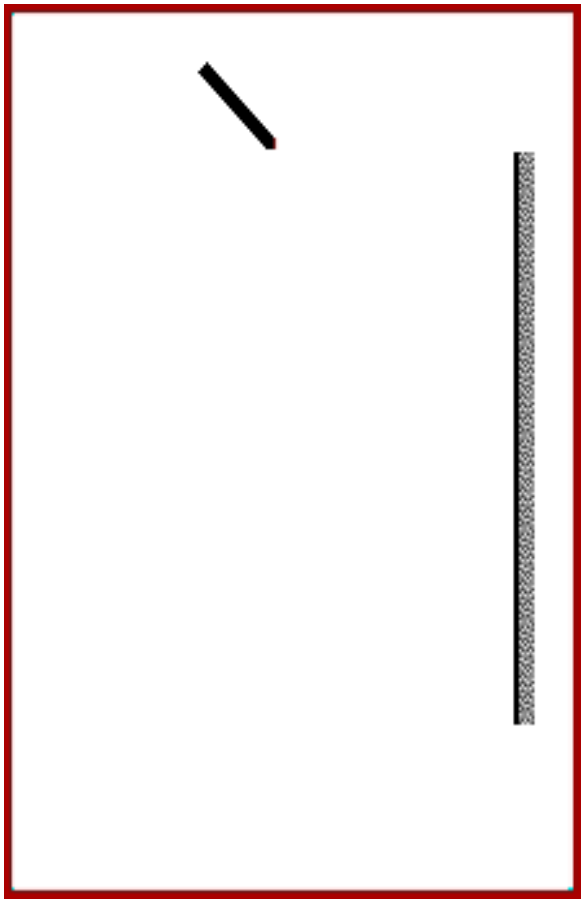
- **Reflection**
  - when a wave strikes an object and bounces off





Reflection

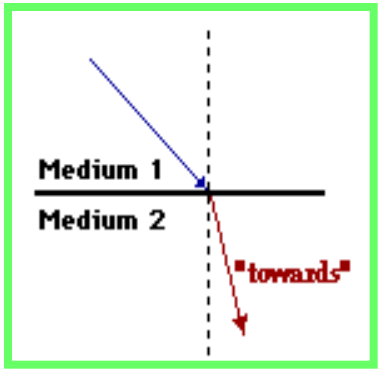
- **Law of Reflection**
  - the angle of incidence equals the angle of reflection



Refraction

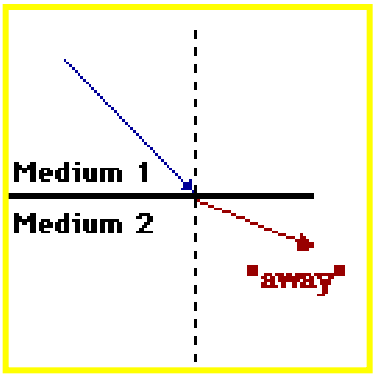
- **Refraction**
  - bending of waves when passing from one medium to another
  - caused by a change in speed
    - slower (more dense) ⇒ light bends in

SLOWER



    - faster (less dense) ⇒ light bends out

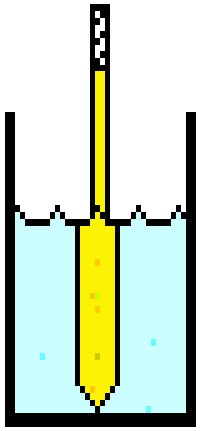
FASTER



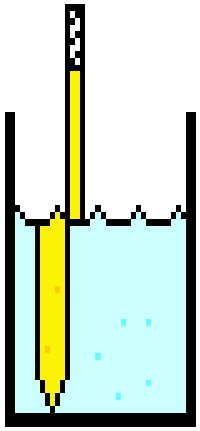
Refraction

When light rays enter a new medium they change in speed, causing them to bend or change direction.

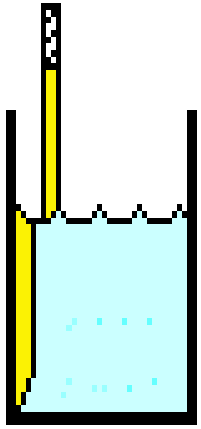
The Broken Pencil Observation



Pencil placed in exact center of container.



Pencil placed to the left of the center.



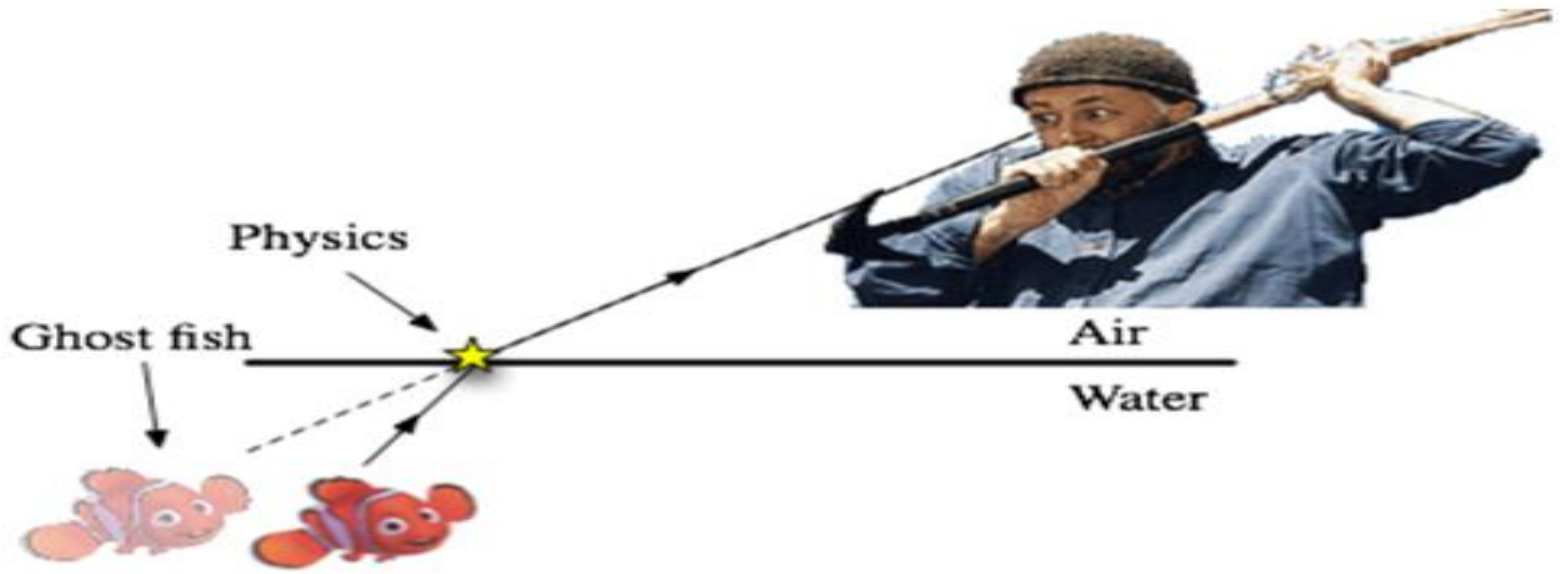
Pencil placed on far left side of container.

Refraction may cause you to see something that may not actually be there.

What is the index of refraction?

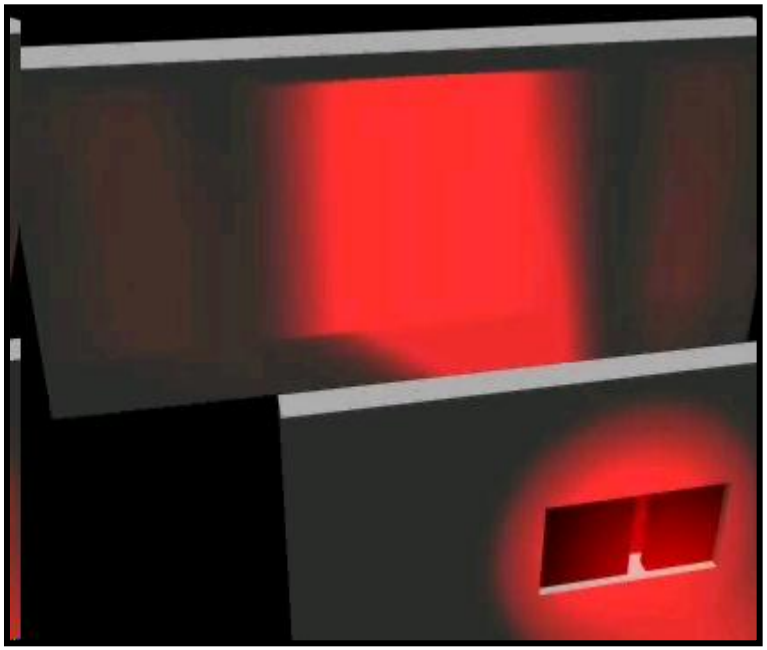
Examples of refraction:

- How much a ray of light bends when it enters a new medium.
  - Air to water



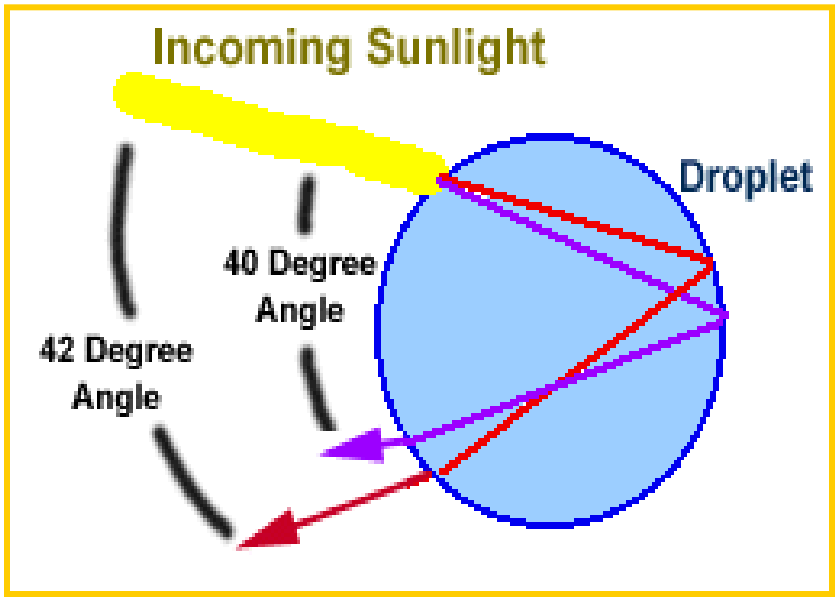
Diffraction

- **bending of waves around a barrier**



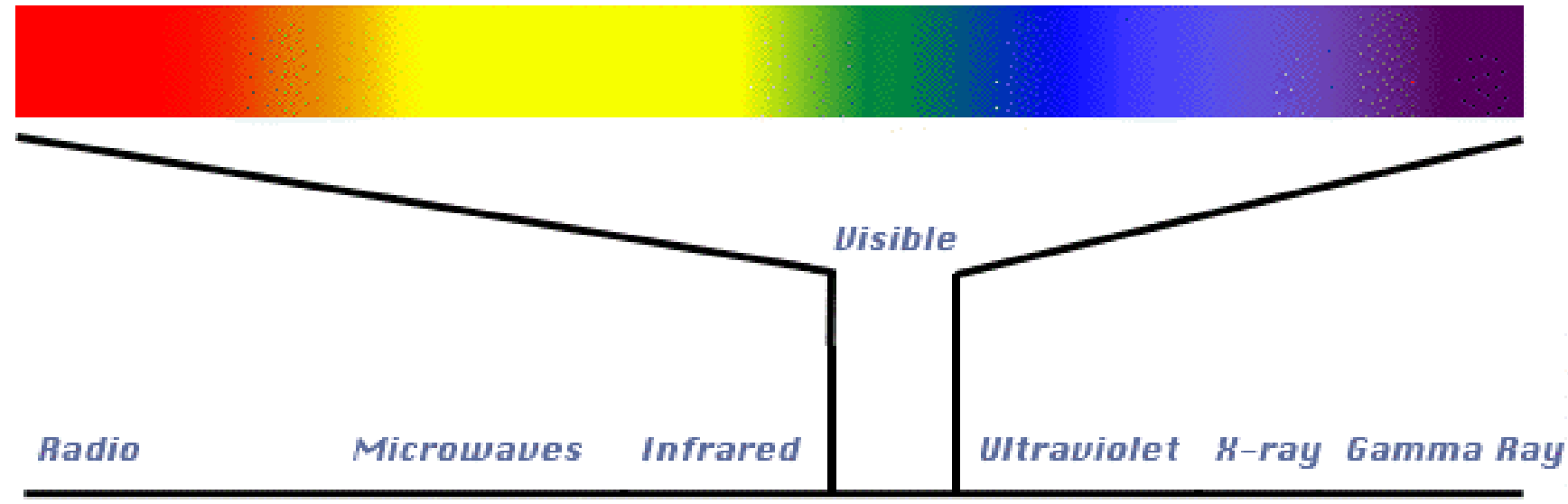
Cool Applications!

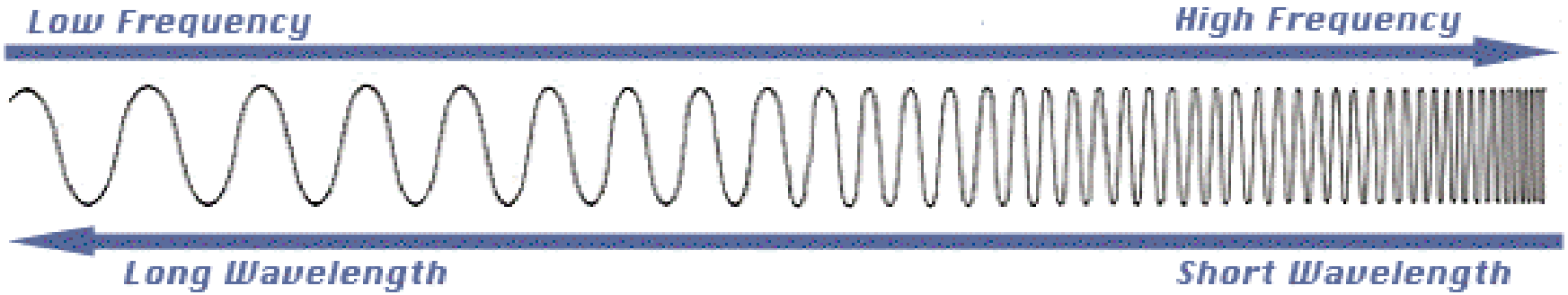
- **Rainbows**
  - refraction-reflection-refraction



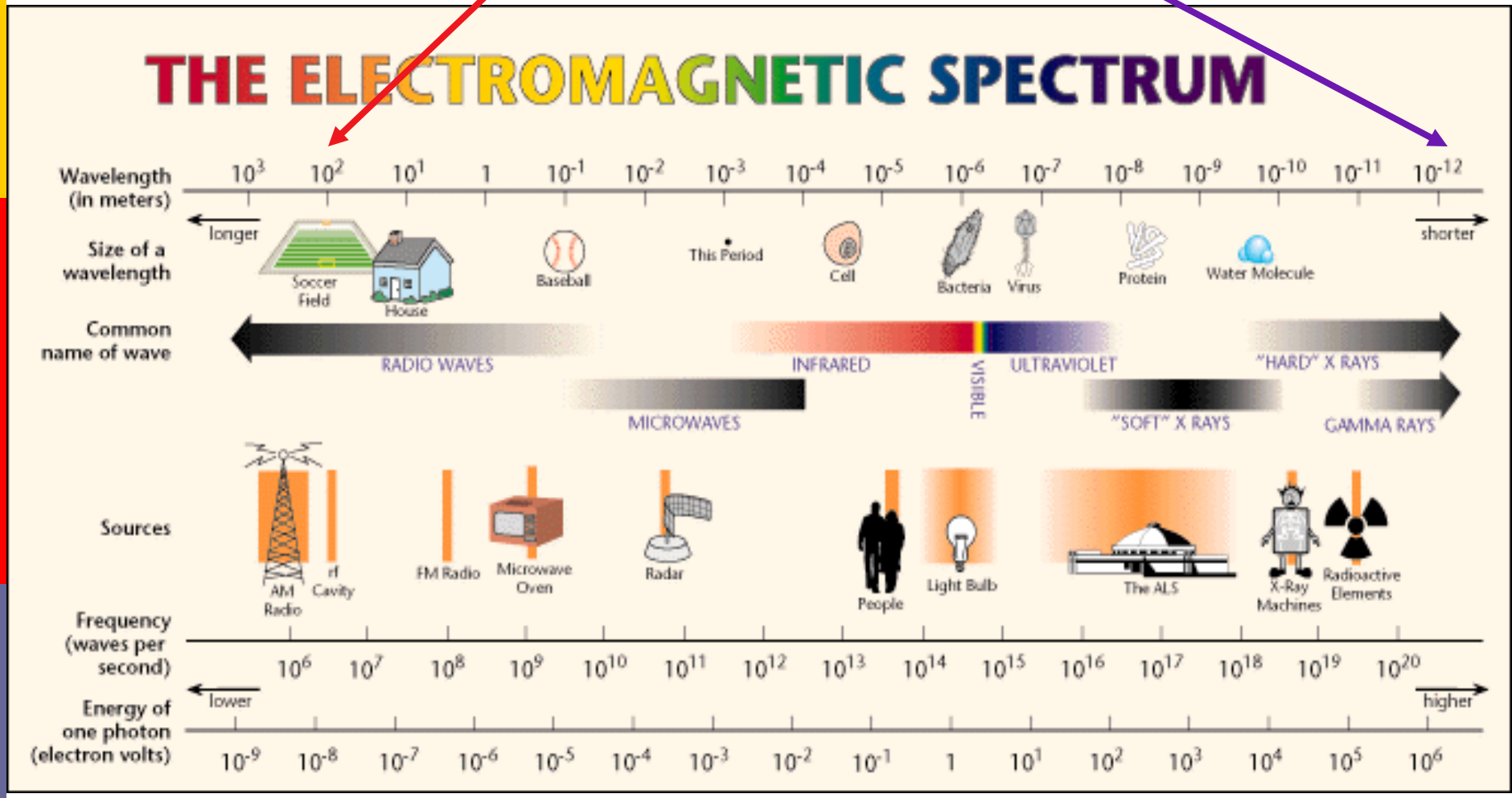
EMS waves

- Long wavelength : Low Frequency & Low Energy
- Short wavelength : High Frequency & High Energy





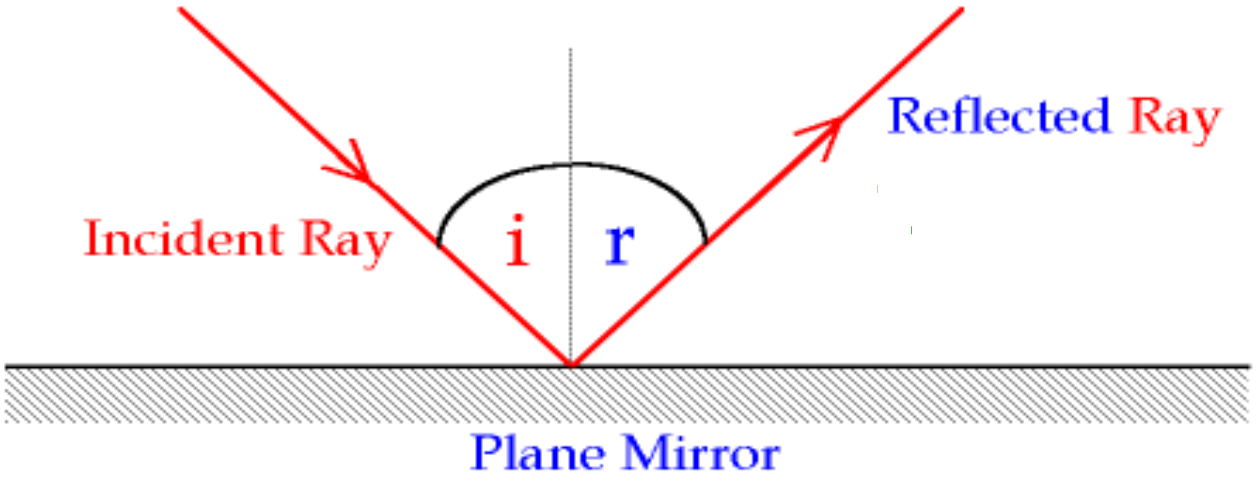
Don’t’ forget…longest waves (radio) ..to shortest waves (cosmic)



*Page info from NSAT Conference 20

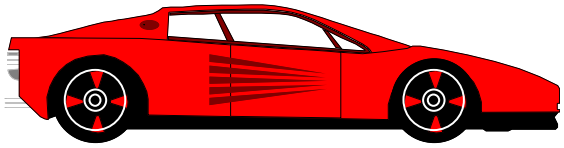
LIGHT & ITS USES: Mirrors

- Plane Mirrors –
  - Perfectly flat
  - Gives a reverse image
  - Direct reflection of light waves

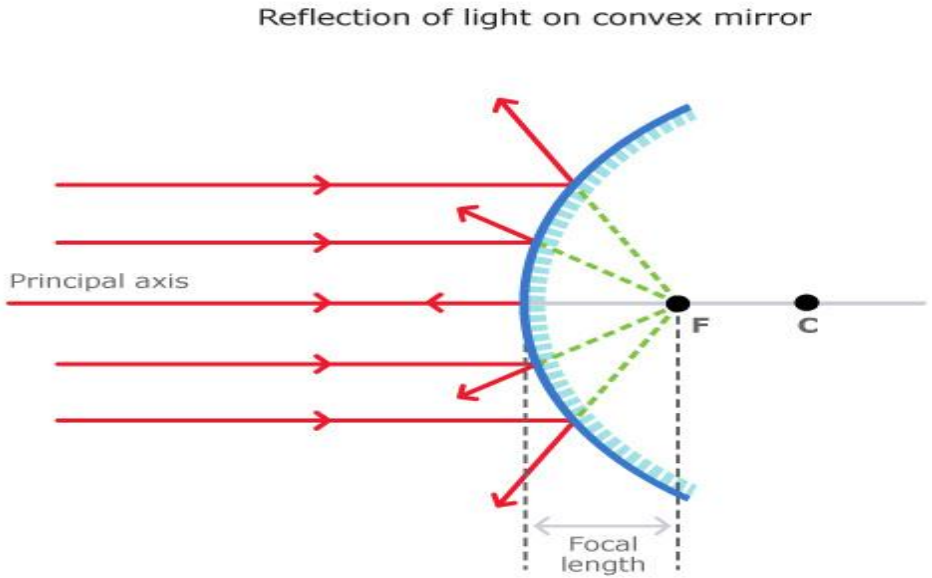


LIGHT & ITS USES: Mirrors

- Convex Mirror
  - Curves outward
  - Makes images appear smaller but gives a wider fieldof view

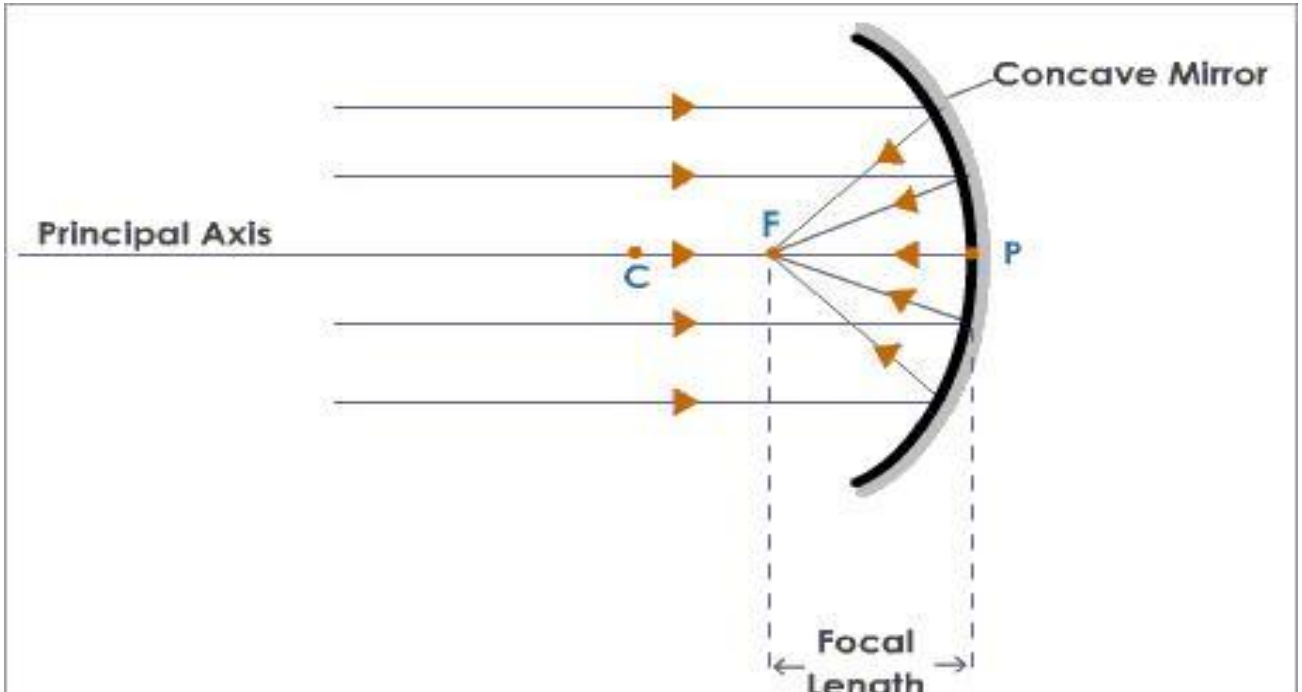


- Uses:Rear view mirrors, store security…



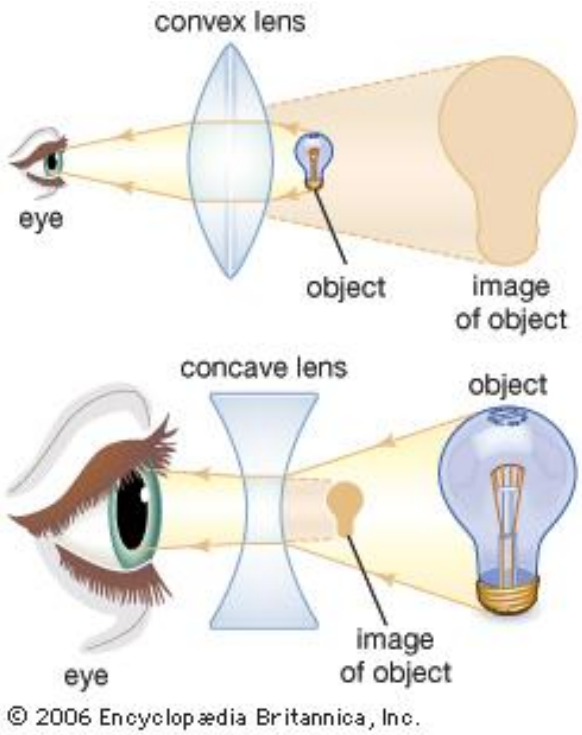
LIGHT & ITS USES: Mirrors

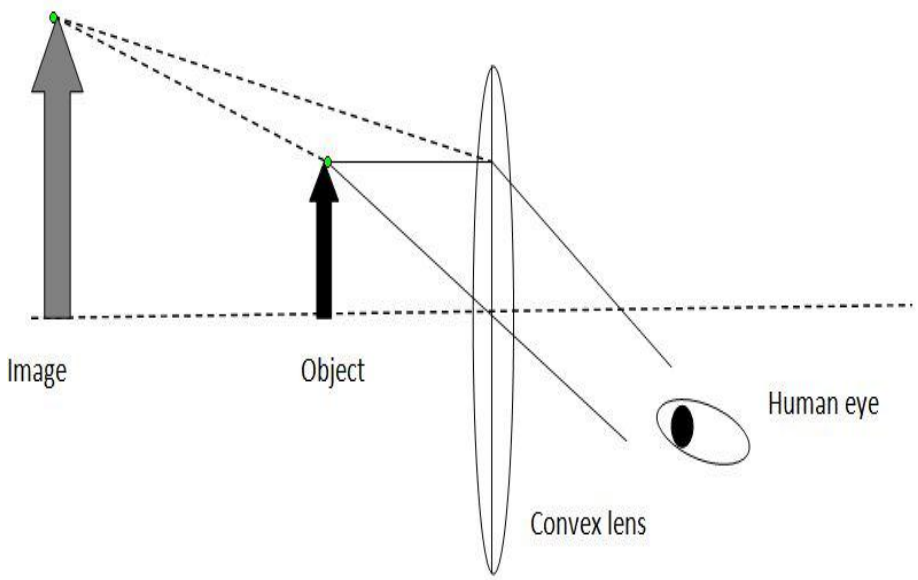
- Concave Mirror
  - Curves inward
  - Enlarges images.
- Uses: make-up mirrors, magnifying mirrors



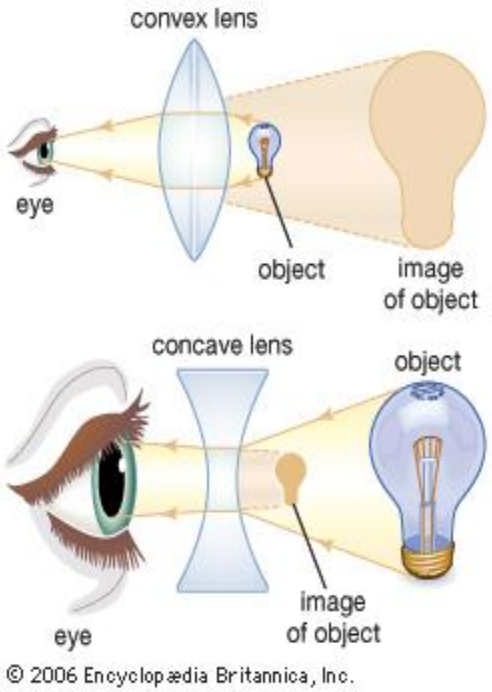
LIGHT & ITS USES: Lenses

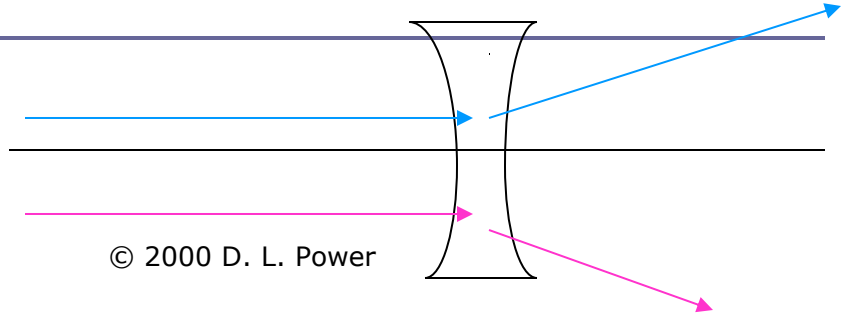
- Convex Lenses
  - Thicker in the center than edges.
  - Lens that converges (brings together) light rays.
  - Makes objects appear larger





LIGHT & ITS USES: Lenses





- Concave Lenses –
  - Lens that is thicker at the edges than in the center.
  - Diverges light rays
  - Makes objects appear smaller