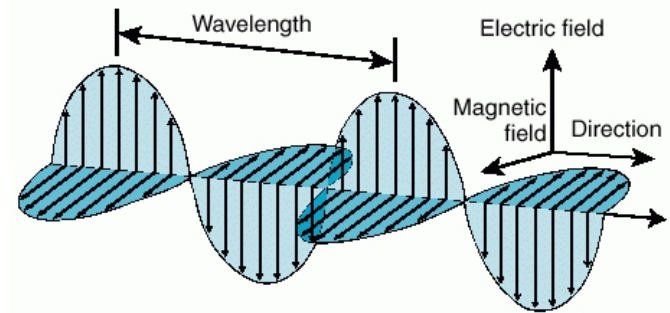




Light  
& the Electromagnetic Spectrum

# Electromagnetic Waves

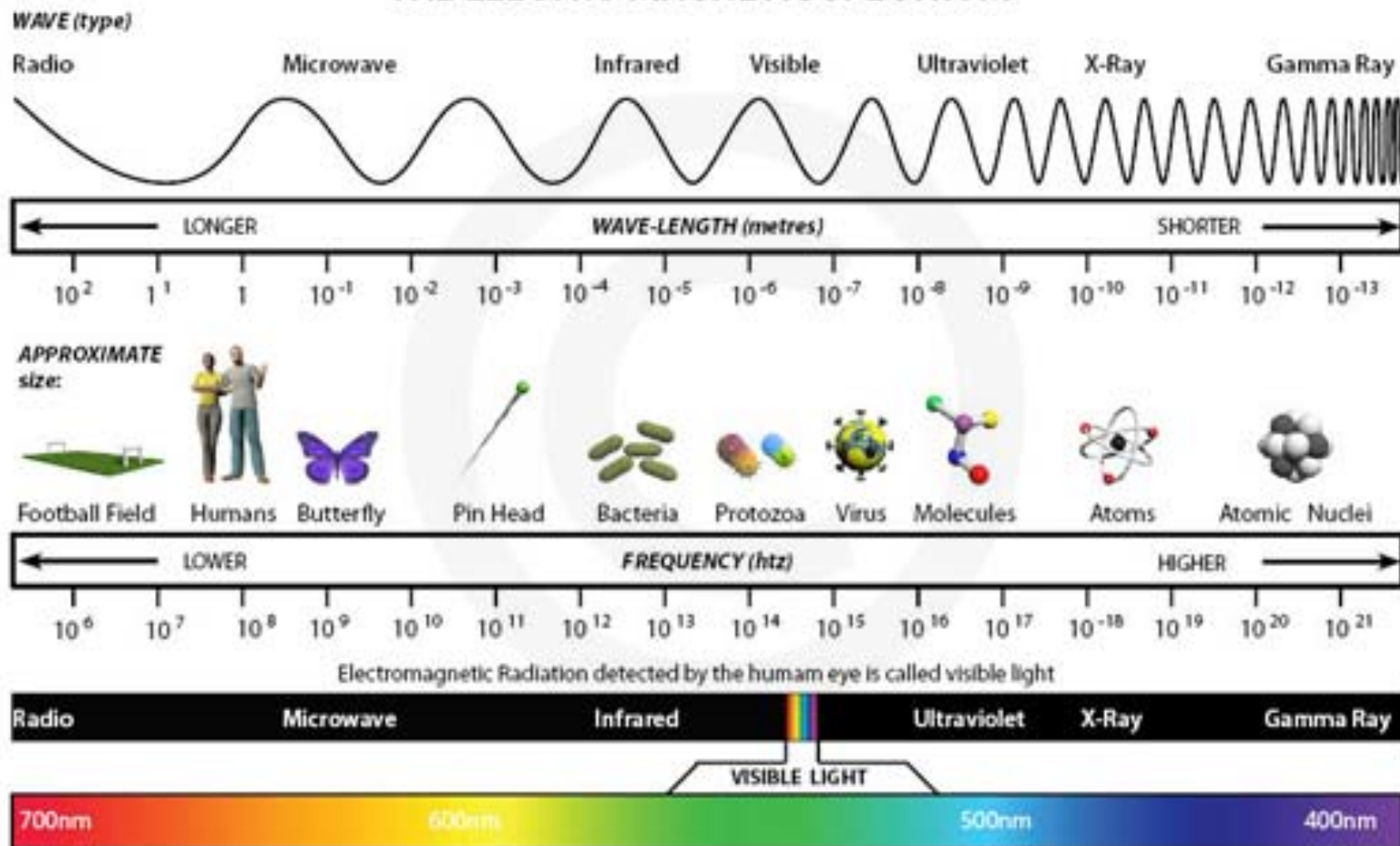


- Electromagnetic Radiation is a transverse wave composed of an electric wave and a magnetic wave.
- Unlike mechanical waves, EM waves can travel through a vacuum.
- The EM spectrum contains waves with a a range of wavelengths and frequencies.
- We only see light in the range of 400-700 nm

speed of light =  $c = 3.0 \times 10^8$  m/s

$$c = \lambda * f$$

# THE ELECTRO MAGNETIC SPECTRUM

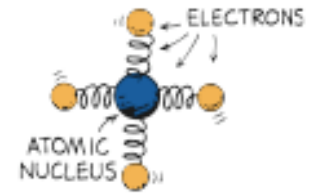


1 metre = 100cm   1 cm = 10mm   1 millimetre = 1000 microns   1 micron = 1000 nanometres (nm)

**Ex 1:** How long does it take for light from the sun to reach Earth if the sun is  $1.5 \times 10^{11}$  m away?

**Ex 2:** Microwave ovens emit waves of about 2450 MHz. What is the wavelength of this light?

# Transparency



- Light is energy carried in an electromagnetic wave that is generated by vibrating electric charges.
  - When light hits electrons in a material, they vibrate.
  - If frequency of light hitting a material  $\neq$  natural frequency of the material, the electrons are forced into vibration with small amplitudes.
  - Only a small amount of energy is lost to heat.
  - Energy of the vibrating electrons is reemitted as transmitted light.
- Materials that transmit light are transparent.

# Opacity



- If frequency of light hitting a material = natural frequency of the material, the electrons are forced into vibration with **large** amplitudes.
- Therefore, more energy is lost to heat.
- Materials that absorb light without reemission and thus allow no light through them are opaque.

## Glass: An example



- Glass is \_\_\_\_\_ to visible light.
- However, electrons in glass have a natural vibration frequency in the ultraviolet range.
- UV light shines on glass and a lot of energy \_\_\_\_\_ to heat
- Therefore, UV light \_\_\_\_\_ pass through glass.
- Glass is \_\_\_\_\_ to UV light.

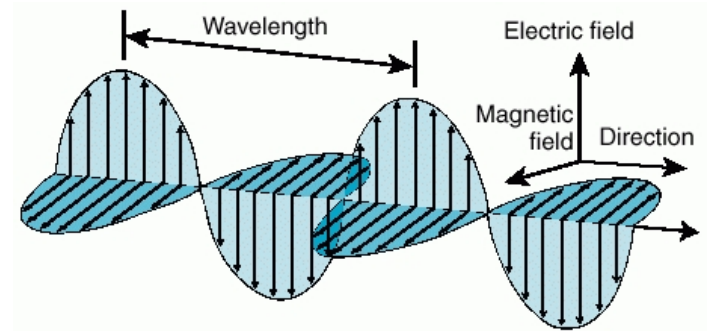
# Shadows



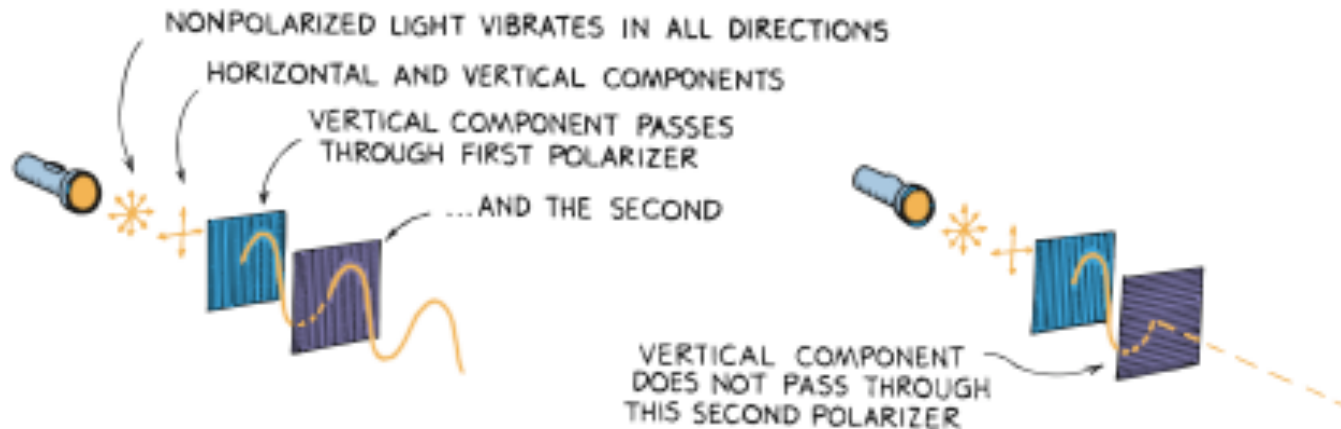
- A thin beam of light is called a ray.
- When light shines on an object, some of the rays may be stopped while others pass on in a straight line path
- A shadow is formed where light rays cannot reach
- Fuzzy part around the edges of the shadow happens when:
  - Light from one source is blocked but where other light fills in
  - Where light from a source is only partially blocked



# Polarization



- When light from a lamp or the sun shines on a polarizing filter, the light that is transmitted is polarized.
- Light will pass through a pair of polarizing filters when their polarization axes are aligned, but *not* when they are crossed at right angles.



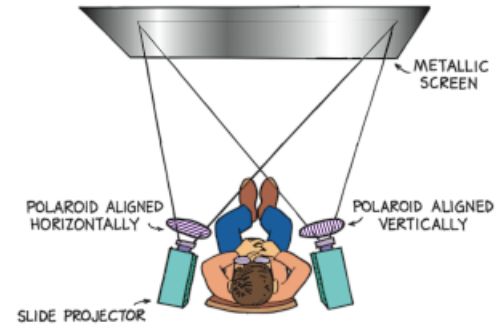
# 3D

*Hold an upright finger at arm's length and see how it switches position relative to the background as you alternately close each eye.*



- Vision in three dimensions depends on the fact that both eyes give impressions simultaneously, each eye viewing a scene from a slightly different angle.
- The view seen by each eye is different.
- The combination of views in the eye-brain system gives depth.
- A pair of photographs or movie frames, taken a short distance apart (about average eye spacing), can be seen in 3-D when the left eye sees only the left view and the right eye sees only the right view.

# 3D Movies!



- Movies project the pair of views through polarization filters onto a screen.
- Their polarization axes are at right angles to each other, so the right eye sees only the right view and the left eye sees only the left view.
- Overlapping pictures look blurry to the naked eye.
- To see in 3-D, the viewer wears polarizing eyeglasses with the lens axes also at right angles.
- Each eye sees a separate picture, just as in real life. The brain interprets the two pictures as a single picture with a feeling of depth.