

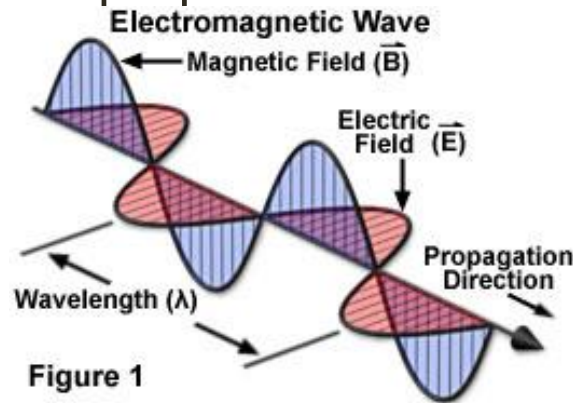
Light as a Wave

Objectives

- Recognize that light is an electromagnetic wave, and shares characteristics with the entire electromagnetic spectrum.
- Explain the concept of polarization and how polarization can be used in applications such as video displays and low-reflection sunglasses.

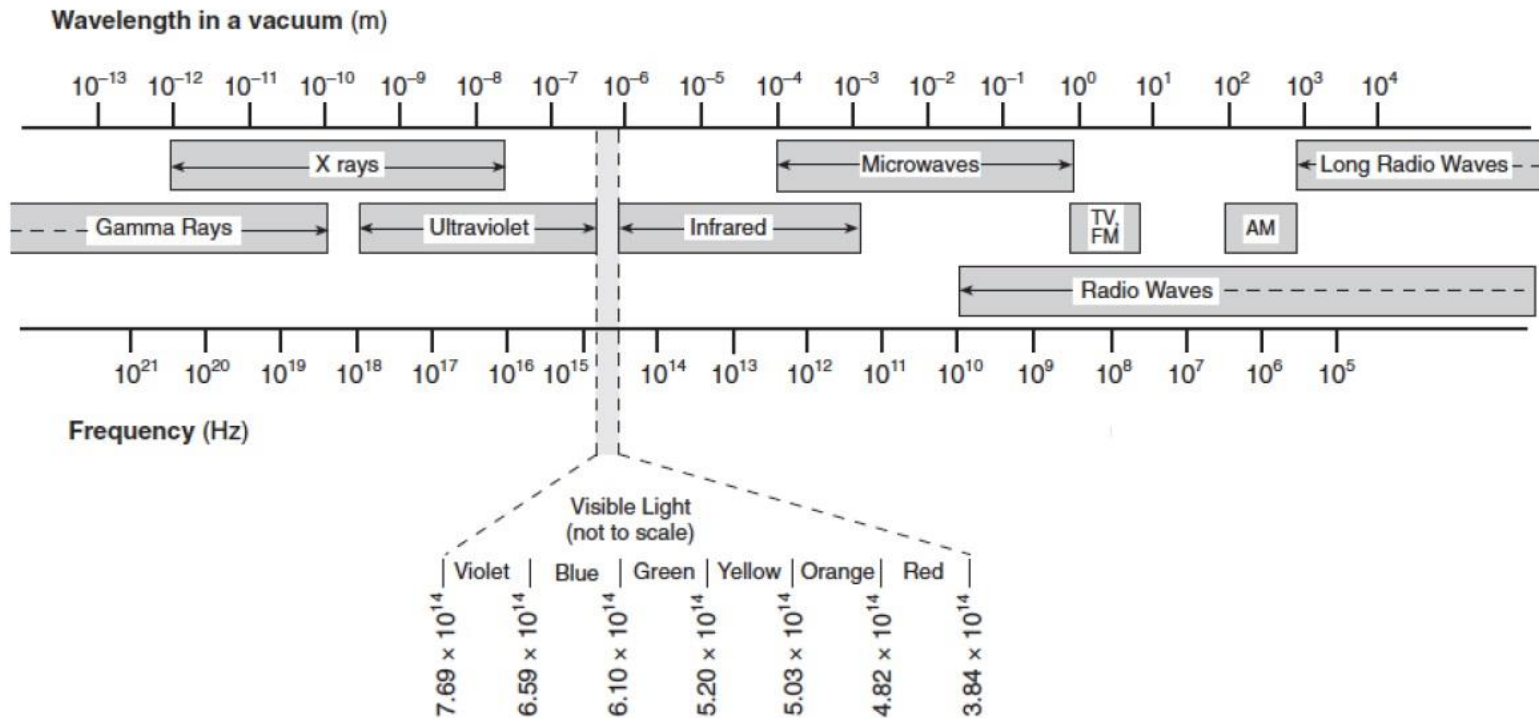
Electromagnetic Waves

- Electromagnetic (EM) waves do not require a medium in which to propagate. Mechanical waves do require a medium in which to propagate.
- Light is an EM wave which is visible to the human eye.
- The speed of all EM waves in a vacuum (c) is approximately 3×10^8 m/s.
- EM waves are transverse due to the modulation of the electric and magnetic fields perpendicular to the wave velocity.



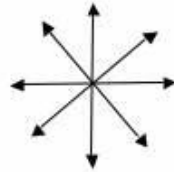
Electromagnetic Spectrum

The Electromagnetic Spectrum



Polarization

- Unpolarized EM waves exhibit modulation in all directions.



unpolarized
light

- Polarized light, however, consists of light vibrating in a single direction.



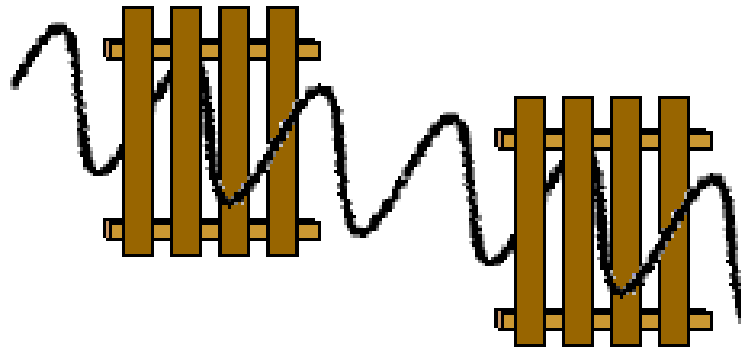
plane
polarized
light

Polarizers

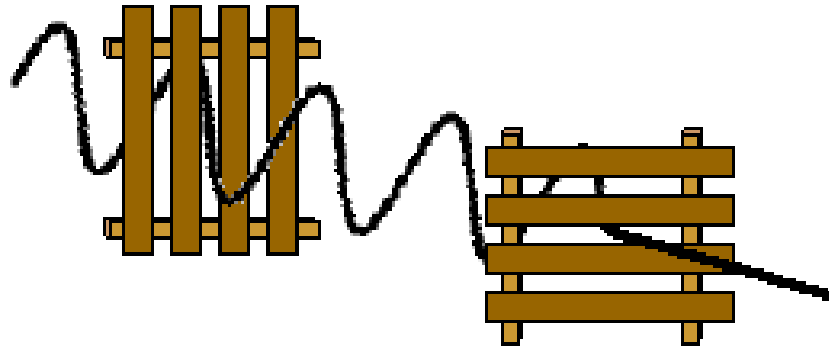
- Polarizers are materials which act like filters to only allow specific polarizations of light to pass.
- Imagine a picket fence through which light of many polarizations attempts to pass... only polarizations parallel to pickets are transmitted.
- Polarizers typically are sheets of material in which long molecules are lined up like a picket fence!

Polarizer

The Picket Fence Analogy



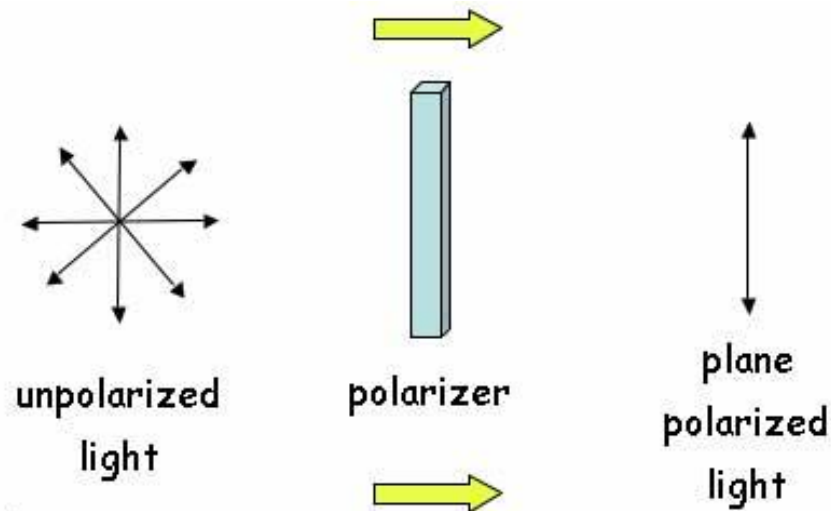
When the pickets of both fences are aligned in the vertical direction, a vertical vibration can make it through both fences.



When the pickets of the second fence are horizontal, vertical vibrations which make it through the first fence will be blocked.

Polarizing Sunglasses

- Sunglasses are often sold with a polarizing filters to reduce reflections.
- Light reflecting off of non metallic surfaces is partially polarized parallel to the surface.
- Polarizing sunglasses have vertical polarizing filters to reduce reflections.



Liquid Crystal Displays

- LCDs use liquid crystals in a suspension that align themselves in a specific orientation when a voltage is applied.
- As the liquid crystals align, they take on a specific polarizing orientation.
- By cross-orienting a polarizer and a matrix of liquid crystals, light can be modulated pixel-by-pixel.

Sample Problem 1:

- What color of light has a wavelength of 5×10^{-7} meters in air? (Refer to chart from notes.)

Sample Problem 2

- A microwave and an x ray are travelling in a vacuum. Compared to the wavelength and period of the microwave, the x-ray has a wavelength that is
 - a) Longer and frequency that is shorter
 - b) Longer and a frequency that is longer
 - c) Shorter and a period that is longer
 - d) Shorter and a period that is shorter