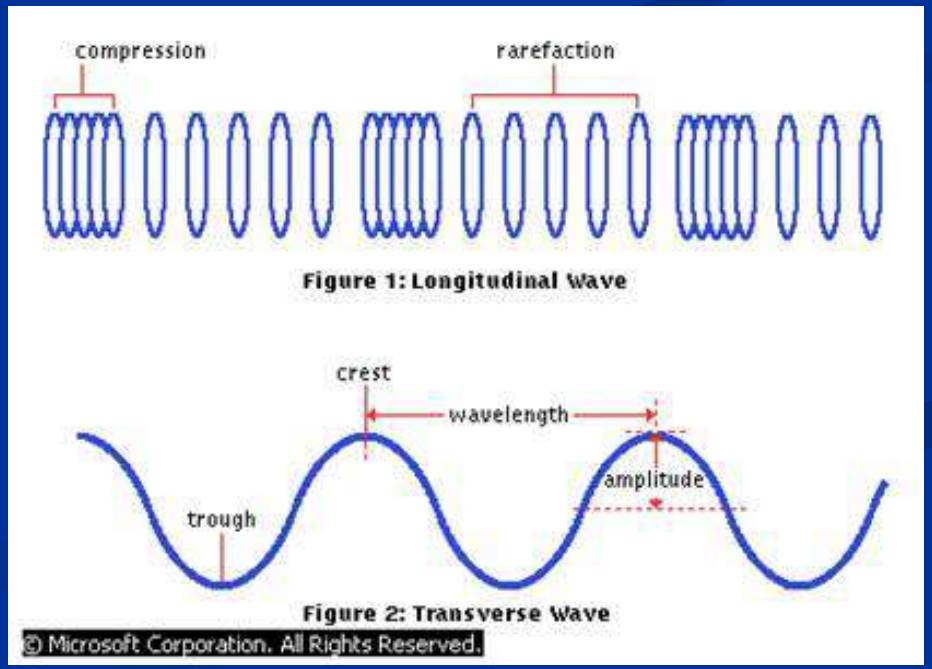
Physical Science

Chapter 17

Characteristics of Waves

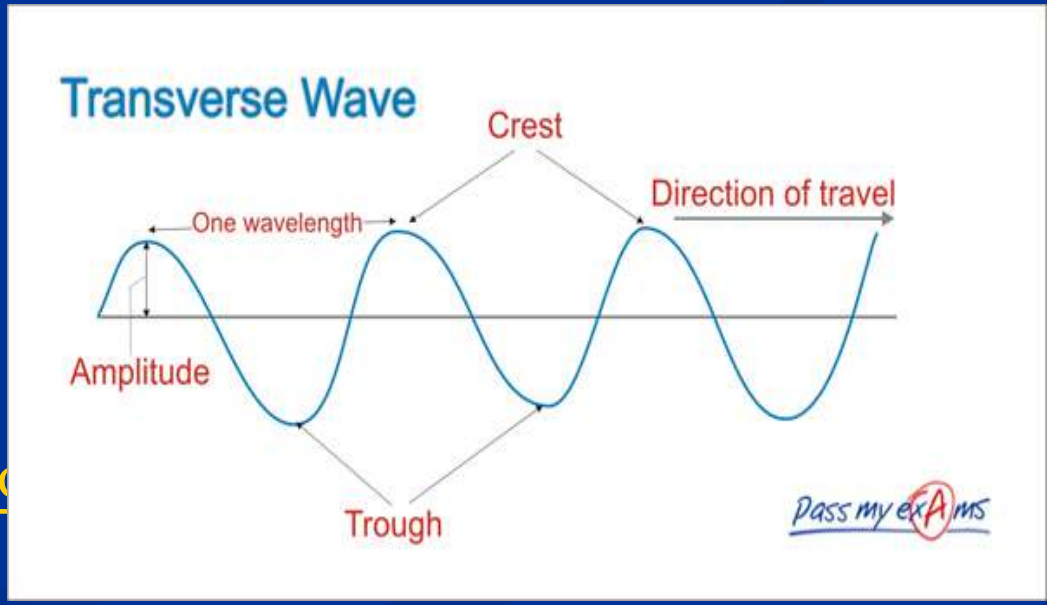
What are waves?

- **Wave** – when energy moves through a medium as a vibration
- **Medium** – the material through which a wave passes
  - Waves travel through the medium without actually moving the medium with it.
- 3 main types
  - Transverse
  - Longitudinal
  - Surface



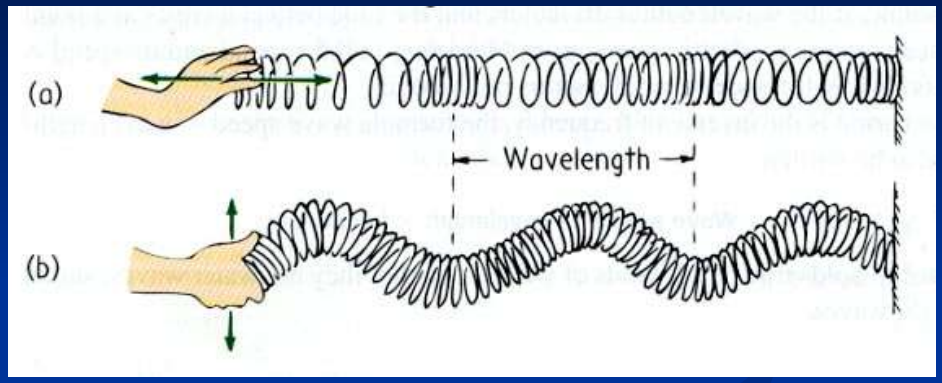
Transverse Waves

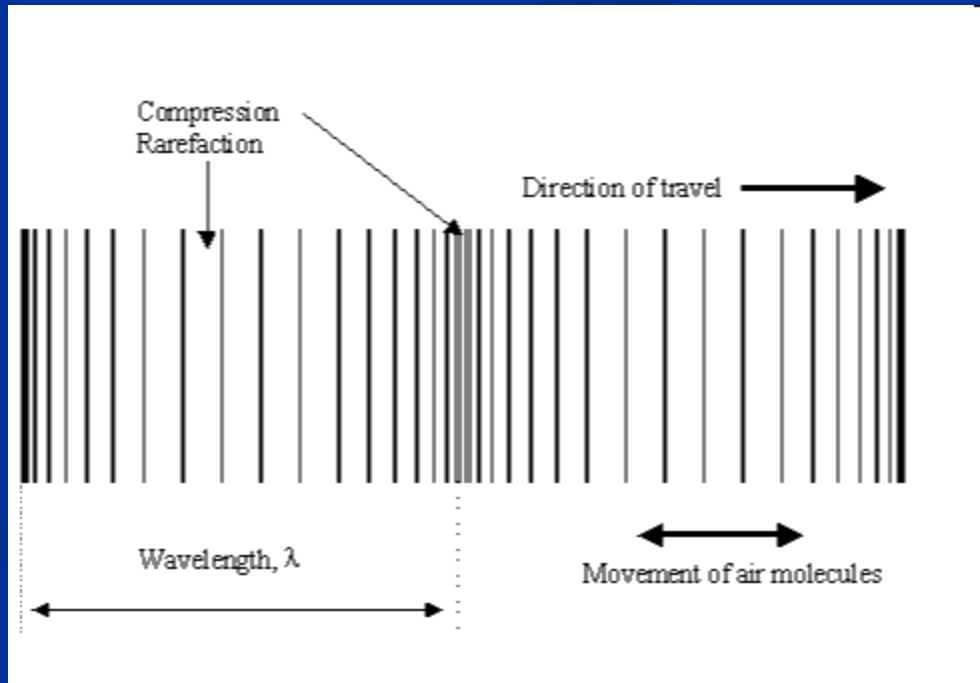
- Cause the medium to vibrate at right angles to the direction the wave travels
- Has a crest (top) and trough (bottom)
- Draw this!!!
- Example – ripple on a pond
- Transverse Wave Video
- Wave animation



Longitudinal Waves

- move particles parallel to the direction the wave is moving, "push-pull" waves.
  - Example – sound waves in air
- Draw this!
- Video clip transverse vs. longitudinal waves
- Has compression and rarefaction (decompression)





Surface Waves

- Travel on a surface separating 2 media
- object on the surface moves in circles - a combo of transverse and longitudinal wave movement
- Example – ocean waves
- Ocean waves animation

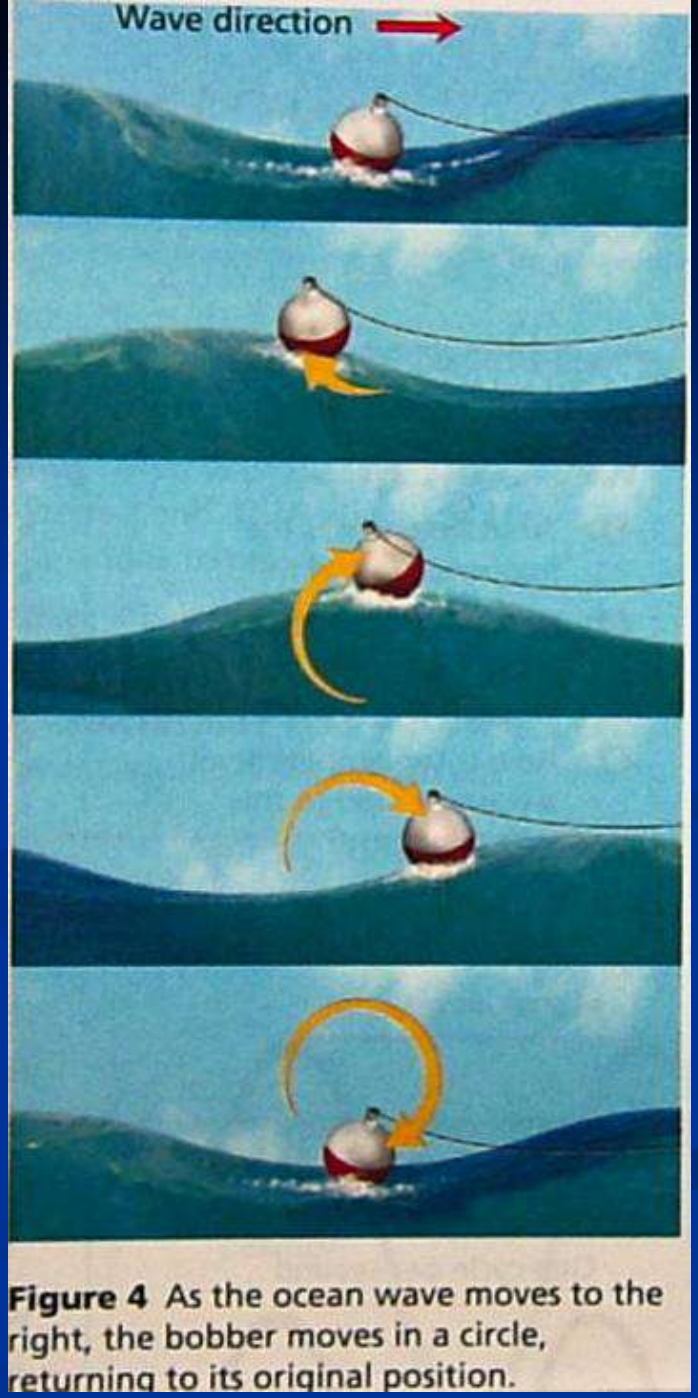


Figure 4 As the ocean wave moves to the right, the bobber moves in a circle, returning to its original position.

Ocean Waves Near Shore

- Wave simulation
- Waves near shore will break and carry the medium with it, which is why seaweed washes up on shore
  - Waves far from shore continue as usual

Properties of Waves

- Period (T)
- Frequency (*f*)
- Wavelength (λ)
- Speed (v)
- Amplitude

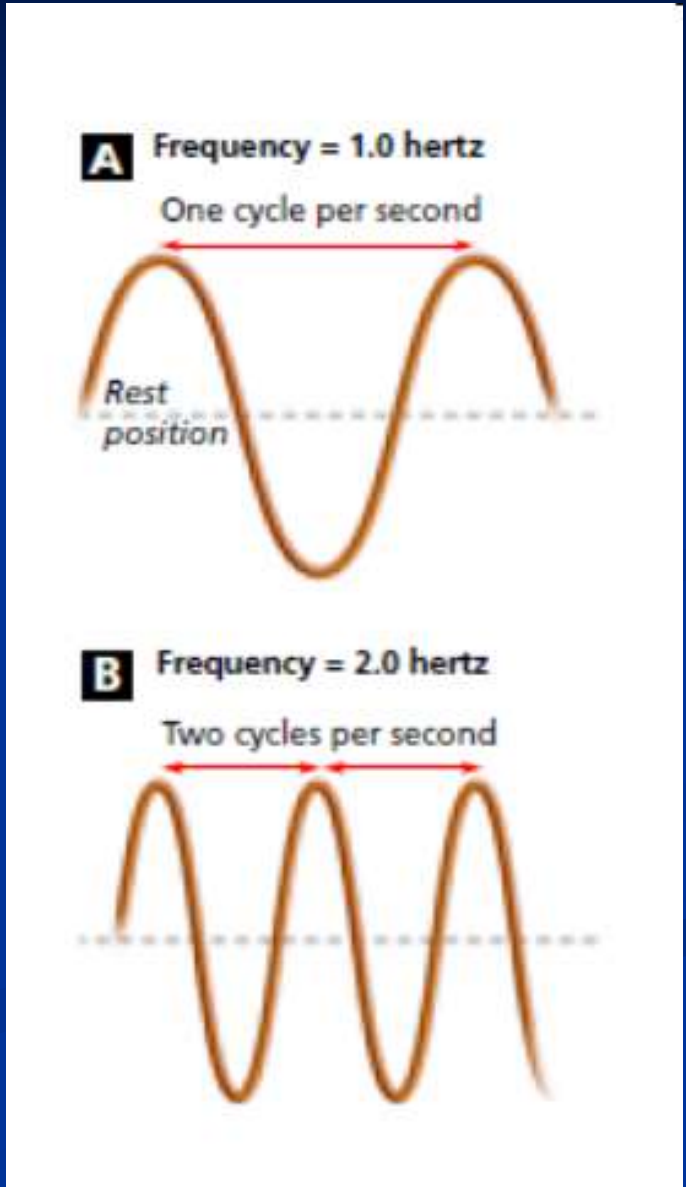
- Properties of waves video clip

Period and Frequency

- **Period (T)** - time required to go through one cycle. Measured in seconds

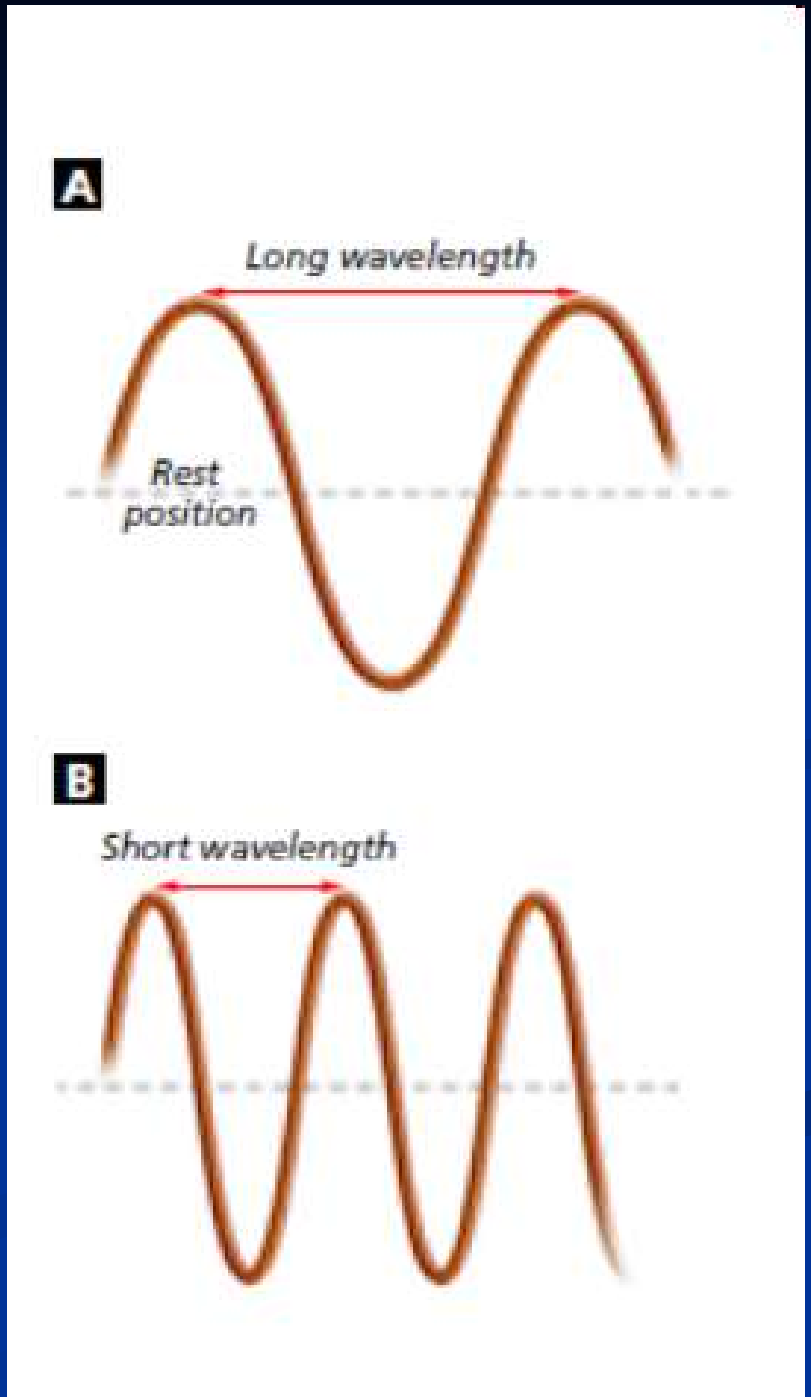
- **Frequency (*f*)-** number of cycles in a certain time.

- $f = 1/T$
- measured in s-1 or Hz
- HERTZ, one Hz



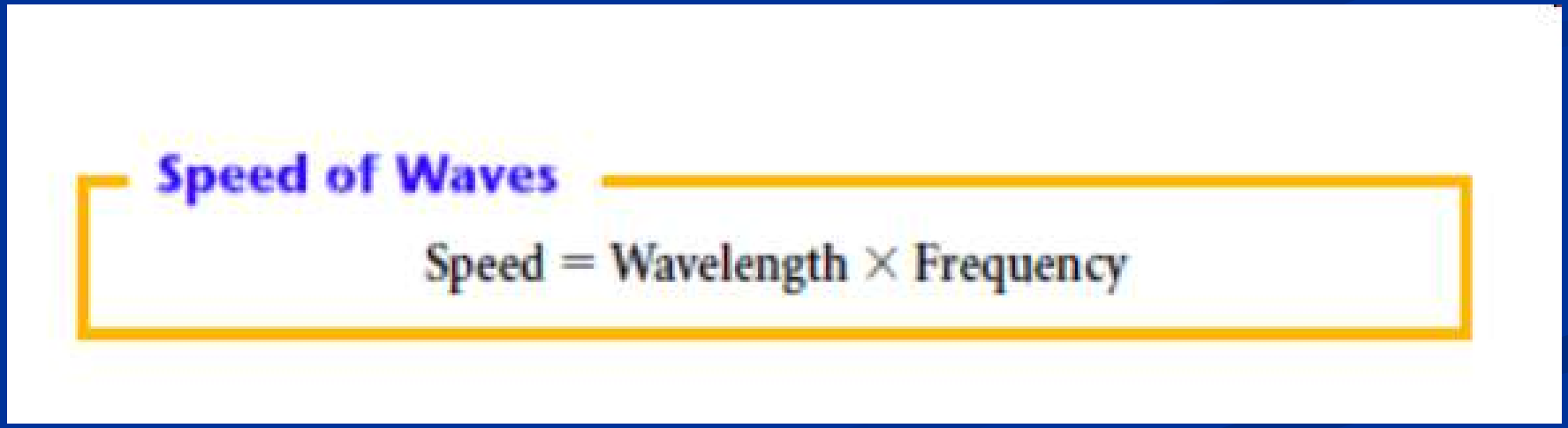
Wavelength

- **Wavelength (λ)-** distance between two identical points on consecutive waves
  - measured in meters (or km, cm, etc)
- Increasing the frequency of a wave decreases its wavelength.



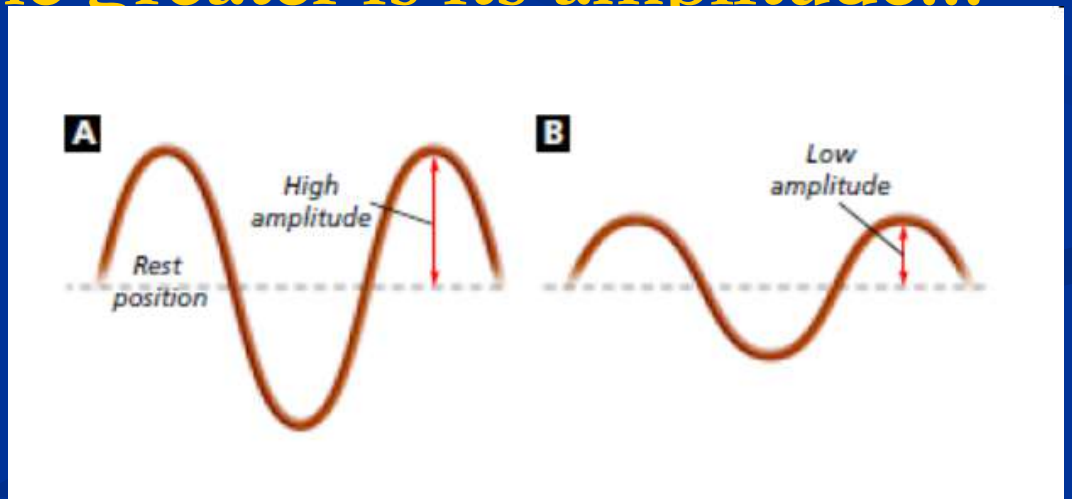
Speed

- Speed (v) - how fast the wave is moving
- $v = \lambda f$
- measured in m/s (or km/s, cm/s, etc)

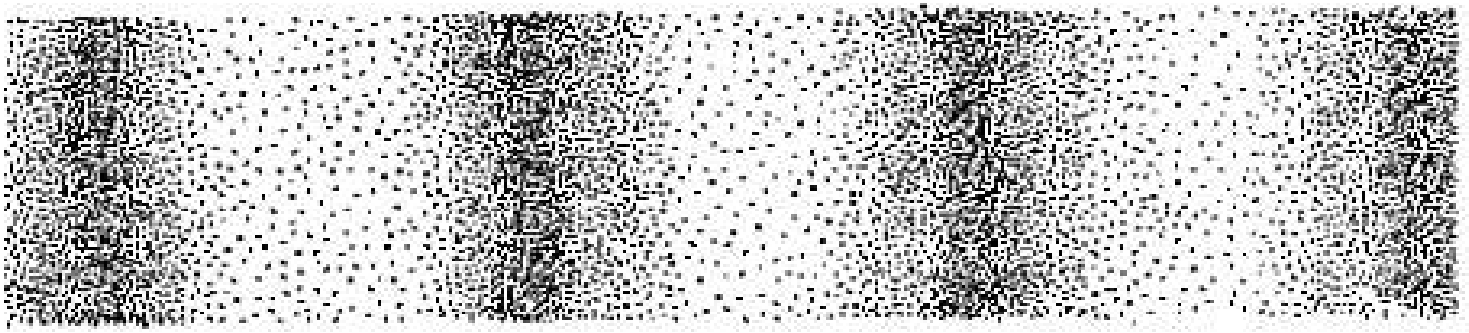


Amplitude

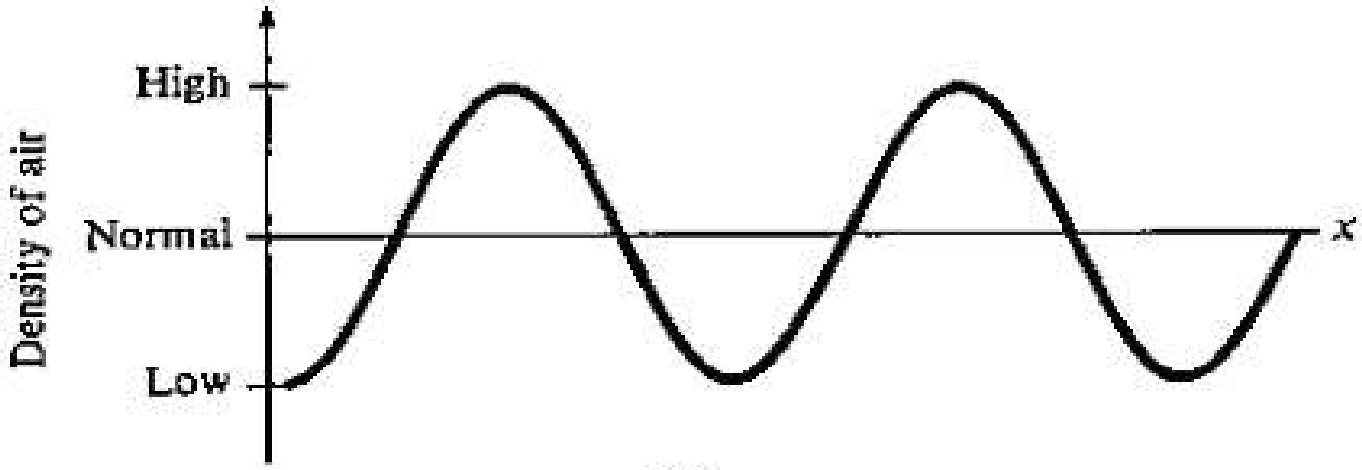
- **Amplitude -** max displacement from its rest position (also known as wave height)
- measured in meters (or km, cm, etc)
- Example – dropping a pebble in the water vs. doing a "cannonball" jump into the water
- **VERY IMPORTANT: The more energy a wave has, the greater is its amplitude!!!**



Label these waves…their type and parts. Also list examples of each!!



(a)



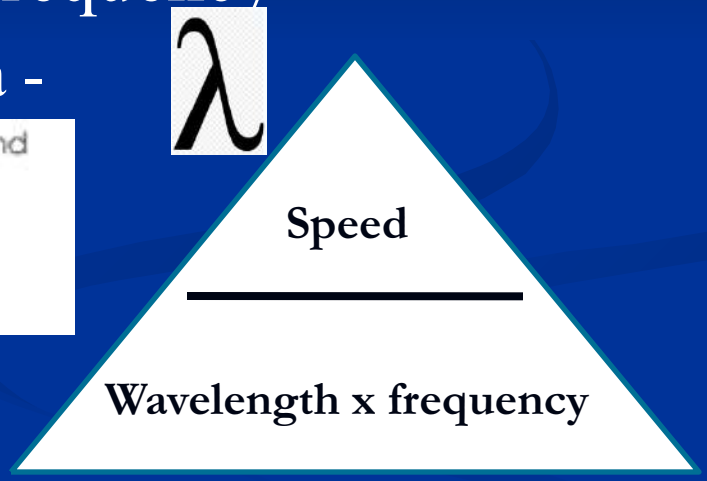
(b)

Speed Frequency & Wavelength

- Speed (meters/sec)= wavelength x frequency
- Frequency (Hz = 1/sec)= speed / Wavelength
- Wavelength (meters) = speed / Frequency
  - Designated by Greek letter lambda - λ

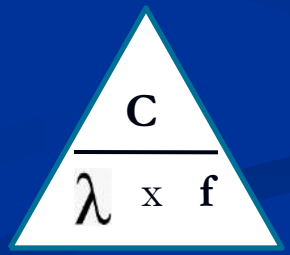
A tuning fork has a frequency of 280 hertz, and the wavelength of the sound produced is 1.5 meters. Calculate the velocity of the wave.

$C = \lambda \times f = 1.5\ m \times 280\ Hz = 420\ m/s$



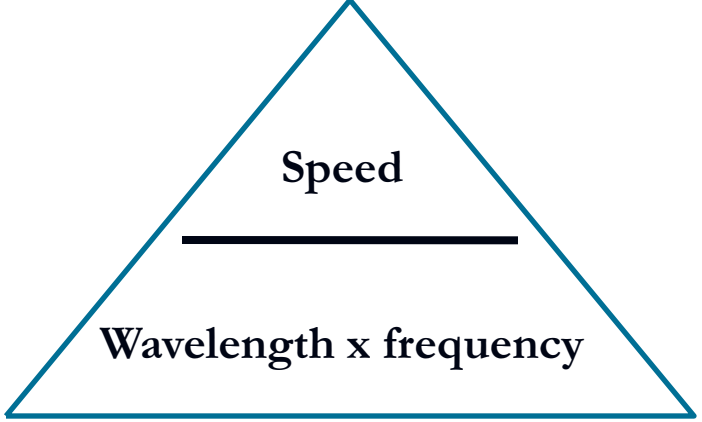
A wave is moving toward shore with a velocity of 5.0 m/s. If its frequency is 2.5 hertz, what is its wavelength?

$\lambda = C / f \quad \lambda = 5.0\ m/s \ / \ 2.5\ Hz \quad \lambda = 2\ m$



Math Practice

1. A wave on a rope has a wavelength of 2.0 m and a frequency of 2.0 Hz. What is the speed of the wave?
2. A motorboat is tied to a dock with its motor running. The spinning propeller makes a surface wave in the water with a frequency of 4 Hz and a wavelength of 0.1 m. What is the speed of the wave?
3. What is the speed of a wave in a spring if it has a wavelength of 10 cm and a period of 0.2 s?
4. What is the wavelength of an earthquake wave if it has a speed of 5 km/s and a frequency of 10 Hz?



p.506 in textbook

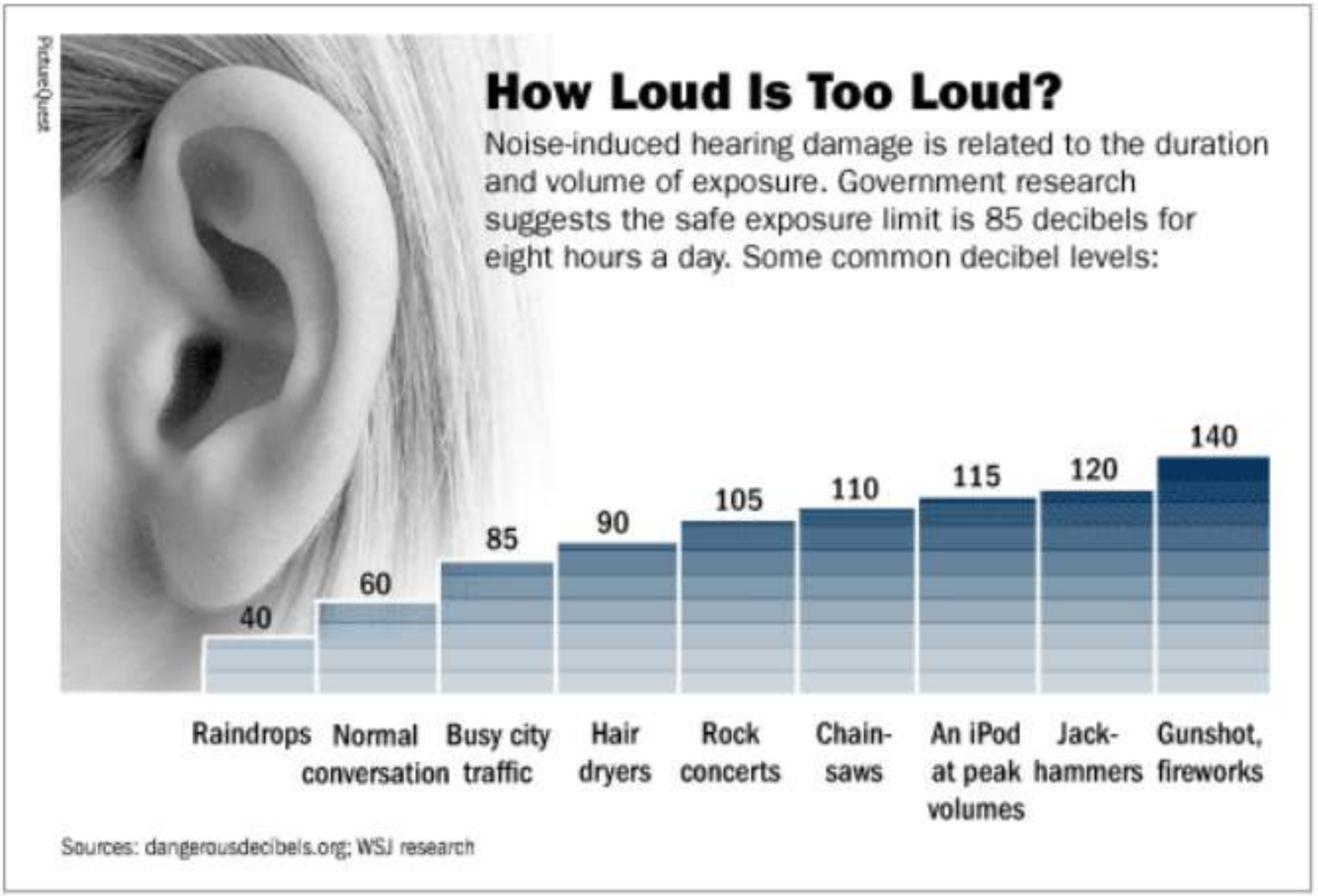
Sound and Hearing

17-4

Properties of Sound Waves

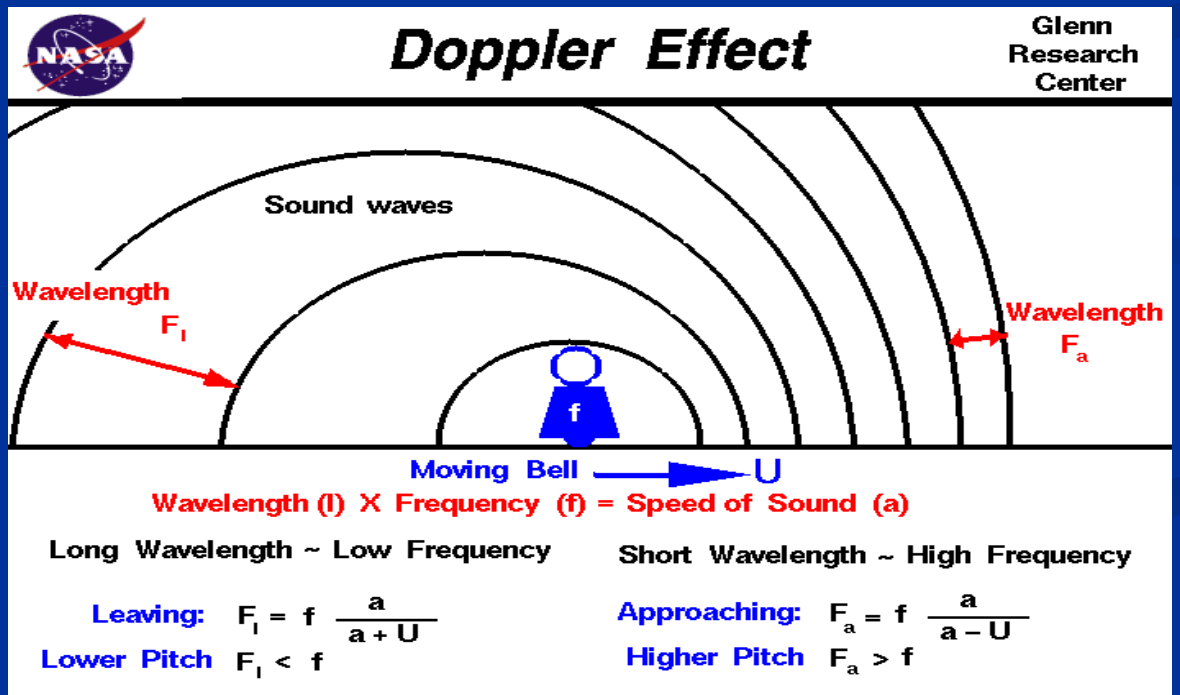
- Longitudinal waves
- **speed**- travels at different speeds in different mediums
- air- 343m/s fresh water- 1510m/s Salt water- 1550m/s
- Aluminum- 5000m/s
- **Intensity**- rate at which a wave's energy flows through an area
- measured in Decibels, dB
- **Loudness**- physical response to sound
- **Pitch**- frequency of sound as you hear it. Higher frequency, higher note
- Infrasound and Ultra sound

Mythbusters Helium Video



The Doppler Effect

- Change in frequency due to motion of source, listener, or both
- Ex: When a vehicle sounding a siren or horn approaches, passes, and recedes from an observer.



Sonic Boom- breaking of sound barrier

- Basically the object goes faster than the speed of sound

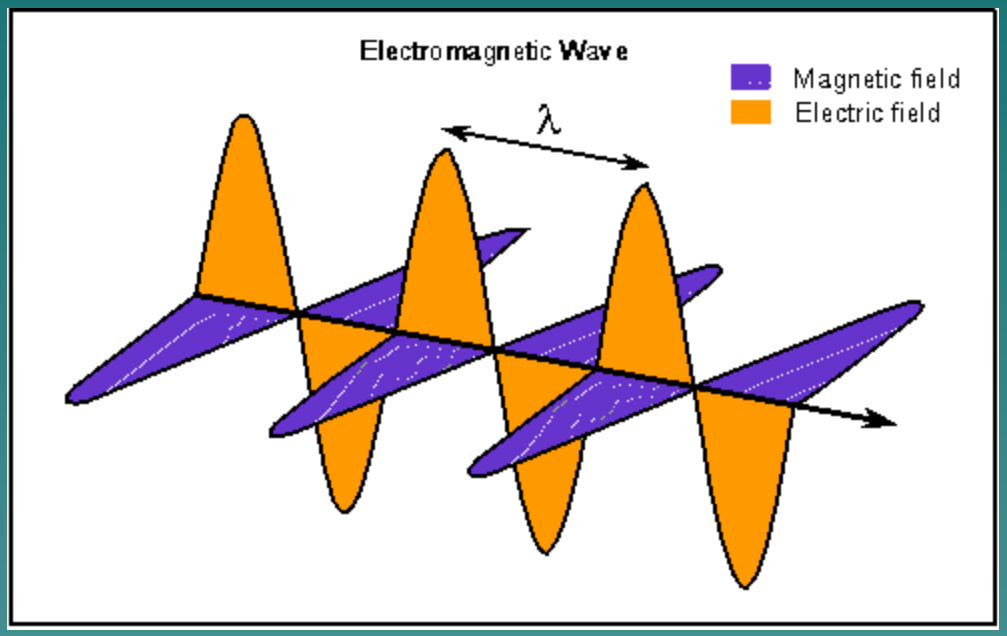
- http://www.kettering.edu/~drussell/Demos/doppler/doppler.html

- Sonic boom explained

Video Clip

- Sonic Boom
- Sonic boom explained
- Deadliest catch – monster waves
- World's Biggest Wave ever surfed

Chapter 18



The Electromagnetic Spectrum and Light

Electromagnetic Waves

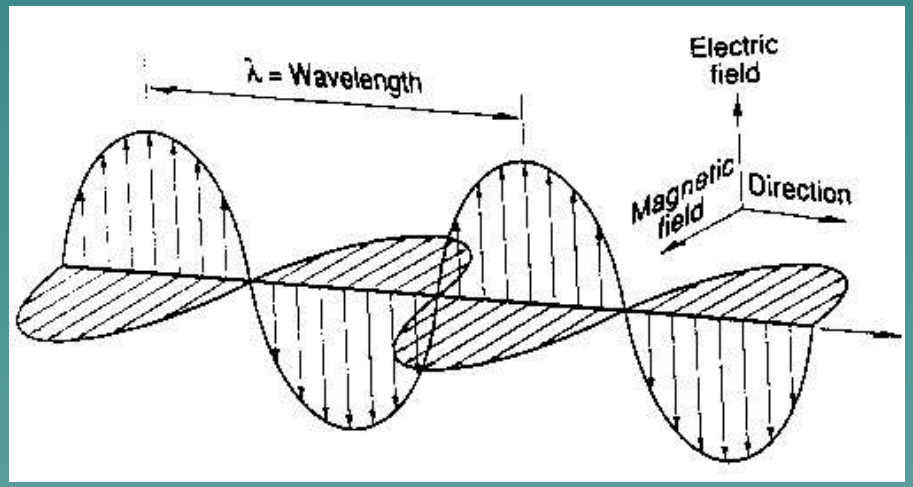
- **transverse waves** consisting of alternating electric and magnetic fields.
- Can travel through a vacuum
- Travel at the speed of light (c)
- $v = 3x10^8$ m/s = c
- Found by Michelson's experiment
- Pg 535: 1-3
- Michelson-Morley Experiment

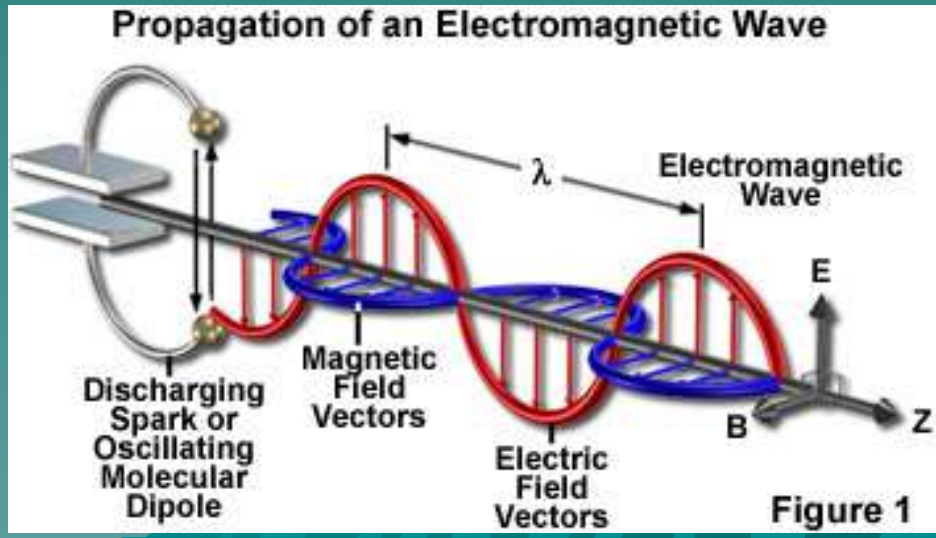
Electromagnetic Radiation

- EMR requires no medium to travel- can travel thru a vacuum
- Speed
  - 300,000 kilometers /sec
  - 186,000 miles /sec
- Consists of changing electric and magnetic fields

Changing electric and magnetic fields

- Electric field is a region where particles can be pushed or pulled.
  - Wherever there is an electric charge there is an electric field associated w/it.
  - A moving electric charge is part of an electric current
  - An electric current is surrounded by a magnetic field
- A magnetic field is a region in which magnetic forces are present
- When electric field changes – so does the magnetic field.





EMR - Wave or Particle?

- Acts like a wave sometimes – ie: Polarizing Filter

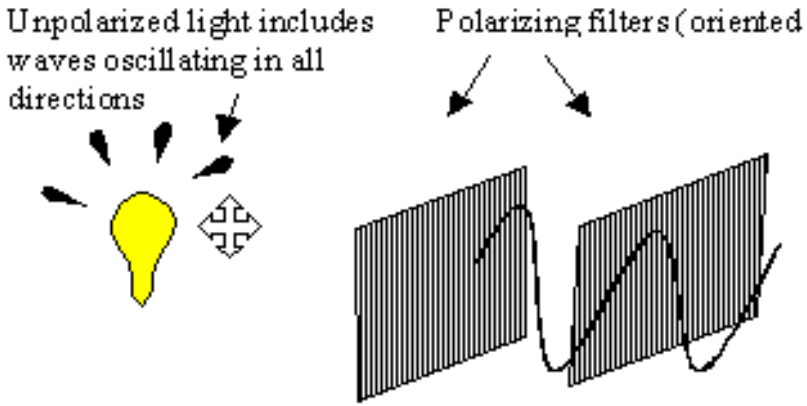


Figure 2a: Light from an incandescent bulb vibrates in all directions. Two vertically oriented polarizing lenses will allow only the vertically polarized light through and will block out the horizontal components.

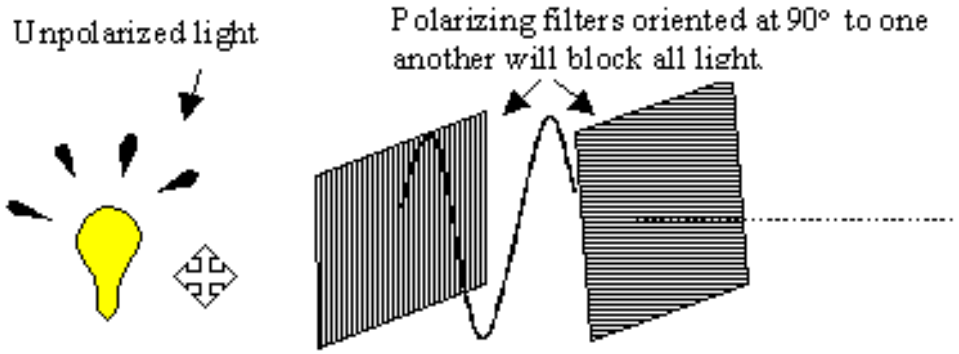
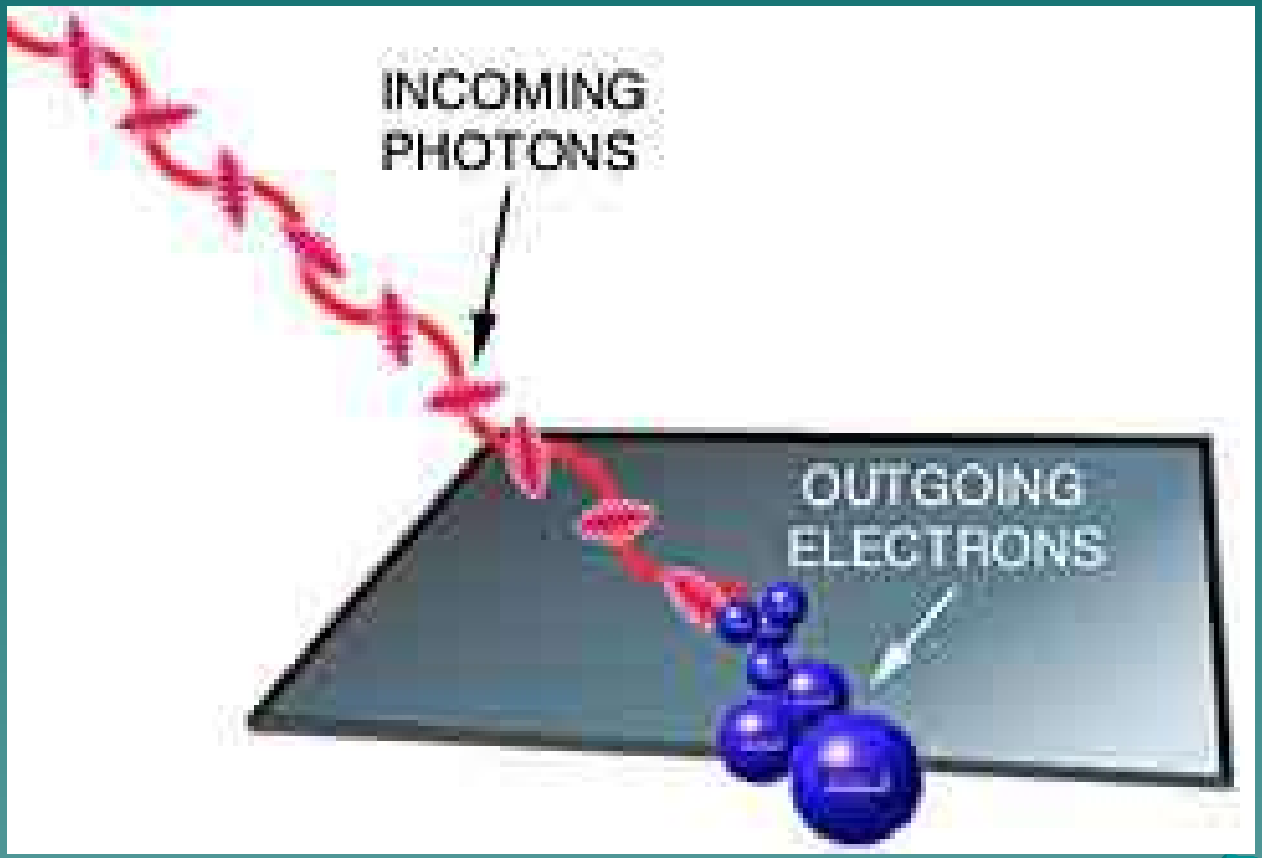


Figure 2b: When the two polarizing filters are placed perpendicular to one another, the first will block all but the vertically polarized waves while the second is oriented only to allow horizontally polarized waves to pass.

EMR - Wave or Particle?

- **Acts like a particle, a photon, sometimes – ie: Photoelectric Cell**



- **Particle-Wave Duality**

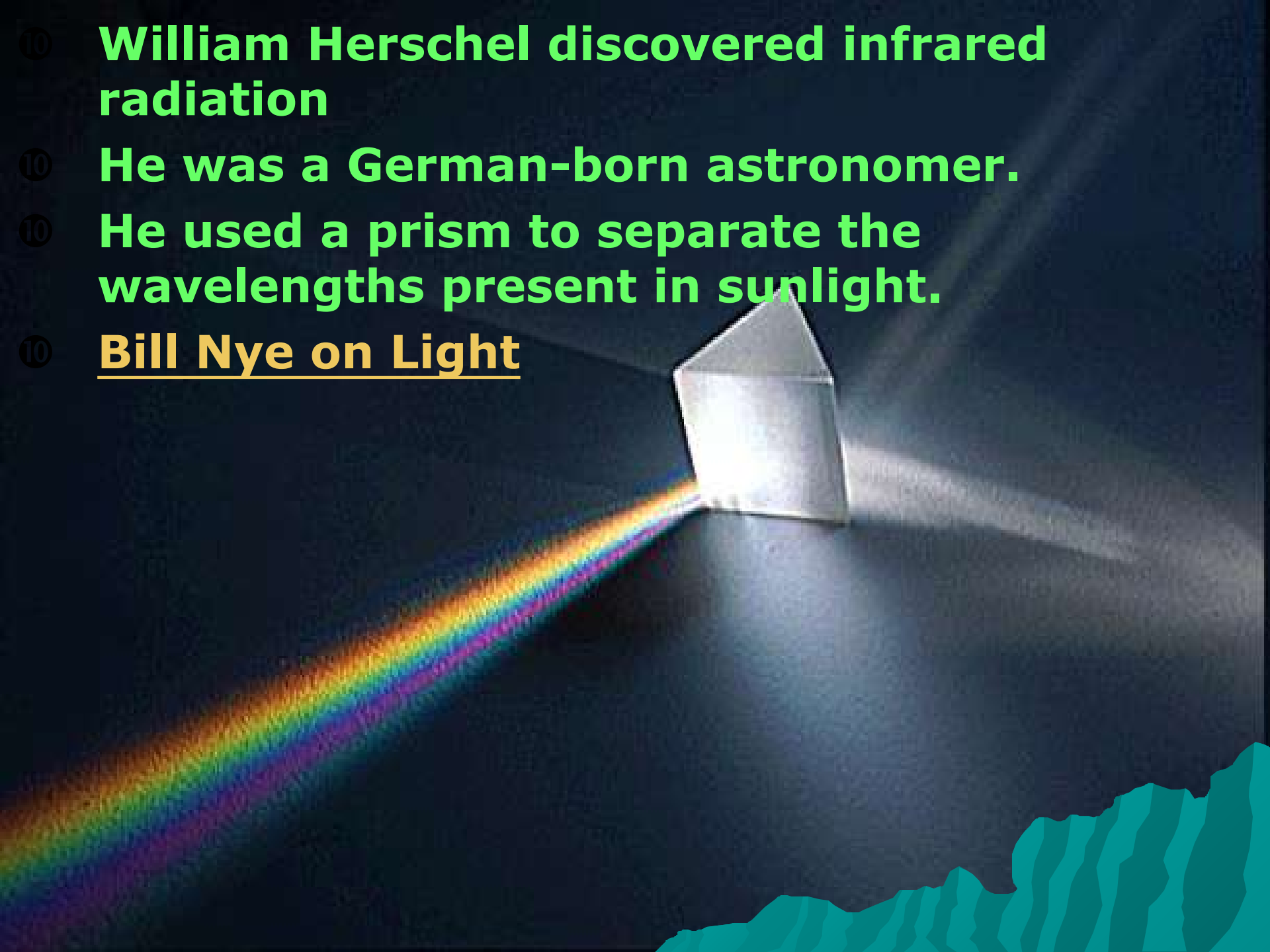
Is light a Solid?

- EMR travels as a wave but can behave like a stream of particles
- Wave model- Young's Experiment showed interference
- Particle model- photoelectric effect is emission of electrons from light hitting metal
- Photons

Intensity

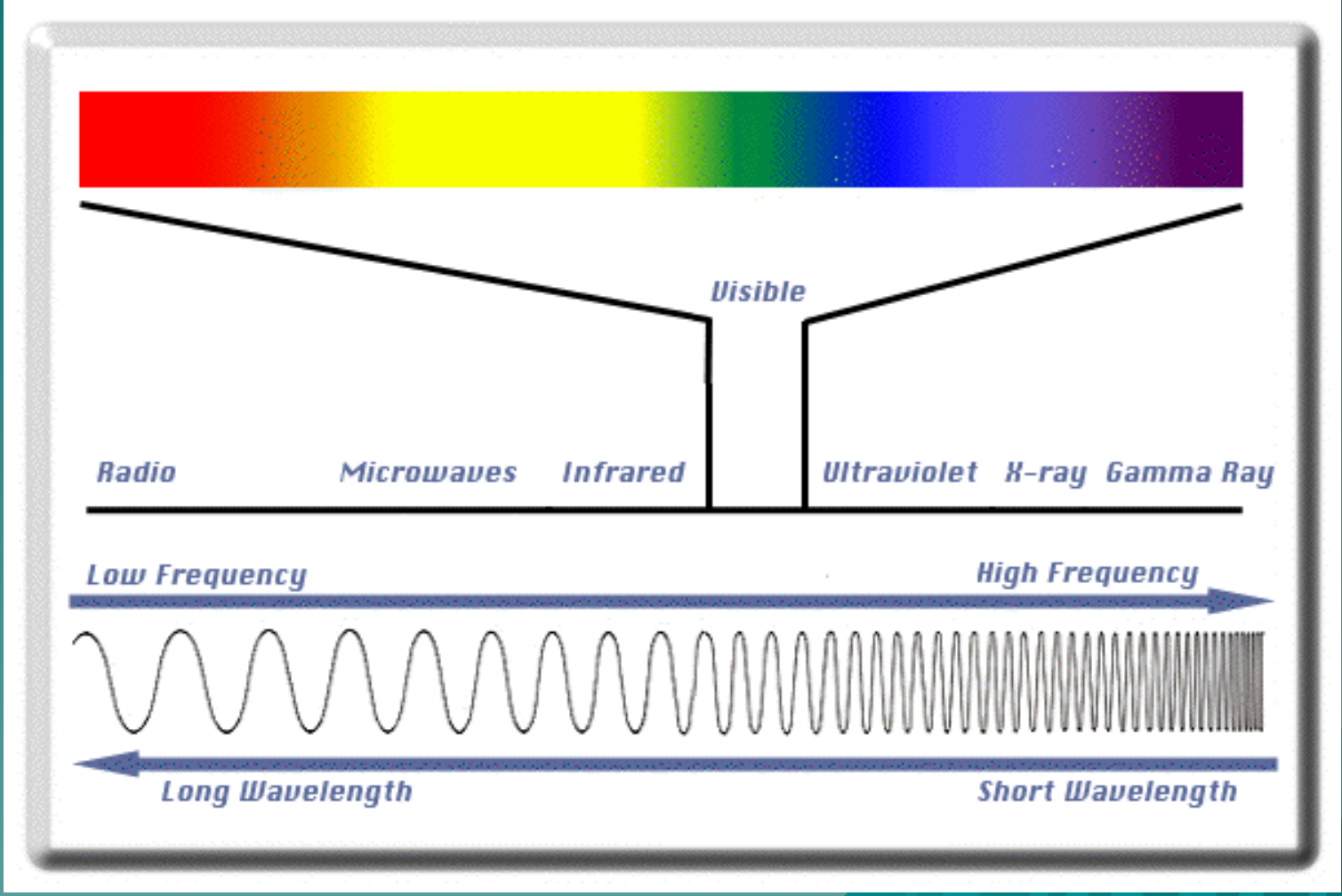
- Rate at which a waves energy flows through an area
- Intensity decreases as distance apart increases
- Think about how bright stars are

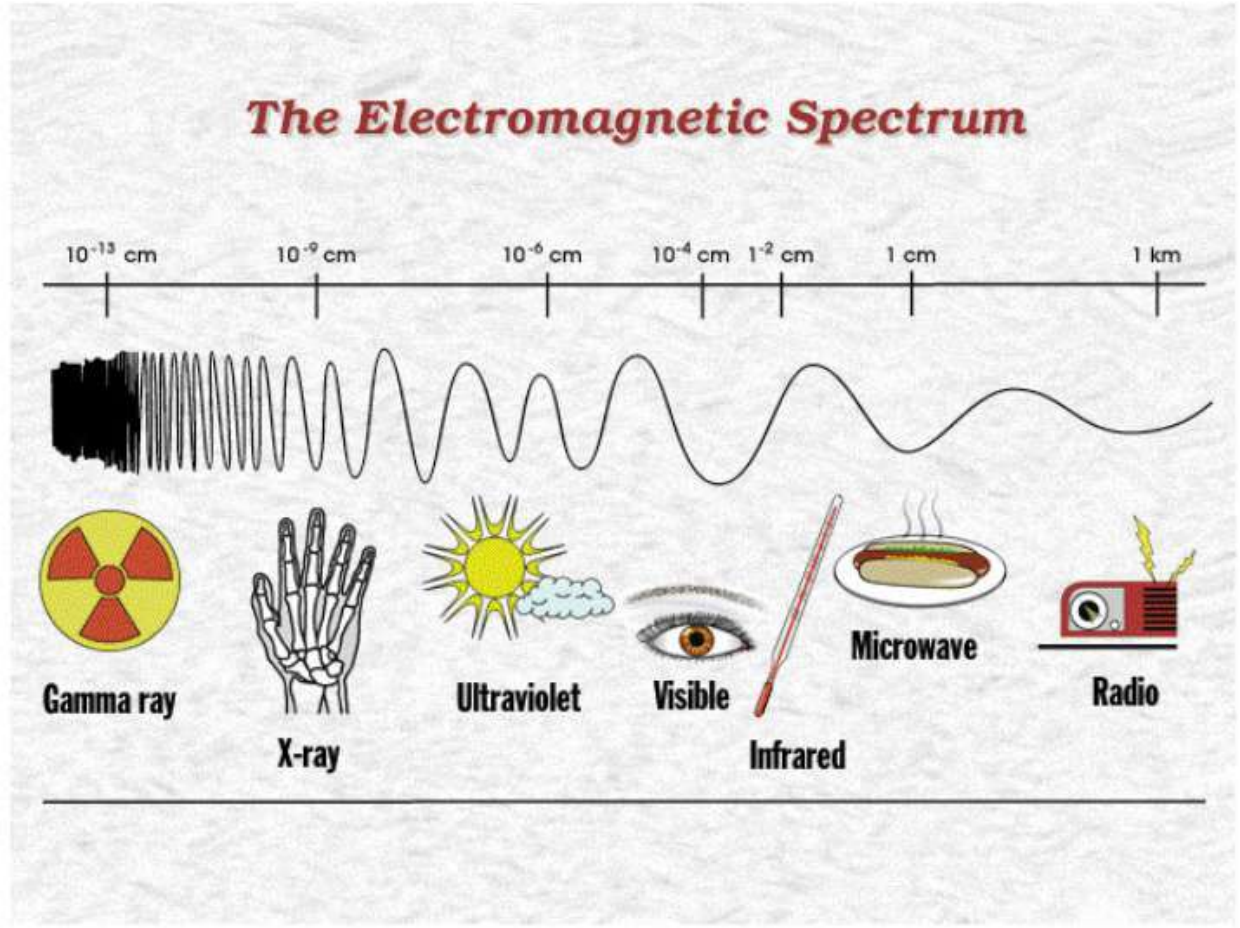
- **William Herschel discovered infrared radiation**
- **He was a German-born astronomer.**
- **He used a prism to separate the wavelengths present in sunlight.**
- **Bill Nye on Light**



EMS waves

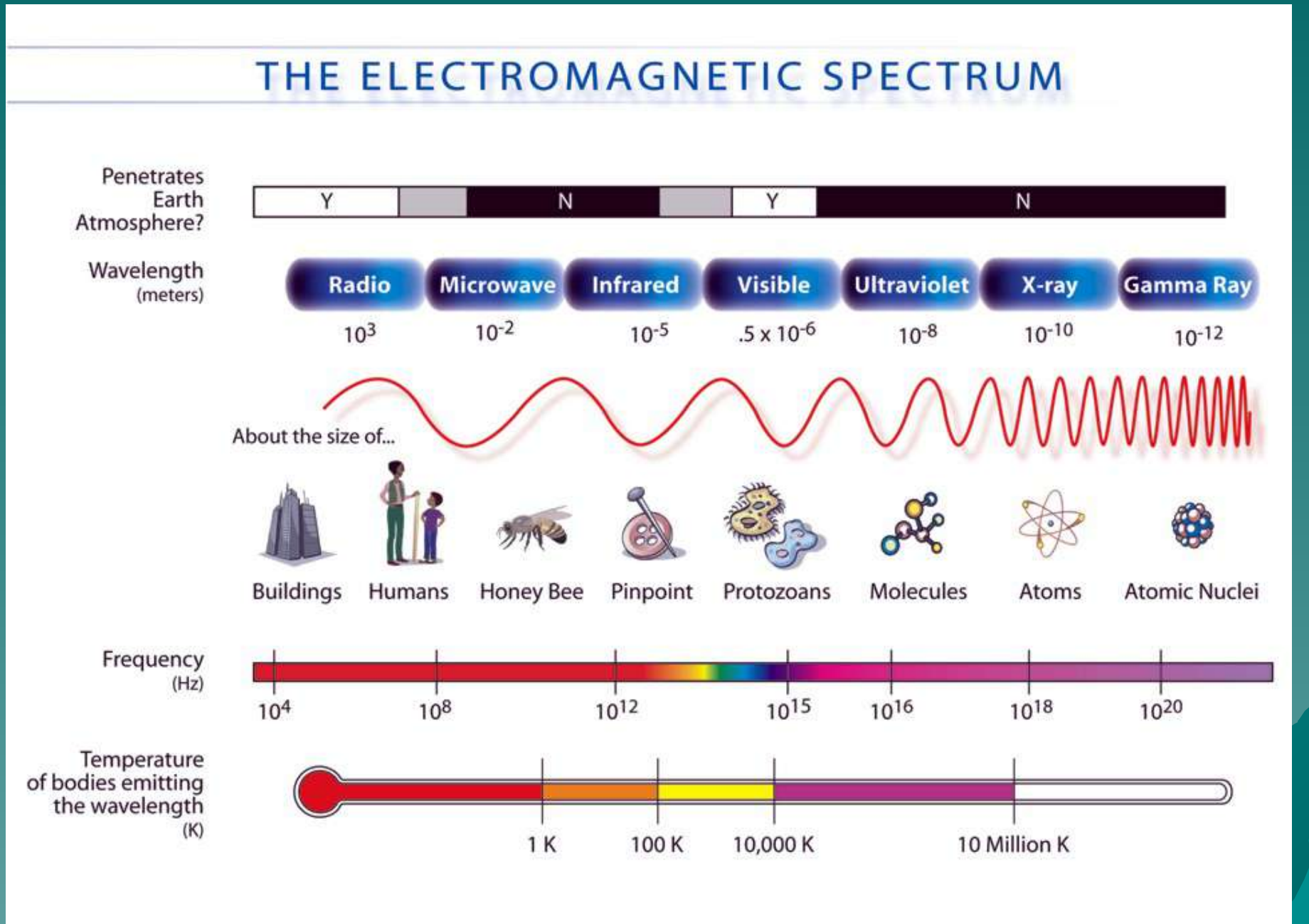
- Long wavelength : Low Frequency & Low Energy
- Short wavelength : High Frequency & High Energy



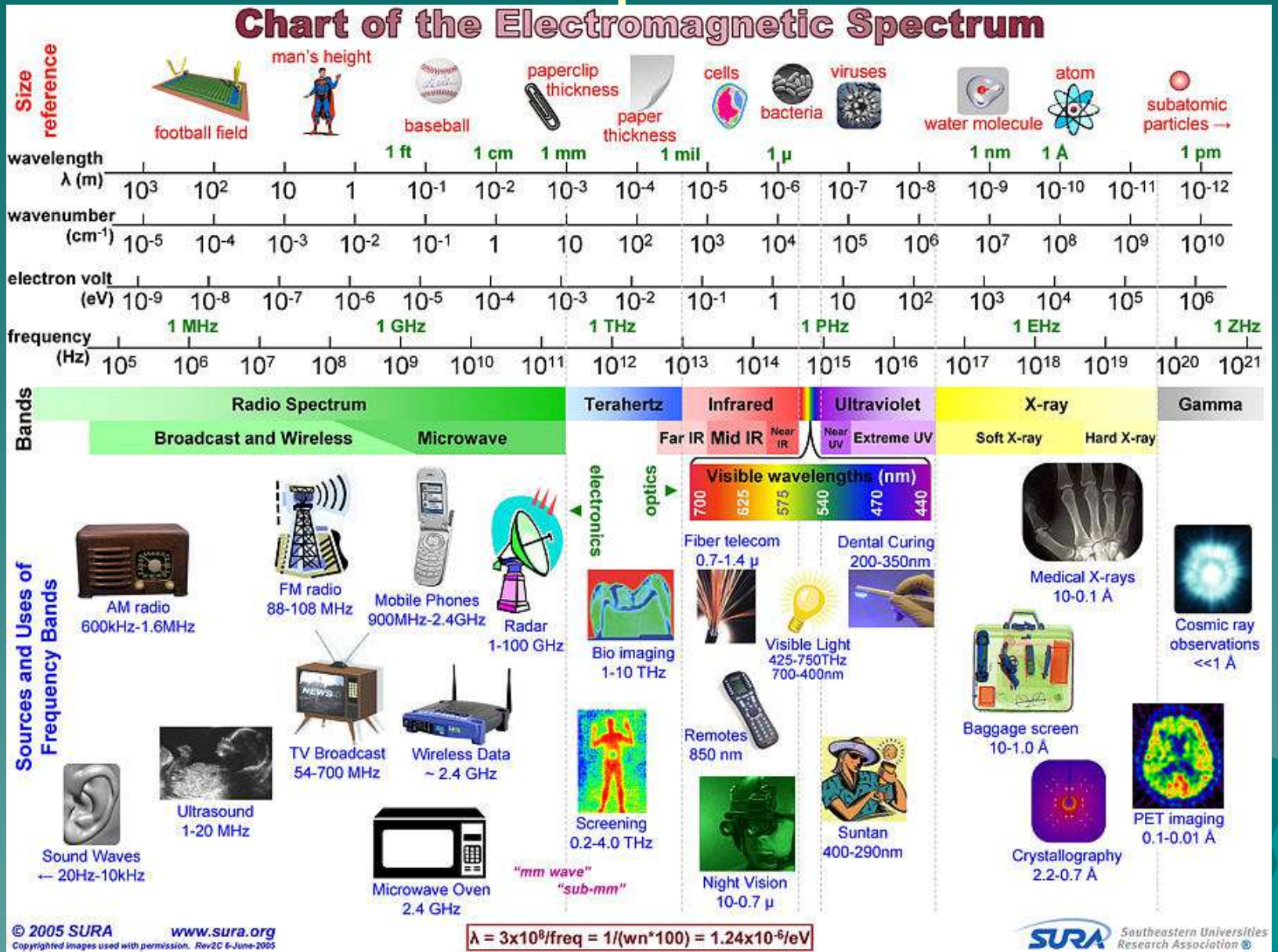


- Frequency is inversely proportional to wavelength
- Large Frequency, small wavelength

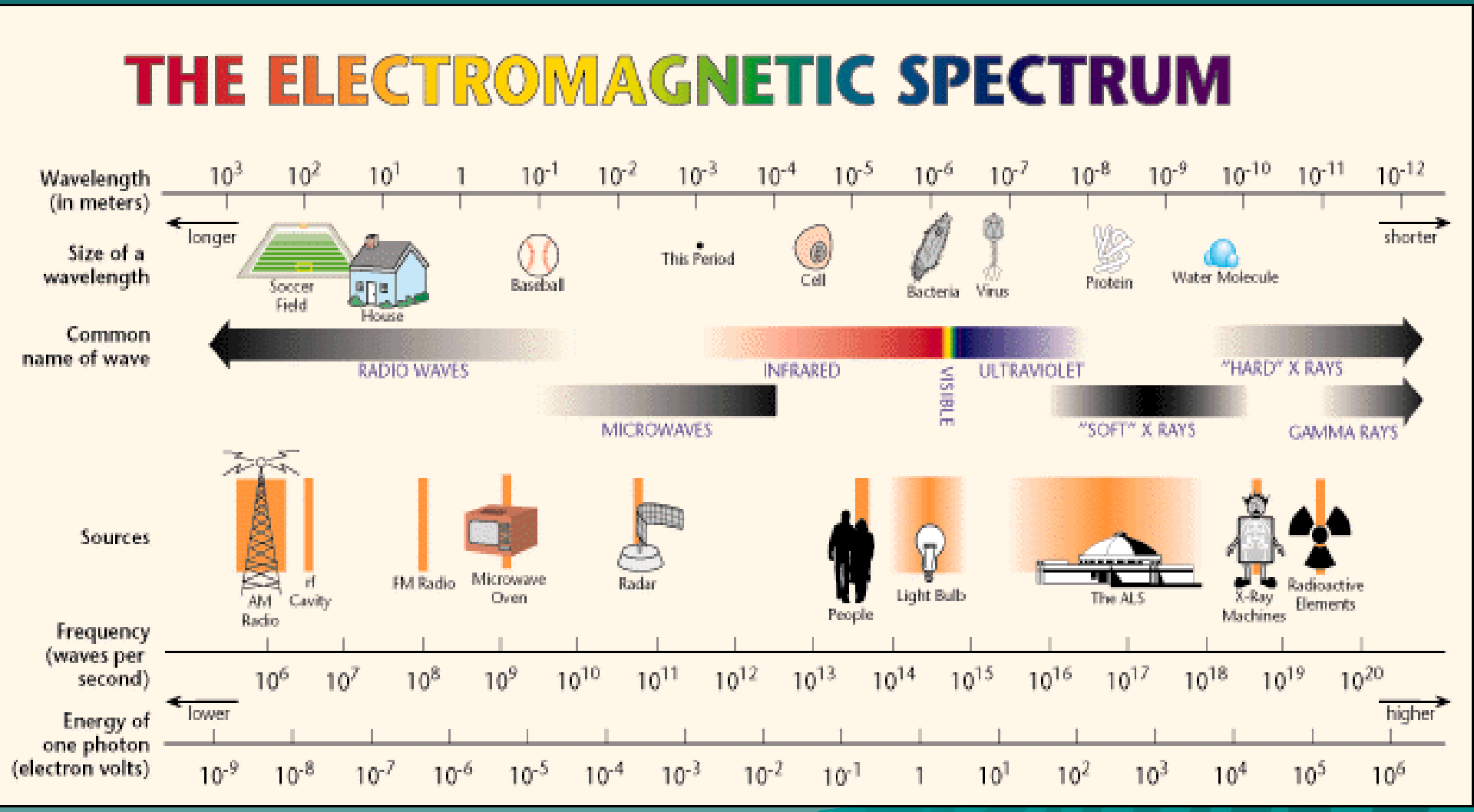
Look at the size comparison of the wavelengths!!



Notice that microwaves fall into the Radio spectrum!



NASA EM Spectrum Video



EMS

- Frequency is inversely proportional to wavelength
- Large Frequency, small wavelength
- Radio- TV, Radios, radar
- Microwaves- Cell phones, Microwave oven, radar
- Infrared Rays- Heat, night vision
- Visible light- ROY G BIV
- Ultraviolet light- black lights, tanning beds
- X-rays- reflected by bones
- Gamma Rays- kill cancer, check brain activity

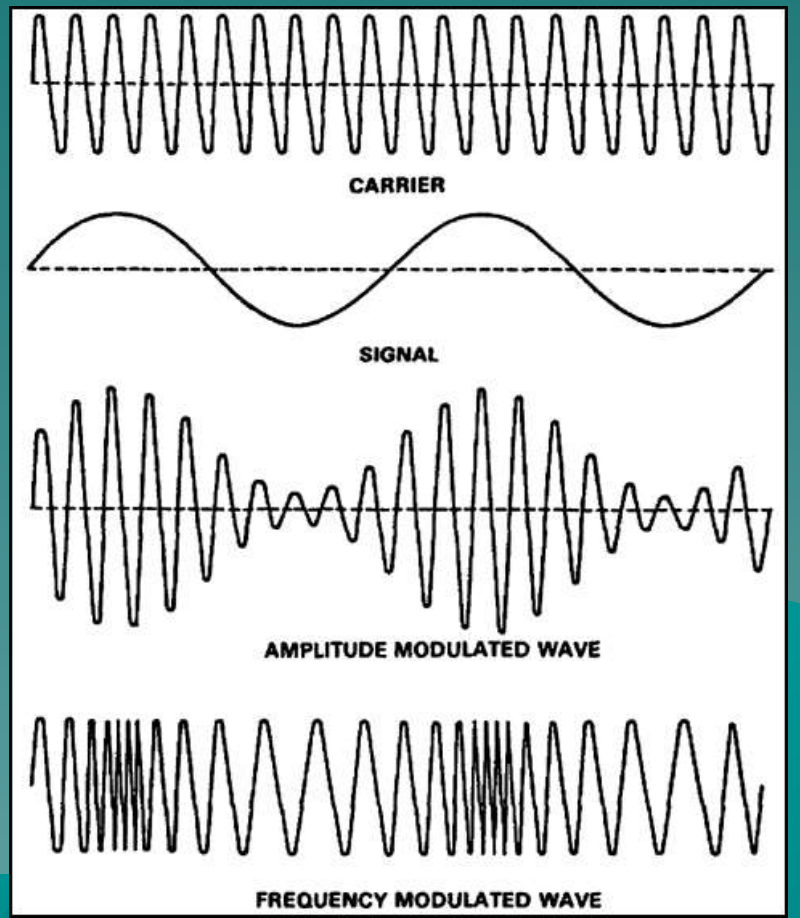
RADAR

- Acronym for Radio Detection and Ranging

- Short bursts of radio waves are sent out..the doppler effect is used…the faster the car is moving toward the source, the higher the frequency of the radio waves returning.

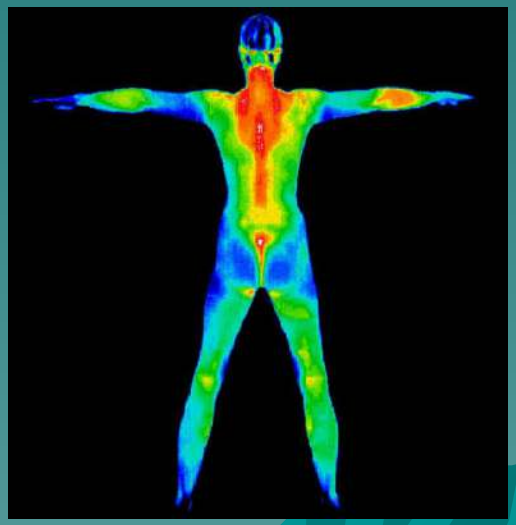
Radio Waves

- Longest wavelengths & lowest frequency of the EMS
  - Include AM, FM and Television frequencies
    - AM – Amplitude modulation: the frequency stays the same, but there is a change in the amplitude to get different sounds etc.(travel further than FM)
    - FM – Frequency Modulation: slight changes in frequency



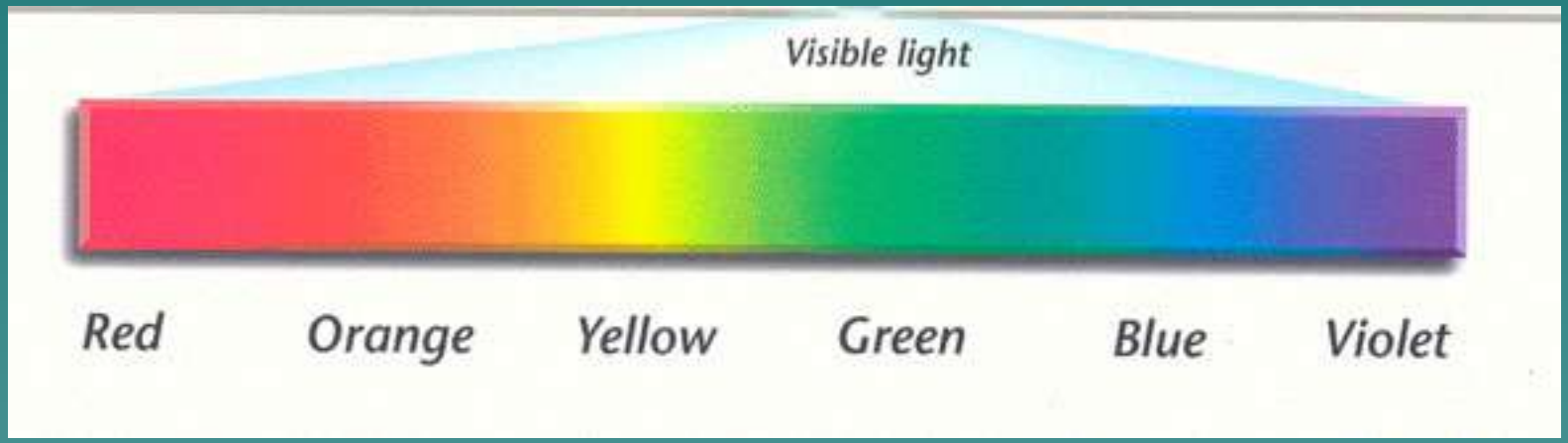
Microwave & Infrared EMR

- Microwave: used in microwave ovens & cellular phones
- Infrared: Fast Food Heat Lamps, use as a night time surveillance tool.



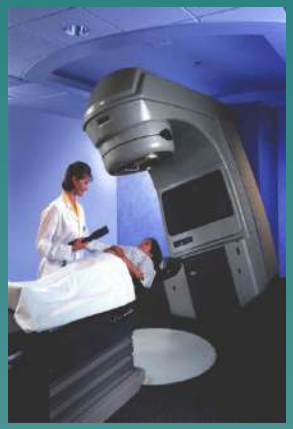
Visible Light

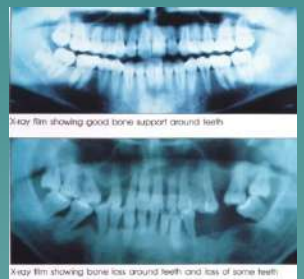
- White light is a mixture of the entire visible light spectrum

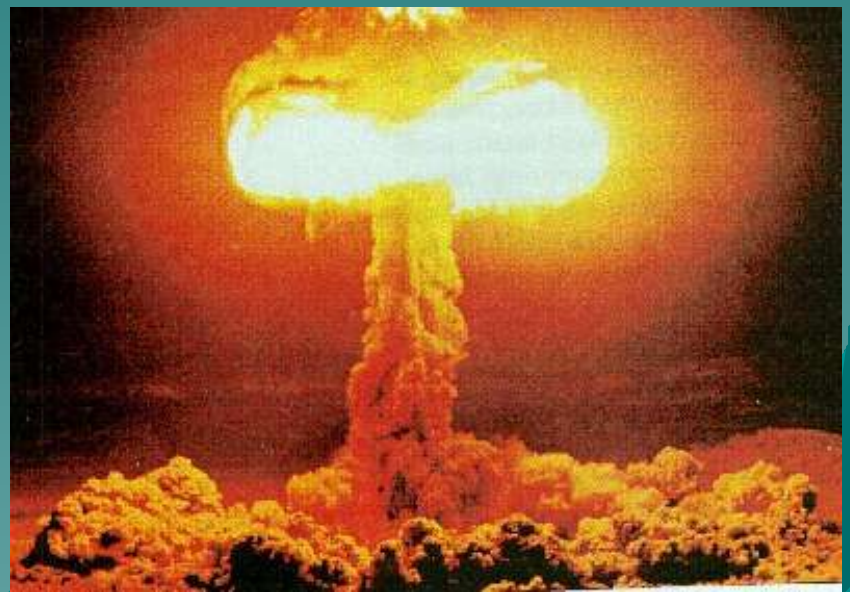


UV, X-ray & Gamma Rays

- UV from the Sun helps the body produce vitamin D, too much exposure can cause skin cancer
- X-rays: used extensively in medicine to see "into" the body
- Gamma Rays: used in medicine to treat cancer or destructive radiation from nuclear explosions.







Waves and EMS wrap up

- Electromagnetic spectrum is a range of wavelengths that can travel through space and a medium
- Mechanical waves require a medium such as air, liquid or solid
  - Travel fastest in solids
  - In space no one can hear you scream
  - waves review website

Demo