Science 8

Unit 2: OPTICS

Topic 1: The Many Properties of Light


Lasers

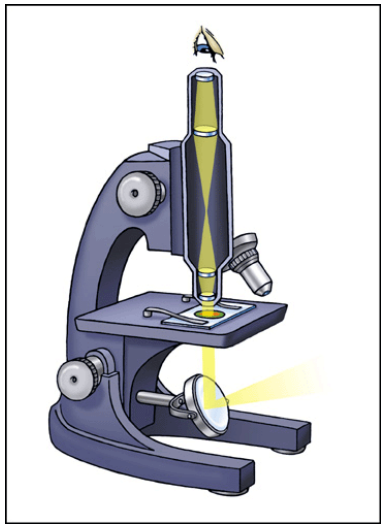
BRAINSTORM!!!!

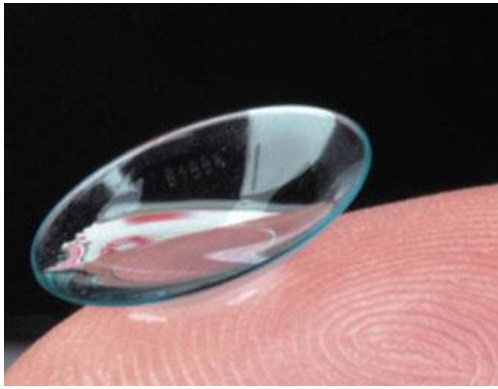
Write a paragraph on:

What is light?

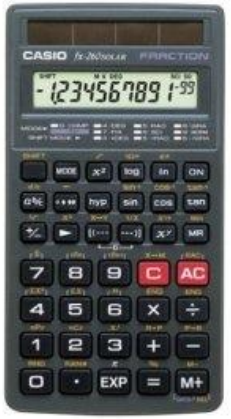
Light Technologies Include…

- Microscope
- Telescope
- Periscope
- Binoculars
- Fibre optics
- Camera
- Overhead projectors
- Prescription contact lenses
- Laser
- Movie projectors





Light is Energy

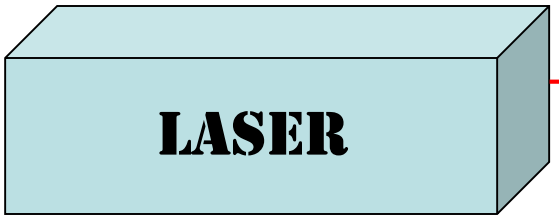


Visible Light: a form of energy that can be detected by the human eye.

Light comes from the Greek word leukos, which means "white"

Properties of Light...

1. *Rectilinear Propagation:* Light travels in a straight line.



2. Reflection: **light bounces off a surface. There are two types of reflection**

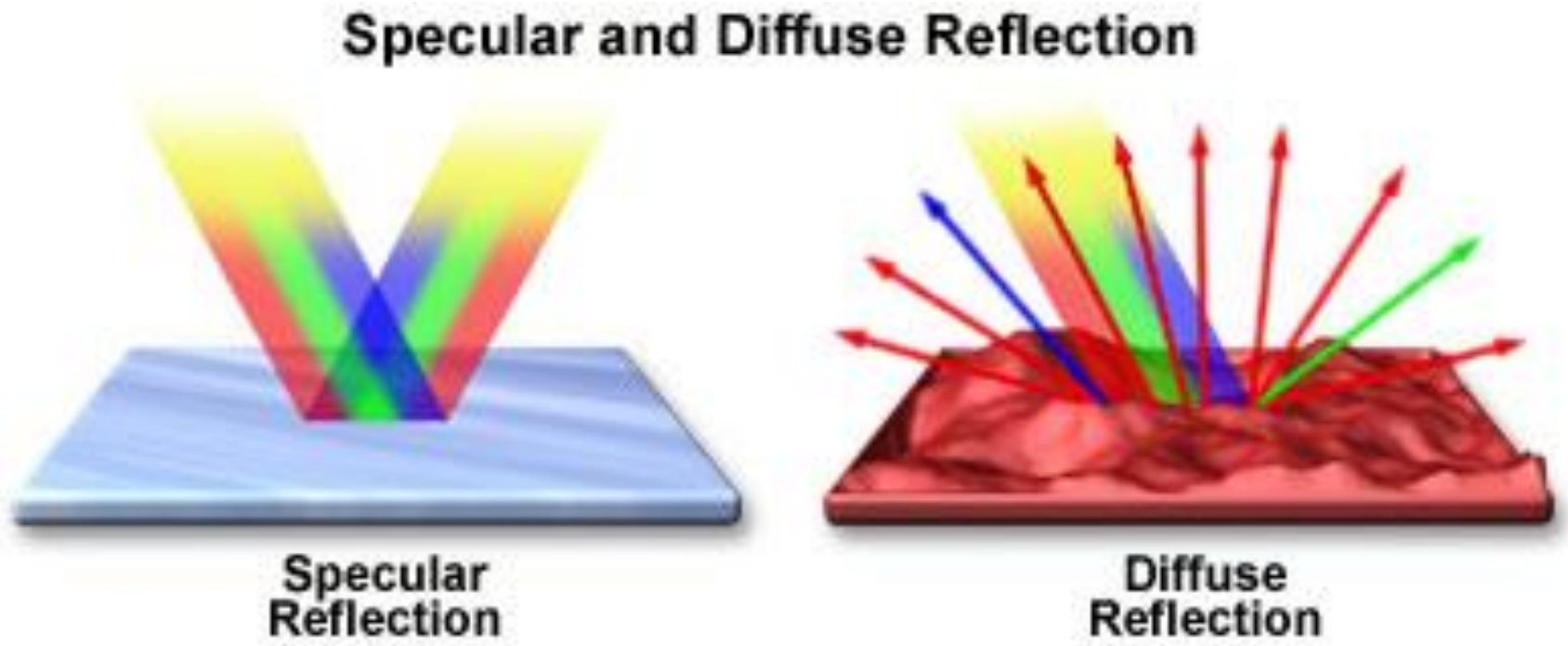


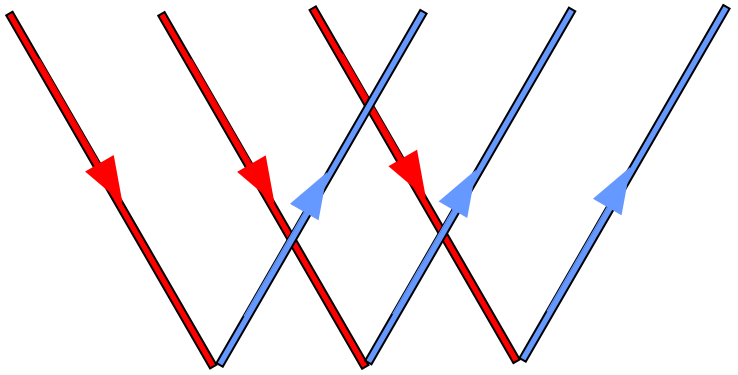
Figure 3

Mirror

Dust

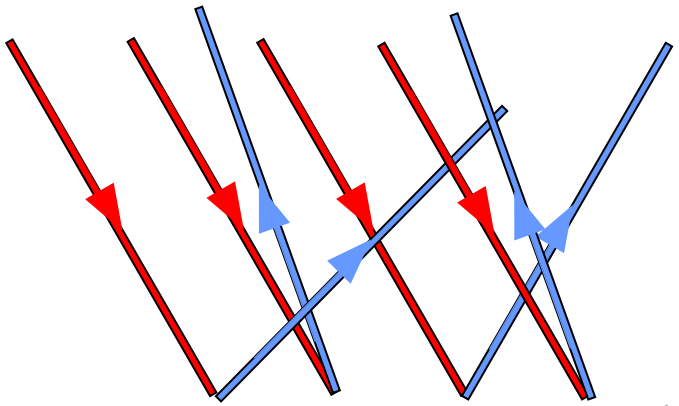
Specular vs. Diffuse Reflection

- Smooth, shiny surfaces have a *Specular* reflection:



Rough, dull surfaces have a *diffuse* reflection.

Diffuse reflection is when light is scattered in different directions

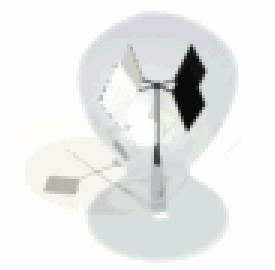


3. Refraction: Light bends has it enters another medium (solid, liquid or gas)

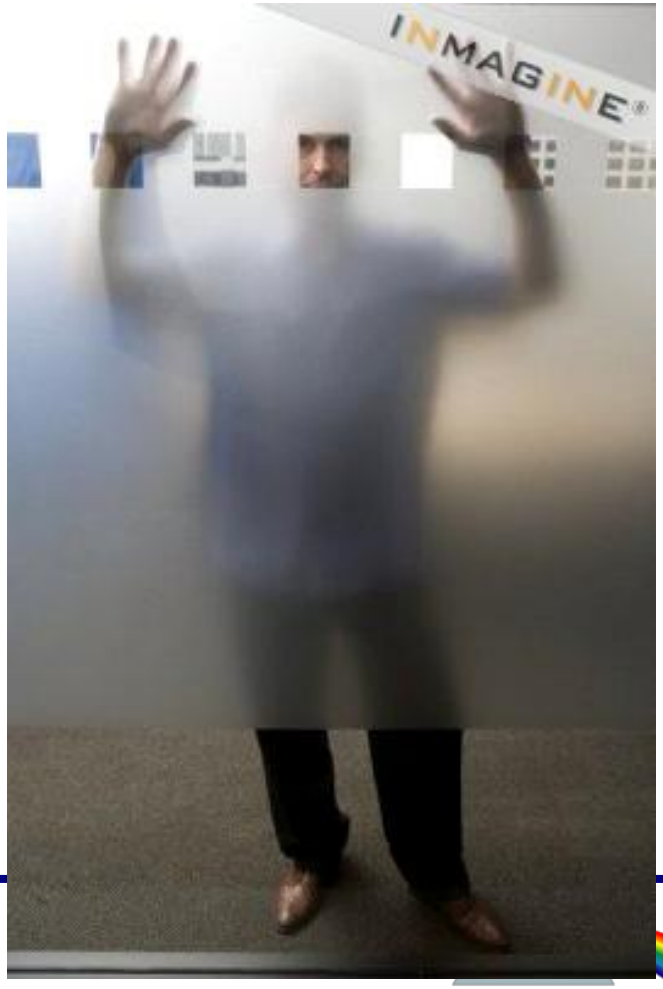
"The Bent Stick Effect"

4. Light Disperses (Dispersion) The separation of visible light into its different colors. It is separated into its component colors - red, orange, yellow, green, blue and violet

5. Light travels through a vacuum (does not require a medium; no particles involved)

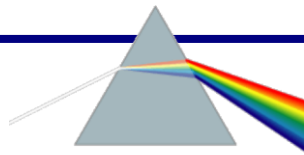


6. Travels through objects to different degrees



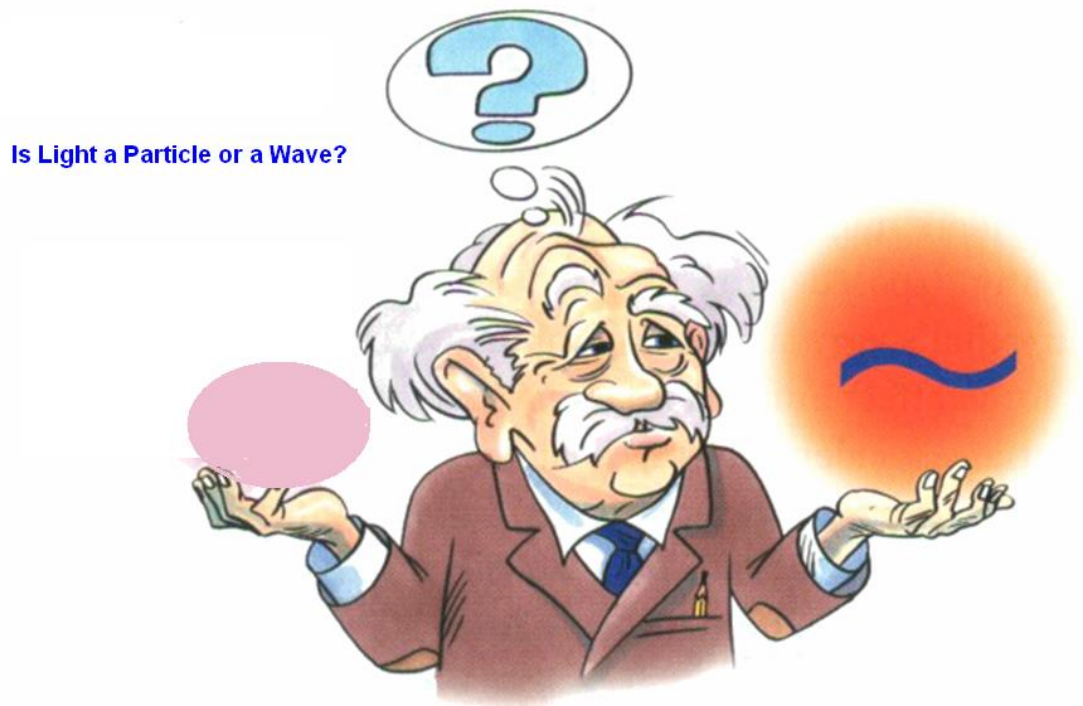
Student Activity

- Page 134
- Assign 1-5



Science 8

Unit 2: OPTICS



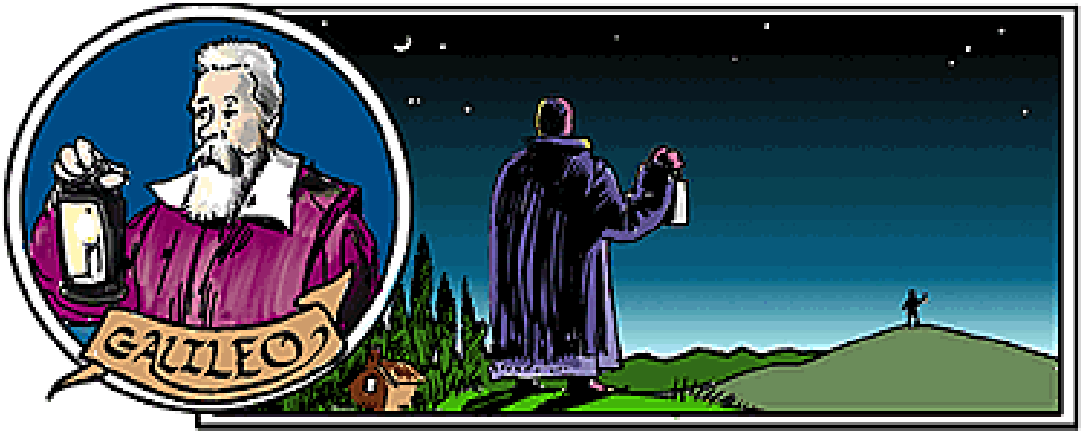
Topic 2: The Nature of Light

Speed of Light

Scientists believed that determining the speed of light would help them understand the nature of light.

(in 1638) is believed to be the first person to try to measure the speed of light.,

Was he successful?

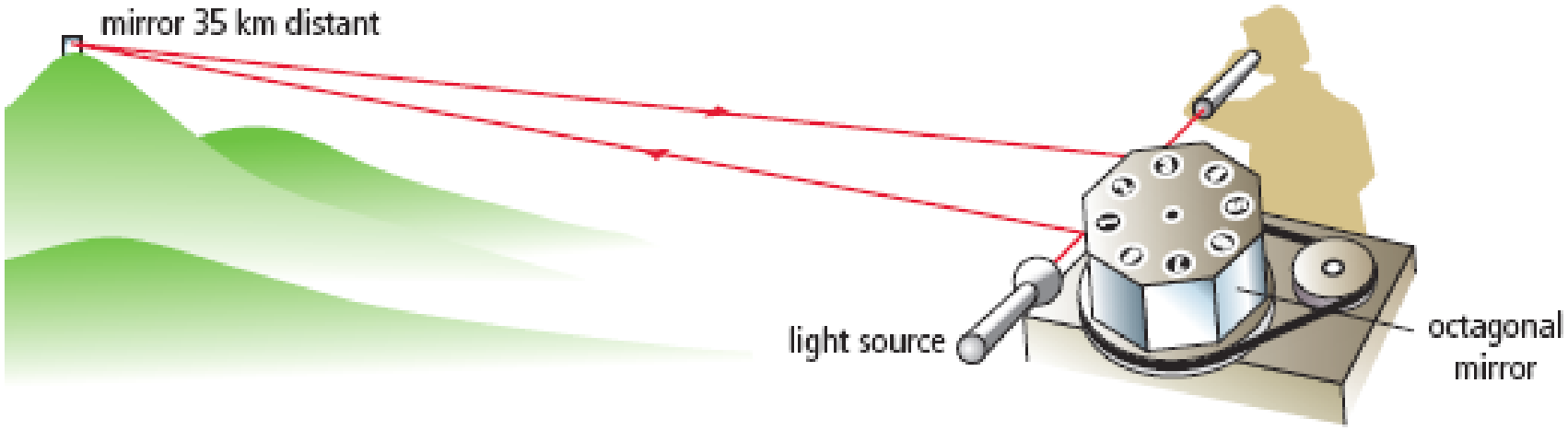


**No, the speed of light was simpl
too fast to be measured this way
There was no way the time coul
have been measured using the
tools Galileo had.**

Albert Michelson

- First person to measure the speed of light (3 x 10^{8} m/s)

8



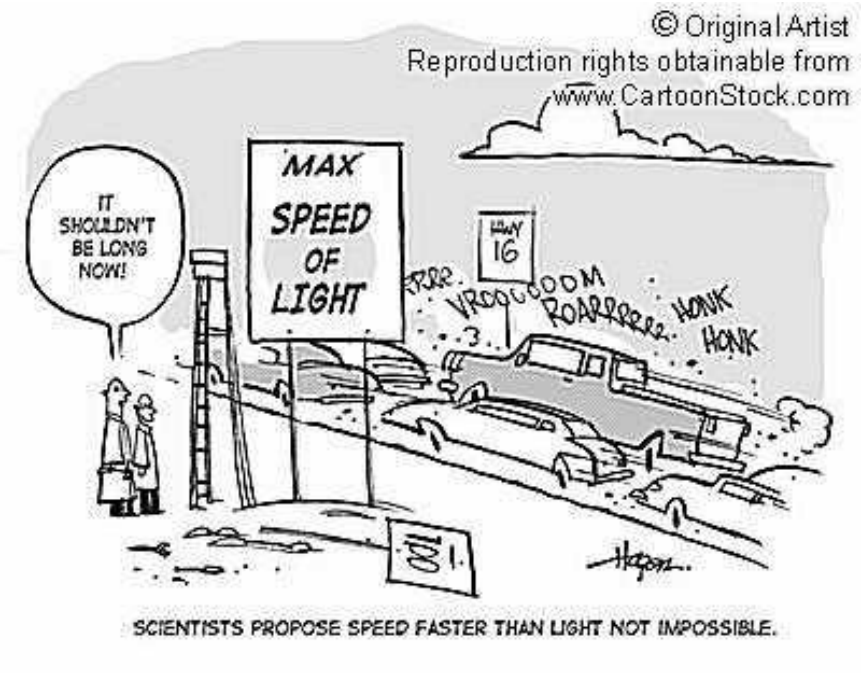
Speed: Light vs. Sound

Light

300 000 000 m/s

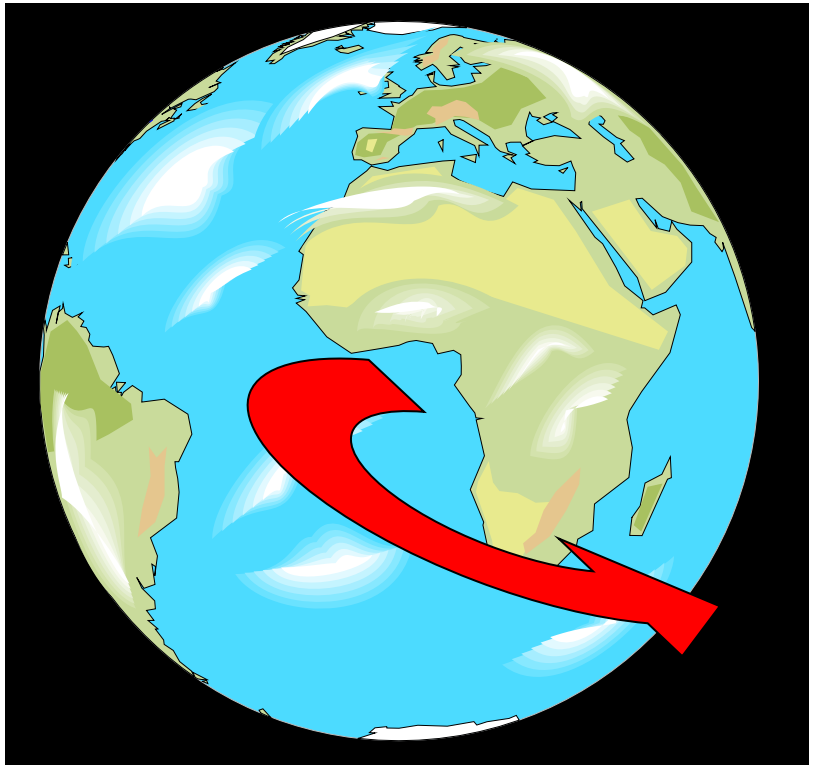
Sound

- 343 m/s



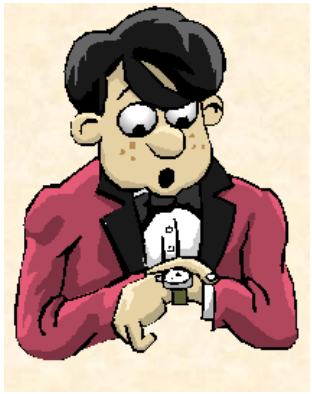
Nothing travels faster than the speed of light !

At this speed it can go around the world 8 times in one second.



Thunder & Lightning

Both the lightning strike and the roar of thunder happen at the same time.



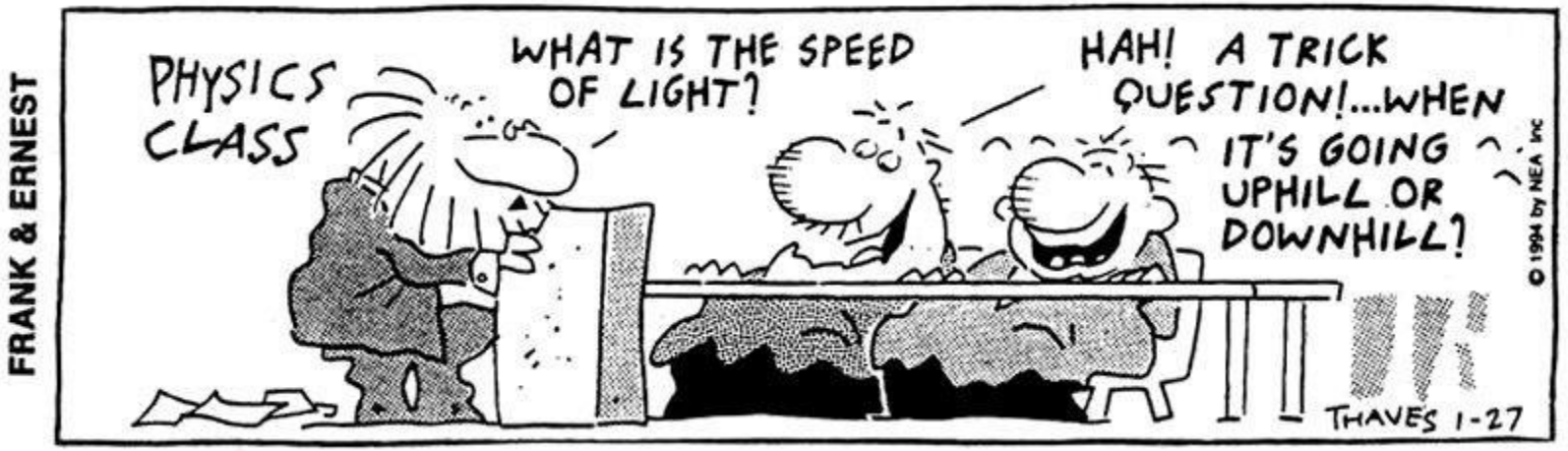
You see the lightning first. If you multiply the time in seconds between the strike and the roar by the speed of sound, you will find the approximate distance

Whenever you look into the night sky, for example, you're really looking back into time. The stars you see are so far away that the light they emit takes years to reach us. Nearby stars are tens or hundreds light-years away.

Orion's Belt

A **light-year** is the distance light travels in one year,

It take 8 minutes for light to get to earth to from the sun!


FRANK & ERNEST
PHYSICS CLASS
WHAT IS THE SPEED OF LIGHT?
HAH! A TRICK QUESTION!...WHEN IT'S GOING UPHILL OR DOWNHILL?
© 1994 by NEA, Inc
THAVES 1-27

How Does Light Travel?

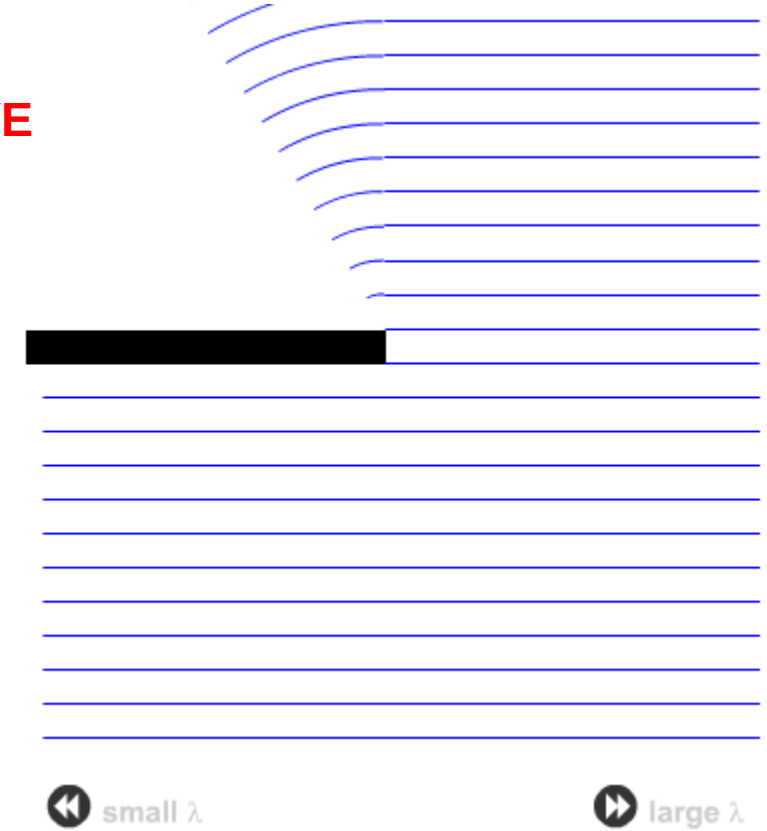
Pythagoras was a Greek philosopher who believed that beams of light were made of tiny particles.

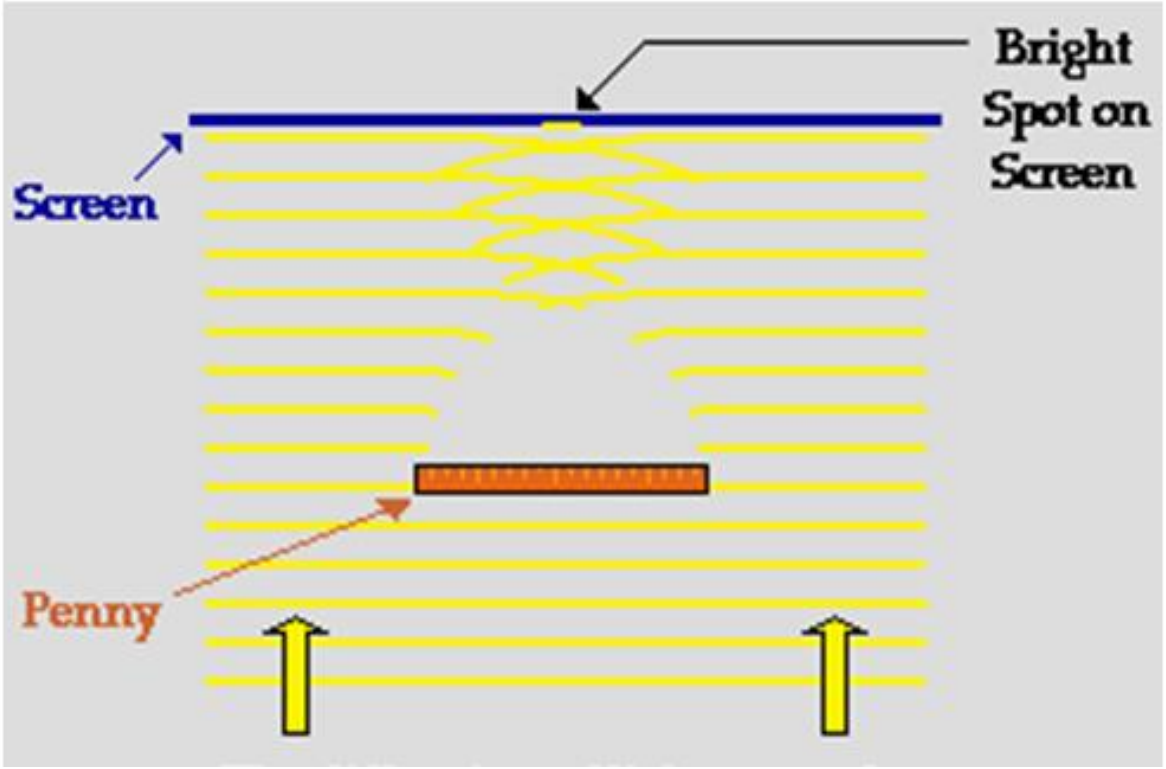
- The eyes detected these particles and could see the object.

For example:

If light was made of particles that travelled only in straight lines, how could it bend around corners or spread out as it passed through narrow openings?

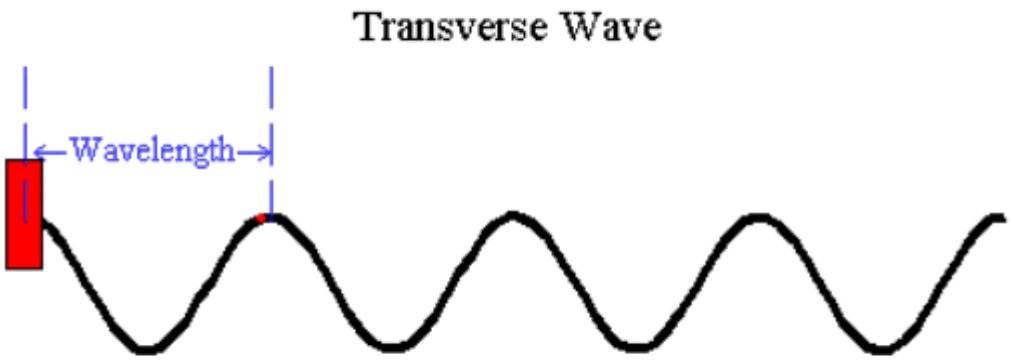
Answer: LIGHT TRAVELLS LIKE A WAVE



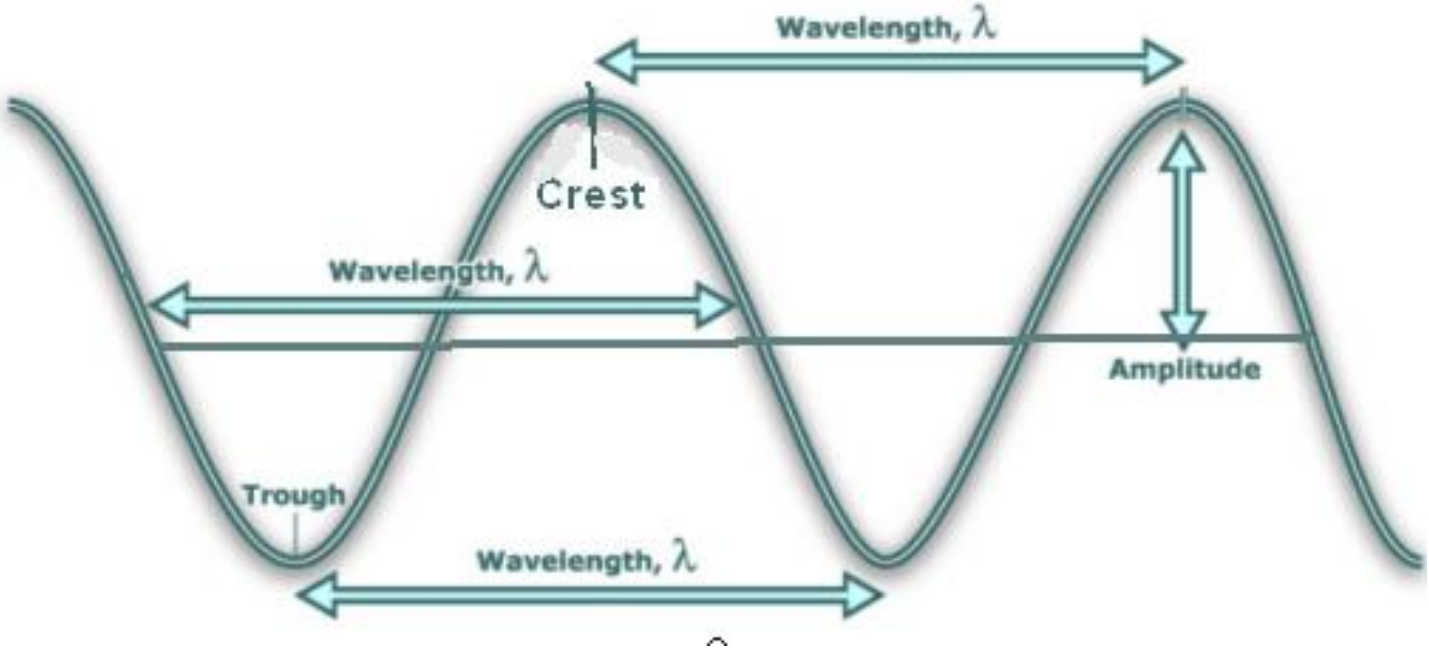

Bright
Spot on
Screen
Screen
Penny

The Wave Model of Light

Explains that light is a type of wave that travels through empty space and transfers energy from one place to another



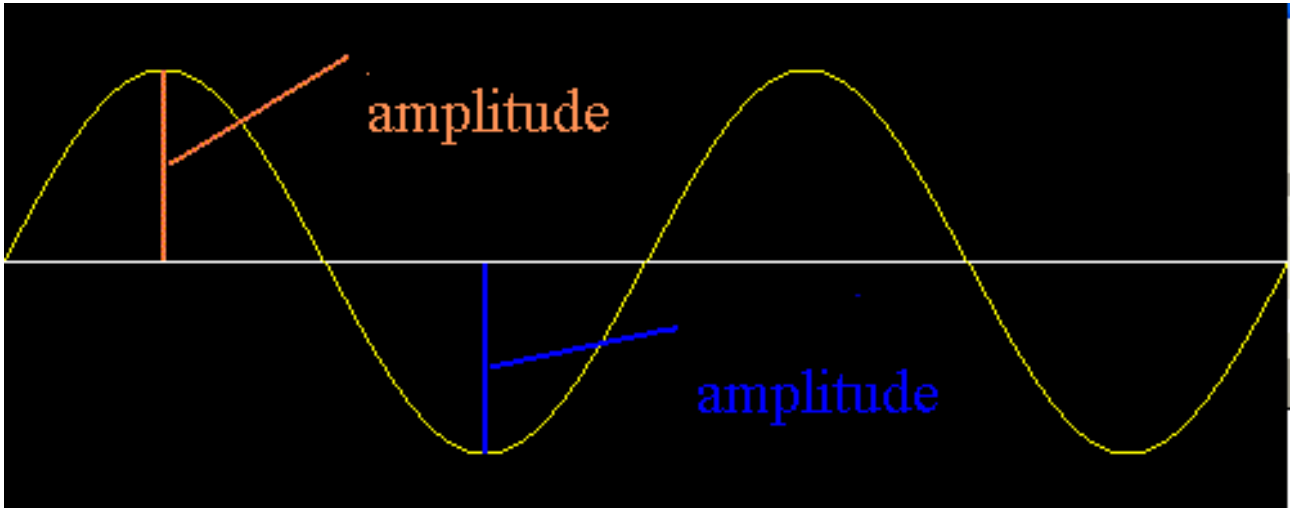
A Wave...


Wavelength, λ
Crest
Wavelength, λ
Amplitude
Trough
Wavelength, λ

Amplitude: the height of a wave crest or depth of a wave trough as measured from the rest position.

- crest height = trough depth

- amplitude of a light's wave tells you about the brightness of the colour



Wavelength:

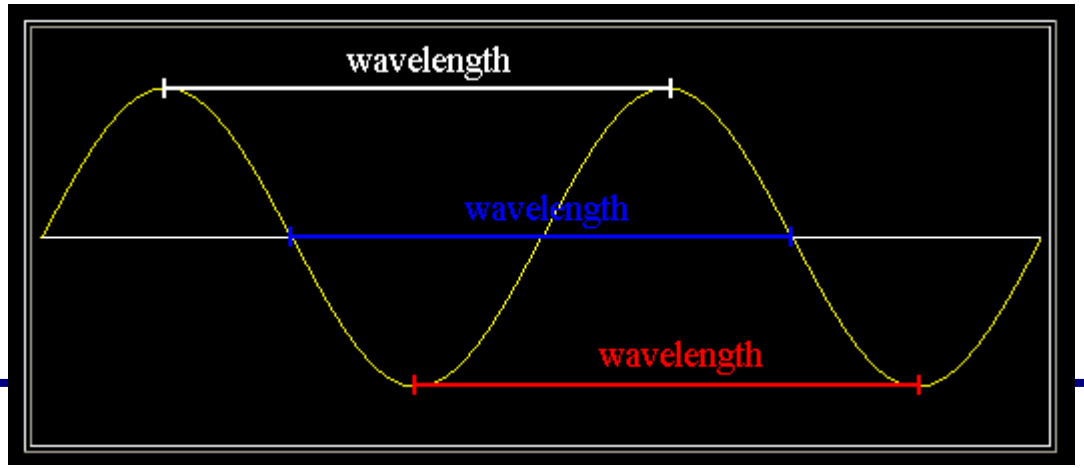
1) the distance from crest to crest,

2 trough to trough or

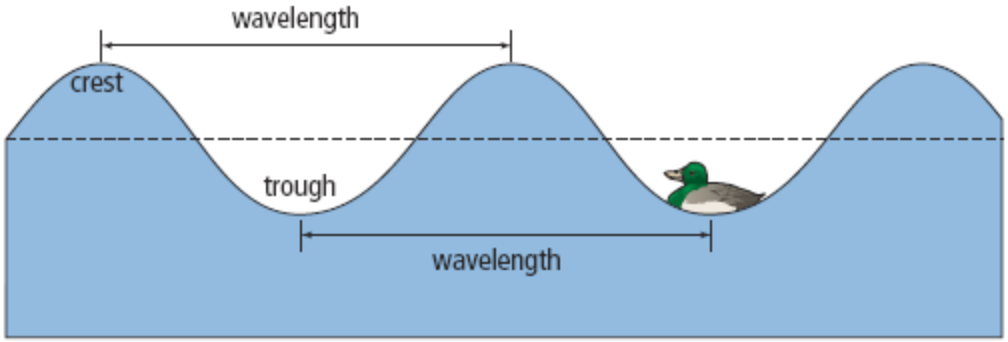
3) the distance covered by one complete crest and one complete trough.

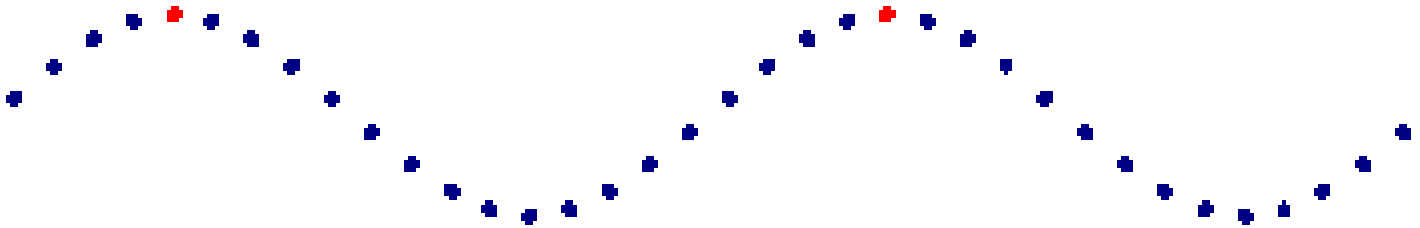
- Measured in meters

- Longer wavelengths refract the least.

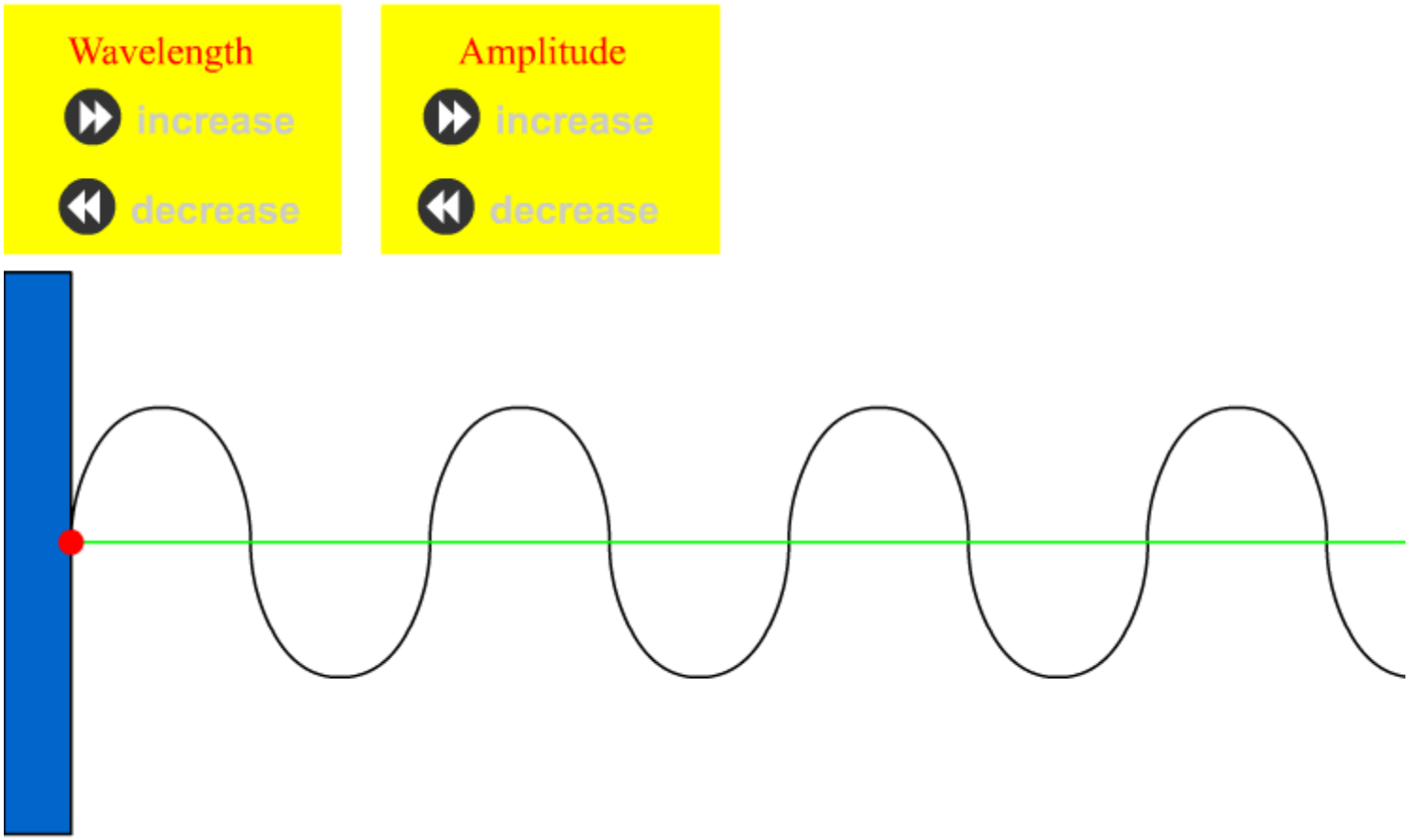


Wavelength is the distance over which the wave repeats





Notice what happens to the wave speed when you change the wavelength and period

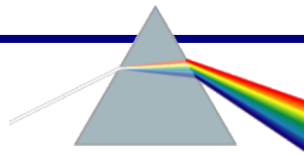


Frequency: the number of repetitive motions that occur during a given time.

$$f = \frac{\#\,\text{cycles}}{\text{total time}}$$

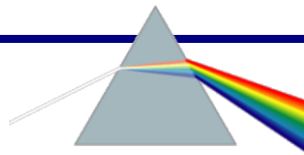
Ex. The number of wavelengths that pass a point in 1 second.

- Measured in Hertz



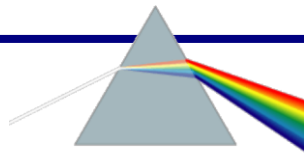
Example 1:

- A person standing on a wharf counts 12 waves passing by in 6 seconds. What is the frequency?



Example 2:

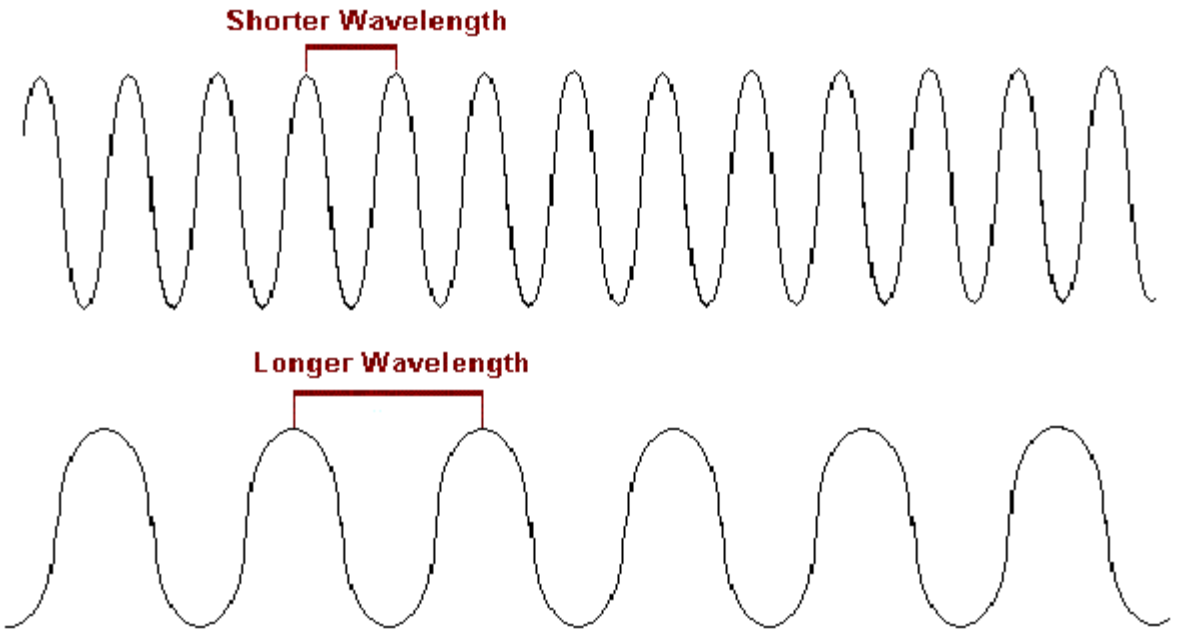
A buoy bobs up and down on the ocean a total of 24 times in 8.0 seconds. What is the frequency of the motion?



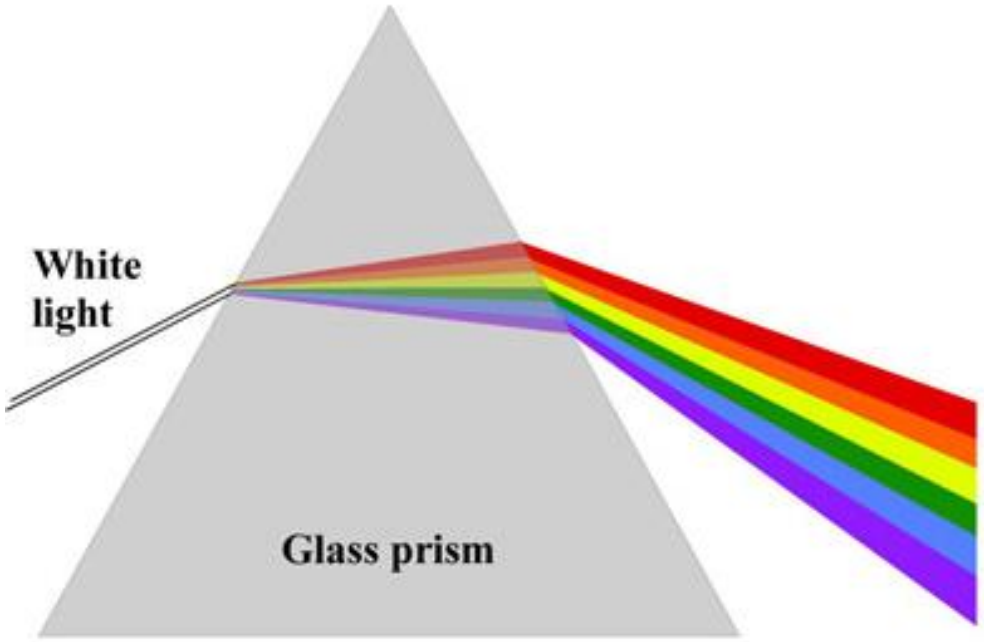
Frequency and Wavelength

- High frequency waves have shorter wavelengths

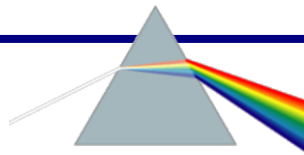
- Low frequency waves have longer wavelengths



Visible Light has range of wavelengths and frequencies. Red light has the lowest frequency (longest wavelength) and violet light has the highest frequency (shortest wavelength) of visible light.



Color	λ (nm)	Freq (Hz)
Red	760-647	4.3×10^{14}
Orange	647-585	4.3×10^{14}
Yellow	585-575	5.2×10^{14}
Green	575-491	5.6×10^{14}
Blue	491-424	6.6×10^{14}
Violet	424-380	7.3×10^{14}



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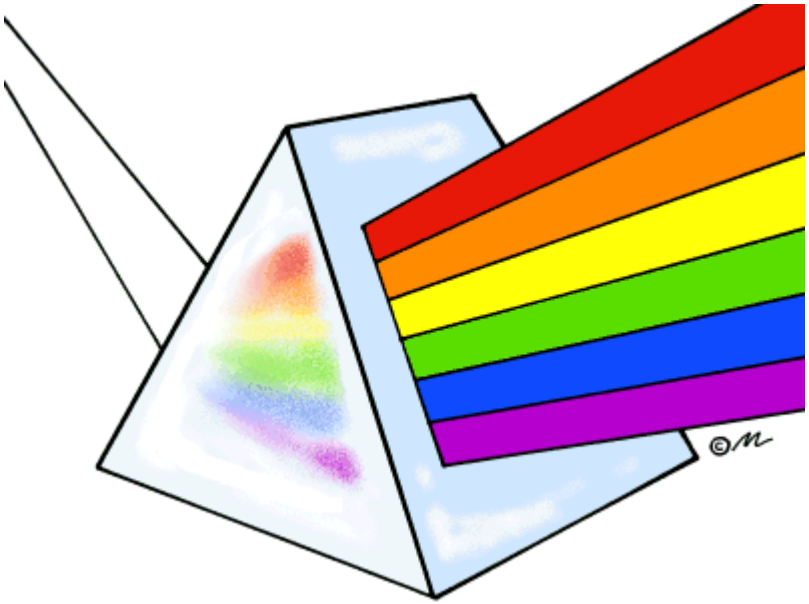
Unit 2: OPTICS



Topic 3: Refraction of White Light

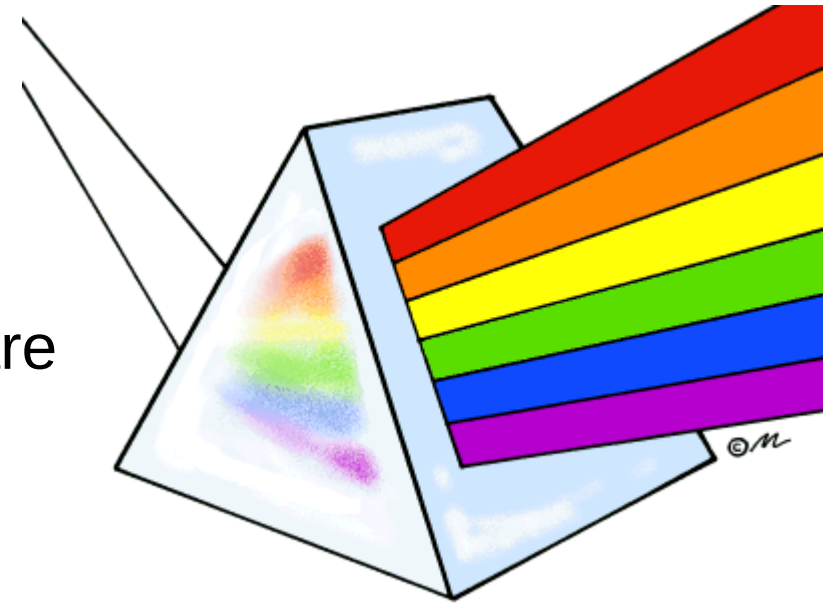
Refraction of White light

Visible light: a mixture of all the colors of the rainbow. It is the form of light you can see.

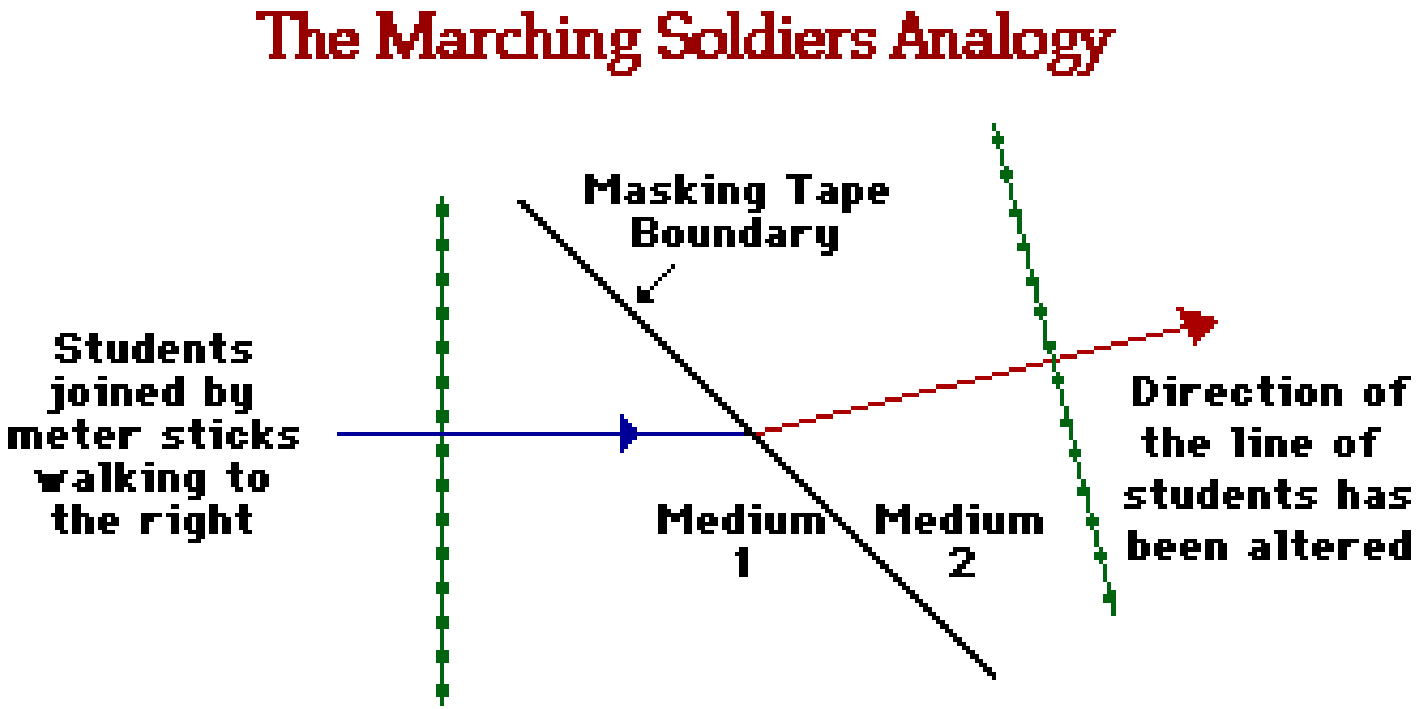
Refraction of Light

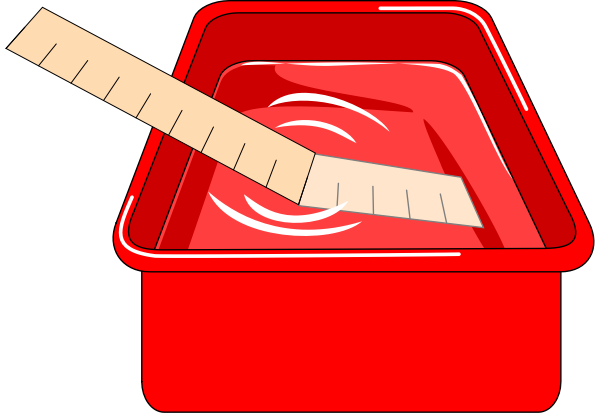
- **Refraction** is the bending or changing direction of a wave as it passes from one material to another. Light bends because it changes speed when it moves through materials that have different densities. Light travels slower in materials that are more dense, because there are more particles.

The longer wavelengths are refracted less than the shorter wavelengths, different colours are separated when they emerge from the prism.



- The analogy of marching soldiers can be used to demonstrate why waves bend as they change from one medium to another.

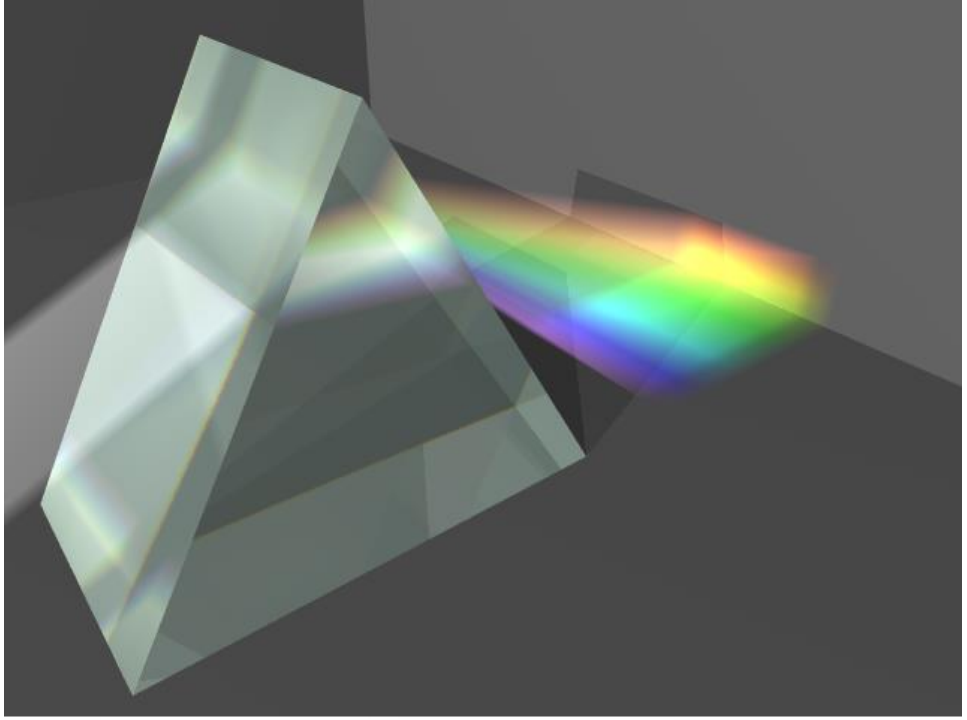


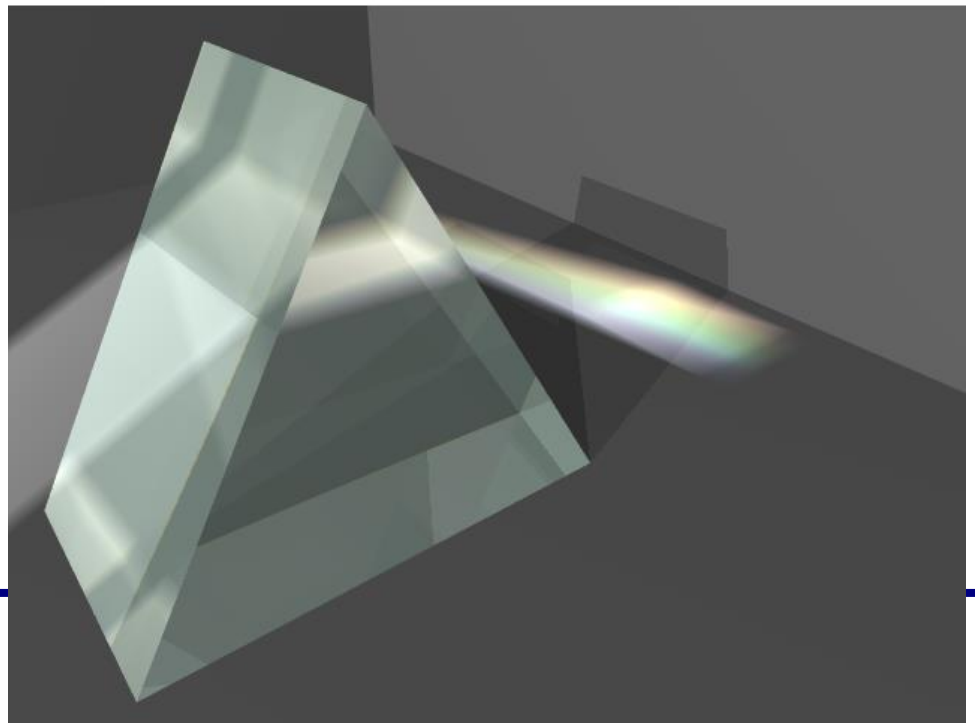


Refraction is when waves ____ __ or slow down due to travelling in a different _____. A medium is something that waves will travel through. When a pen is placed in water it looks like this:

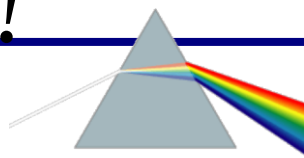
In this case the light rays are slowed down by the water and are _____, causing the pen to look odd. The two mediums in this example are _____ and _____.

Words – speed up, water, air, bent

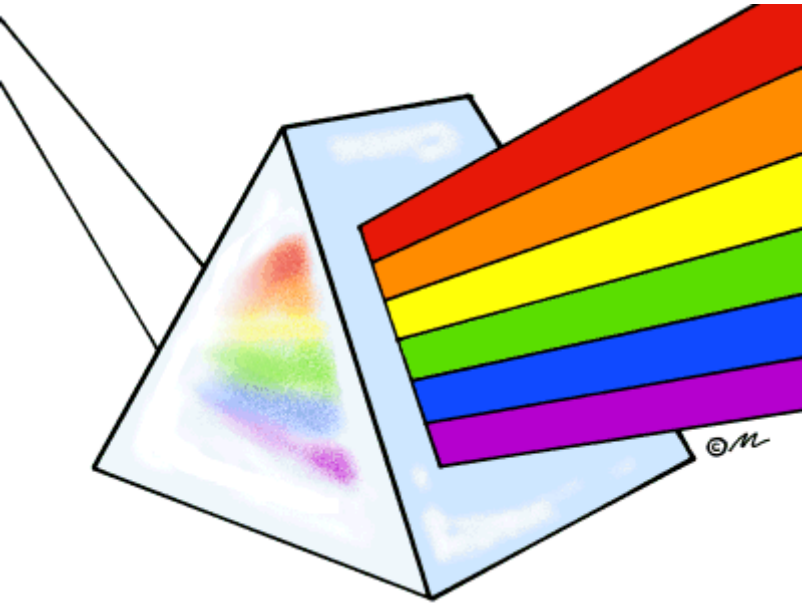


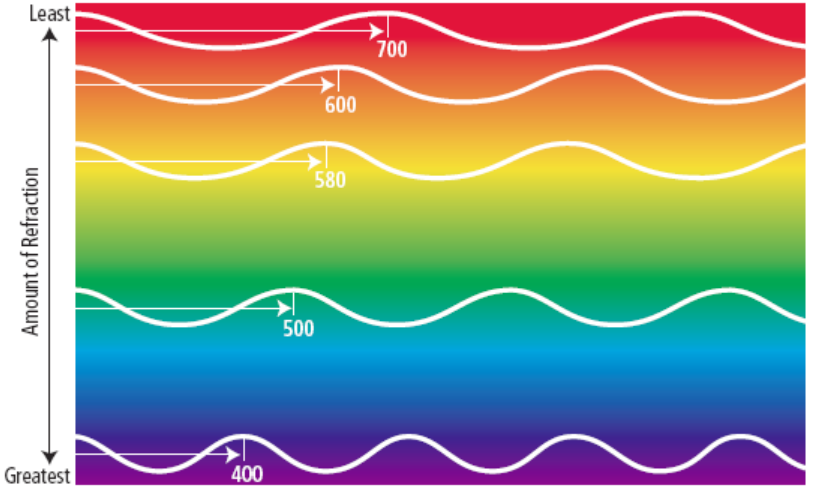


When a laser is shone through a prism, the light will refract but not disperse. Why? *A laser light is one color only!*



Spectrum the array of colours of light that have been separated by the dispersion of white light





Red has the longest wavelength but the lowest frequency

Blue has the lowest wavelength but the highest frequency

The constituent colors of white light are:

Red

Orange

Yellow

Green

Blue

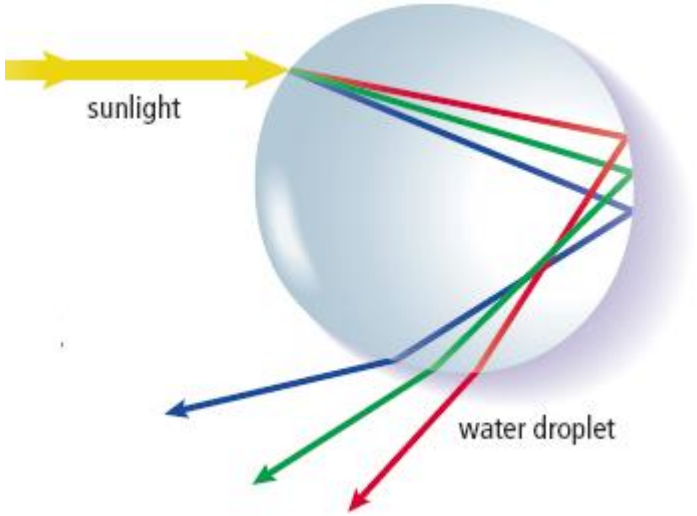
Indigo

Violet

ROY G BIV

Why You See a Rainbow?

Like prisms, water droplets also refract light In a rainbow, the human eye can distinguish a range of colours In order of decreasing wavelength, and increasing frequency.

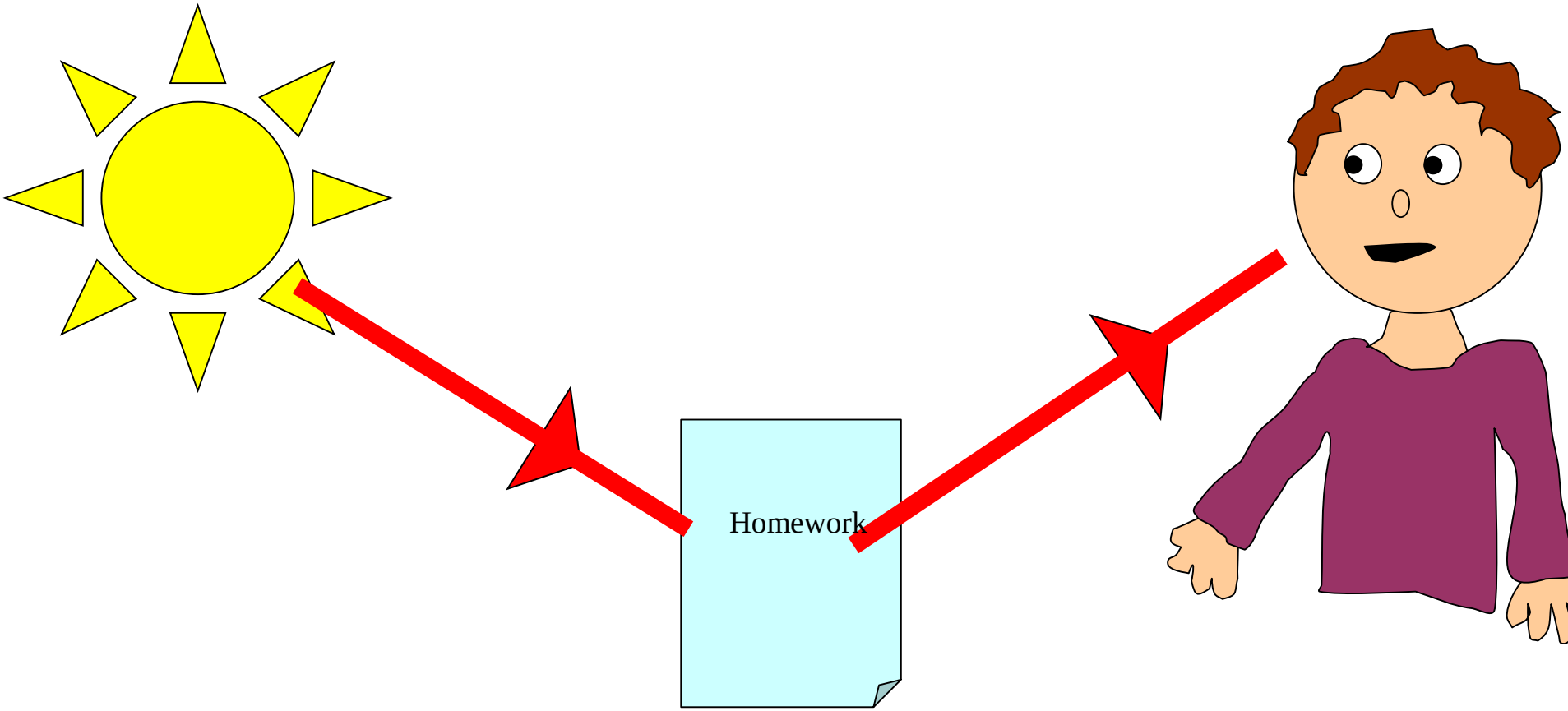


Science 8

Unit 2: OPTICS

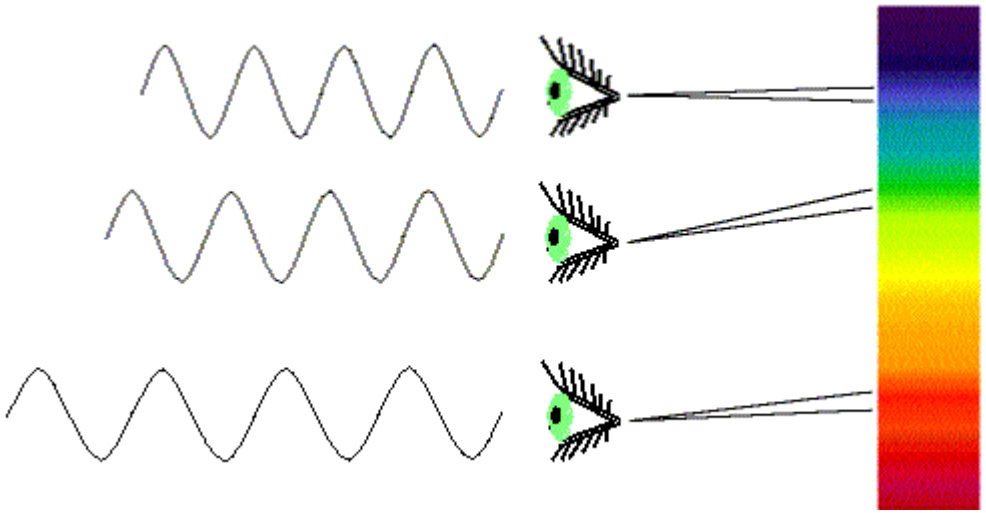
Topic 4: Reflection of White Light

Reflection: light bounces off a surface.



- We see things because they reflect light into our eyes:

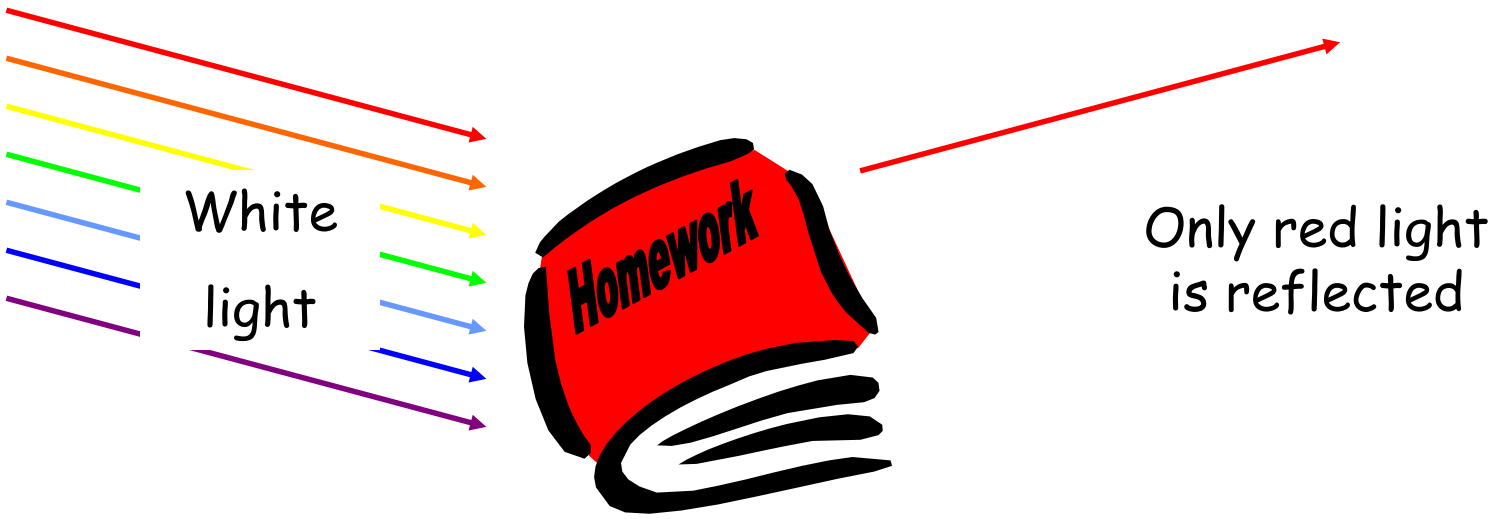
We see certain colours because they consist of a certain frequency and wavelength.



Seeing colour

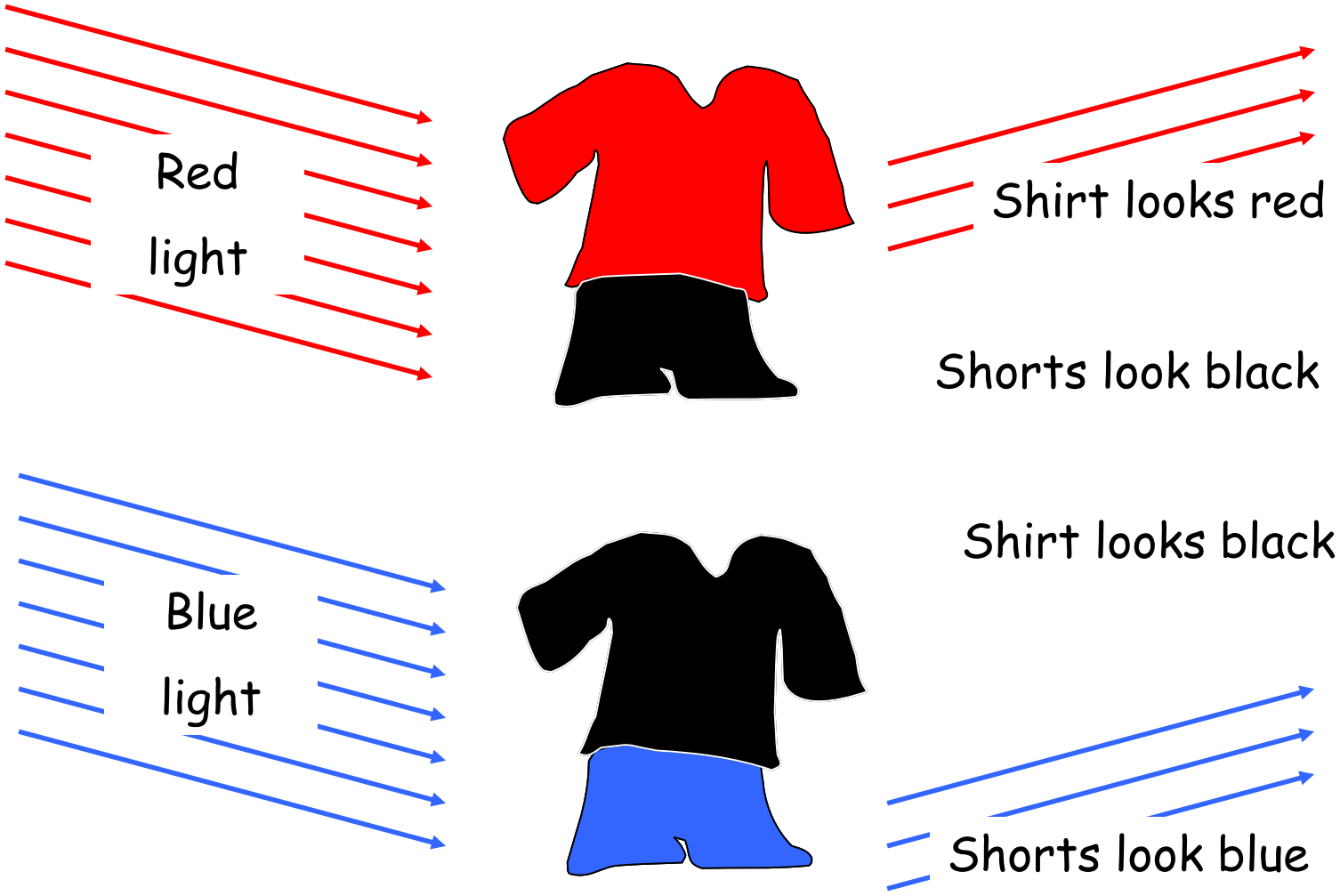
- The colour an object appears depends on the colours of light it reflects.

For example, a red book only reflects red light:

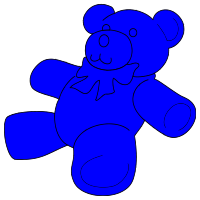


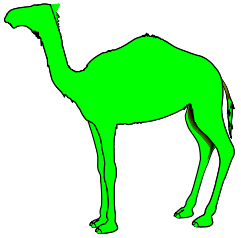
Reflection occurs when a light wave strikes an object and bounces off. When sunlight strikes coloured clothing, some colours are reflected while other colours are absorbed

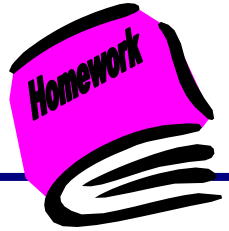
- In different colours of light this shirtwould look different:



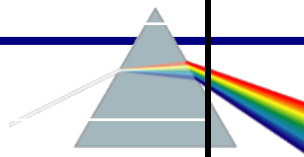
Some further examples:



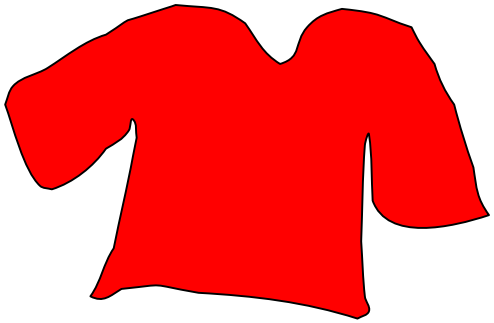


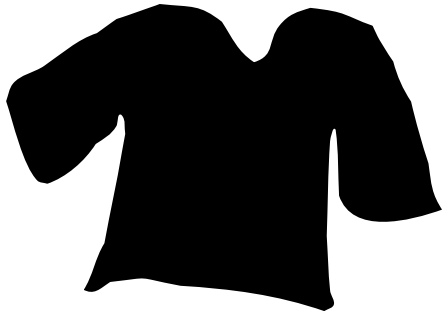


Object	Colour of light	Colour object seems to be
Red socks	Red	Red
	Blue	Black
	Green	Black
Blue teddy	Red	Black
	Blue	
	Green	
Green camel	Red	
	Blue	
	Green	
Magenta book	Red	
	Blue	
	Green	



- Why does a bright red shirt look black when it is placed in a dark room?



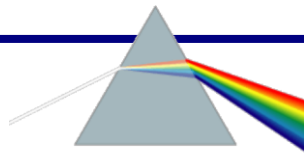


Since a shirt does not produce its own light, but merely reflects the light in the room, the shirt appears to be black when there is no source of light.

What happens when you spin a colour wheel?

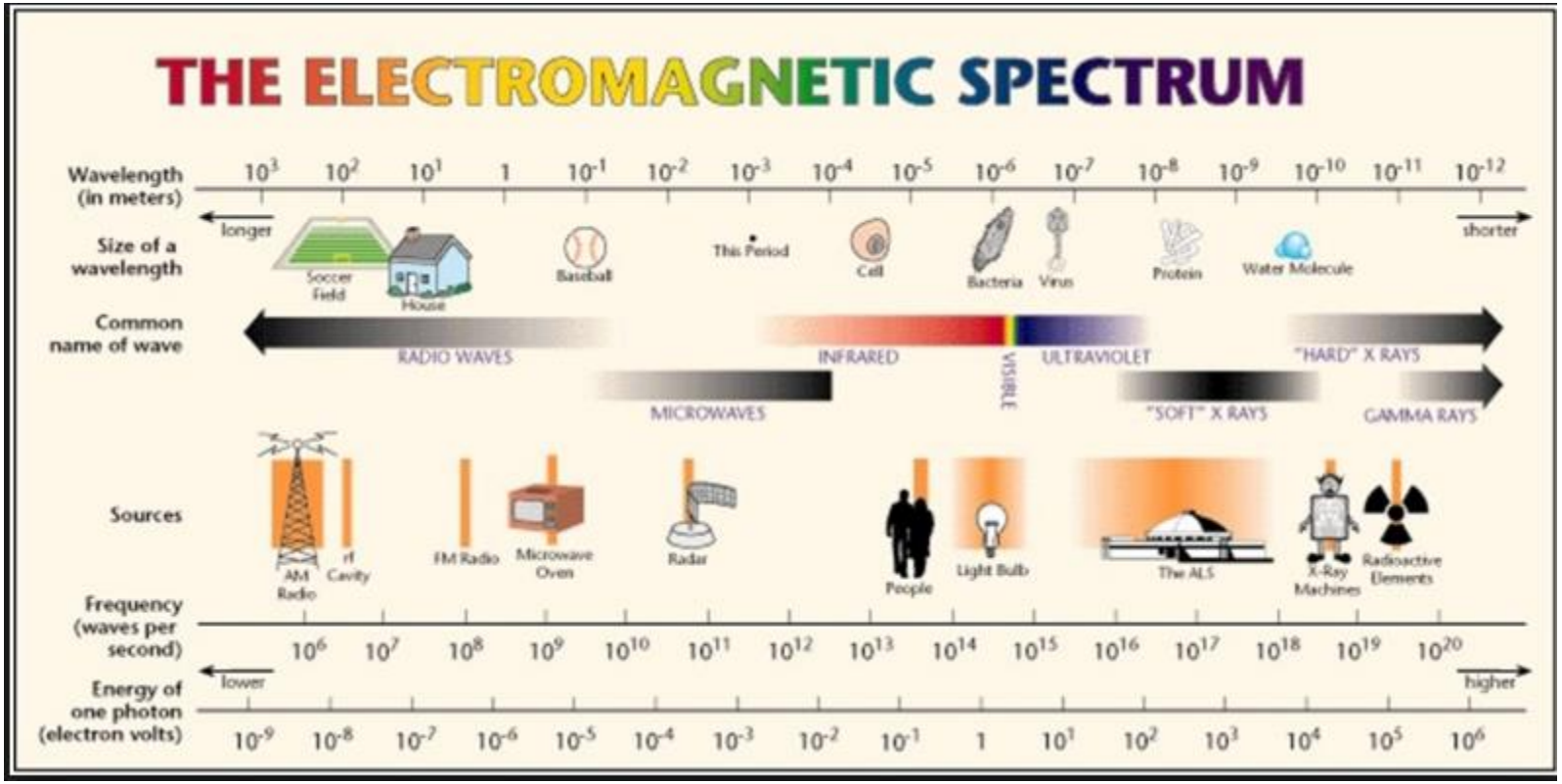
Educational Video

- SCIENCE 8 UNIT 2 OPTICS EXPLORING LIGHT AND COLOUR



Science 8

Unit 2: OPTICS



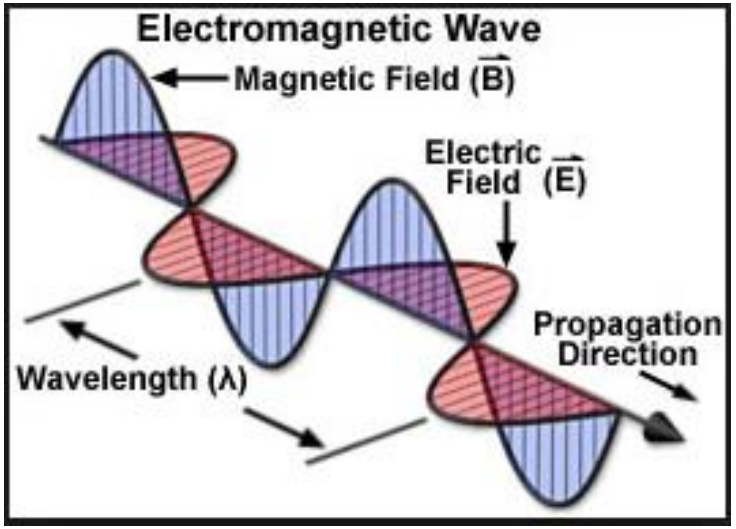
Topic 5: Electromagnetic Radiation

Radiant Energy

Radiant energy refers to energy that spreads out, or radiates, from its source in all directions. It includes visible light and light you can not see.

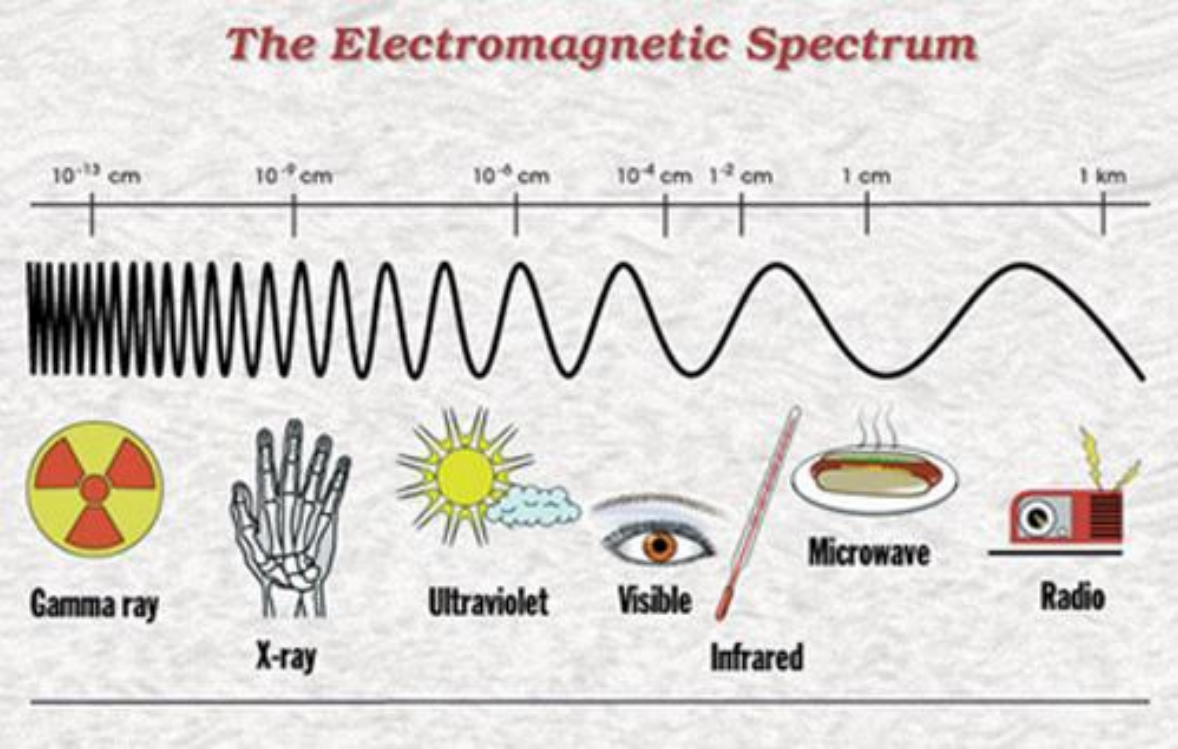
ELECTROMAGNETIC RADTIATION (EMR)

Electromagnetic Radiation is the transmission of radiant energy by waves due to vibration of electrical and magnetic fields in the form of waves that extend from the longest radio waves to the shortest gamma rays.



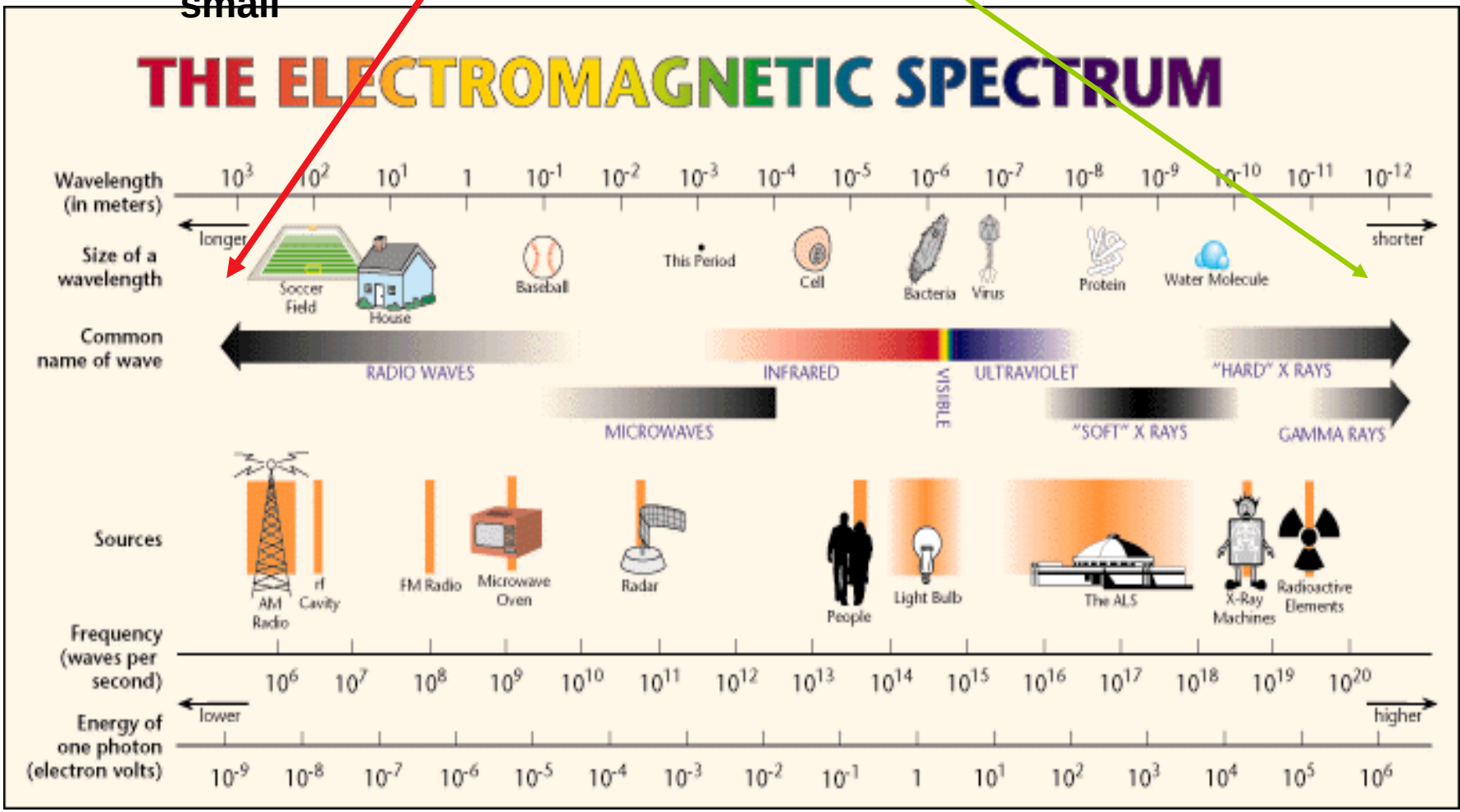
Beyond Visible Light

Electromagnetic Radiation(EMR) is the transmission of energy in the form of waves that extend from the longest radio waves to the shortest gamma rays.



.

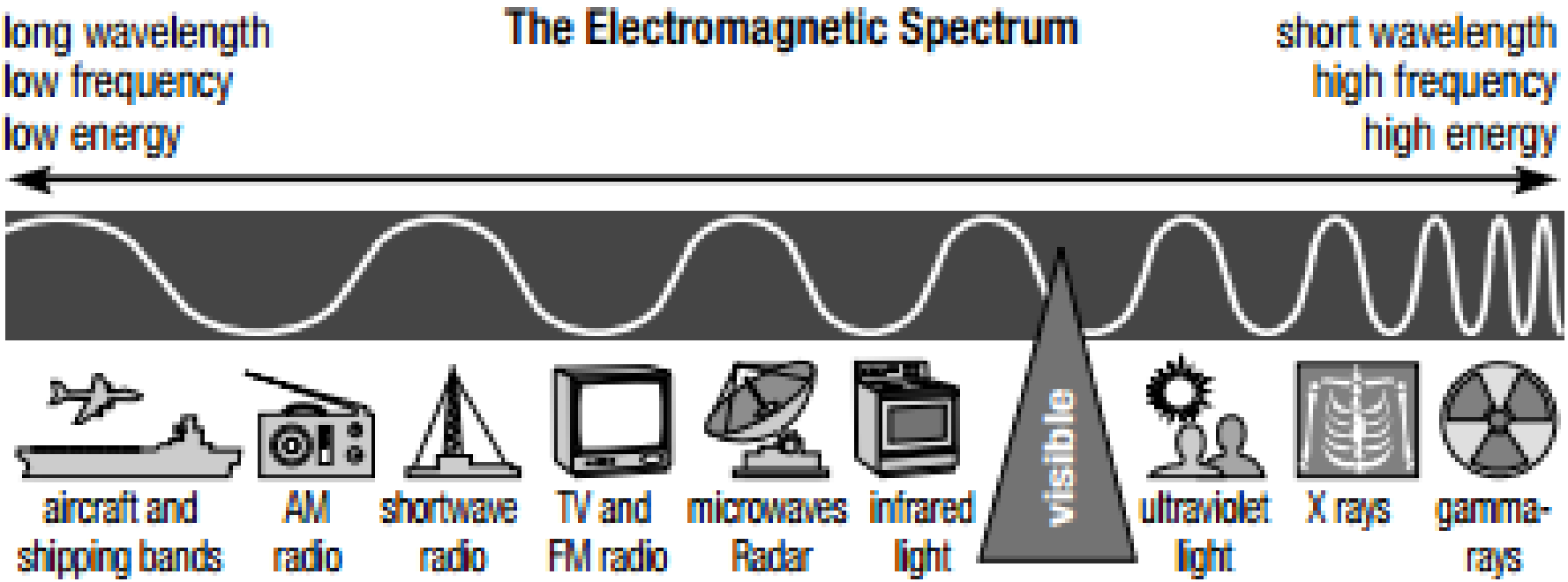
Remember radio waves are long…and gamma rays are small



Radio-TV -Microwave- Infrared - VISIBLE -Ultraviolet -X-rays - Gamma- Cosmic

Higher the frequency, higher the energy

OPTICS


The Electromagnetic Spectrum
long wavelength
low frequency
low energy
short wavelength
high frequency
high energy
aircraft and shipping bands
AM radio
shortwave radio
TV and FM radio
microwaves Radar
infrared light
visible
ultraviolet light
X rays
gamma-rays

How big are the waves?

- A great question!
- Radio waves= (Buildings to human size);
- Microwaves →  (Humans-beetles);
- Infrared waves →  (Eye of a needle);

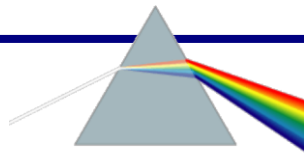
Visible waves (microscopic size)!

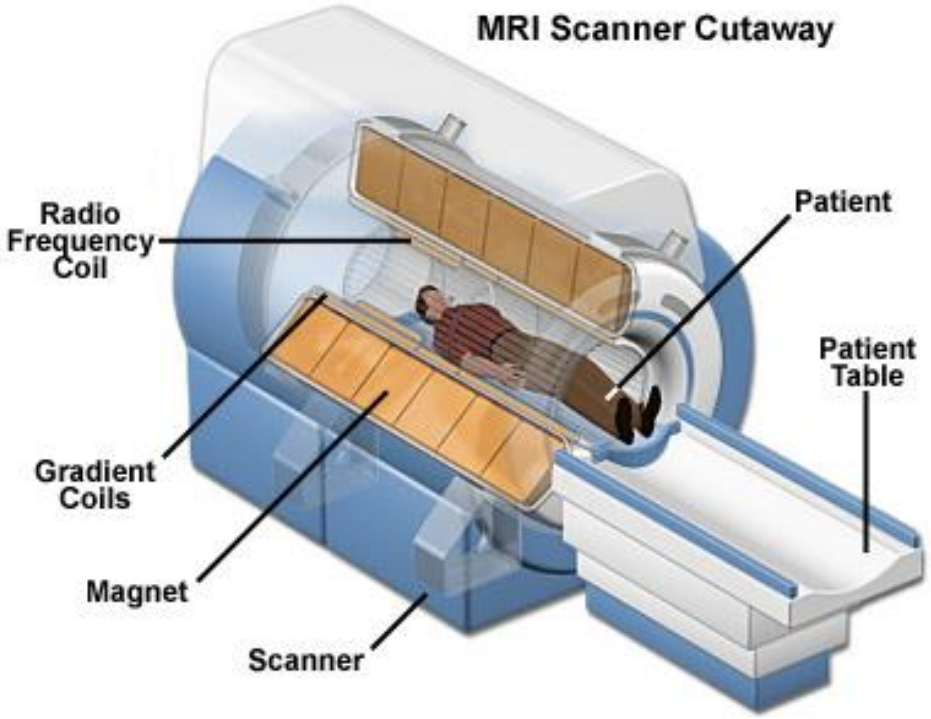
WOW! All the rest are the size of molecules, atoms, atomic nuclei and smaller..

Types of Electromagnetic Radiation

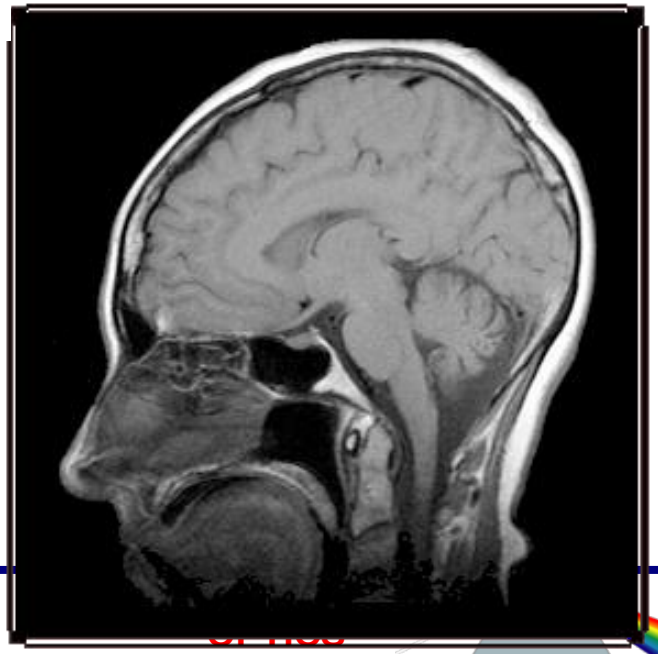
1. Radio waves: the longest wavelength and lowest energy and frequency.

- Can be used to help us see the inside of our bodies to diagnose illness. Ex. MRI



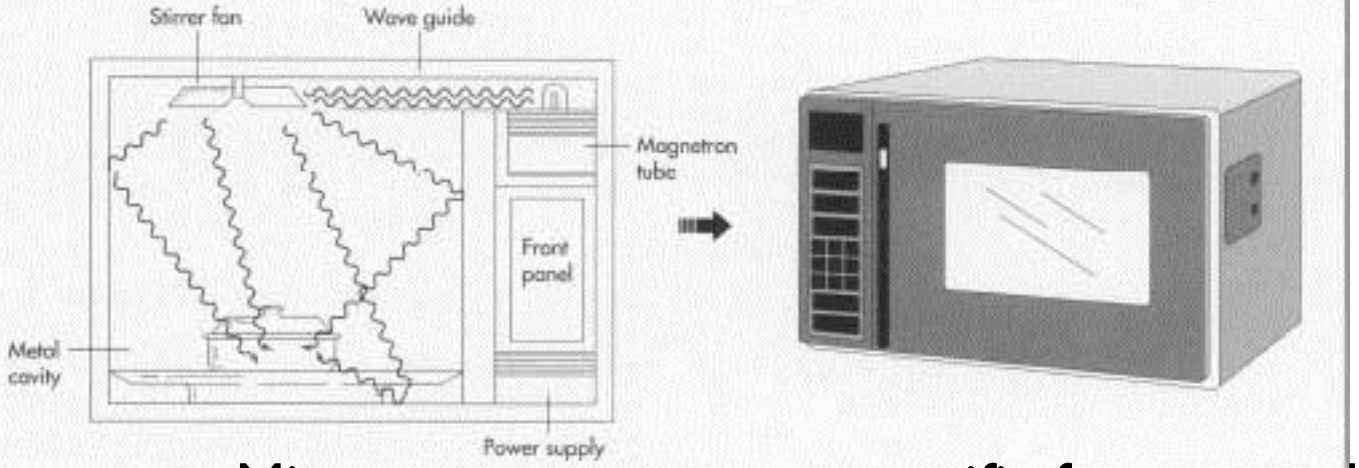


Magnetic Resonance Imaging



2. Microwaves: have the shortest wavelength and the highest frequency of all radio waves.

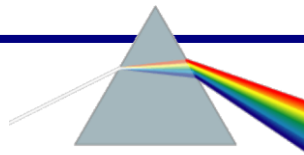
- Ex. Microwave ovens, telecommunication satellites, radio telescopes, radar (remote sensing)



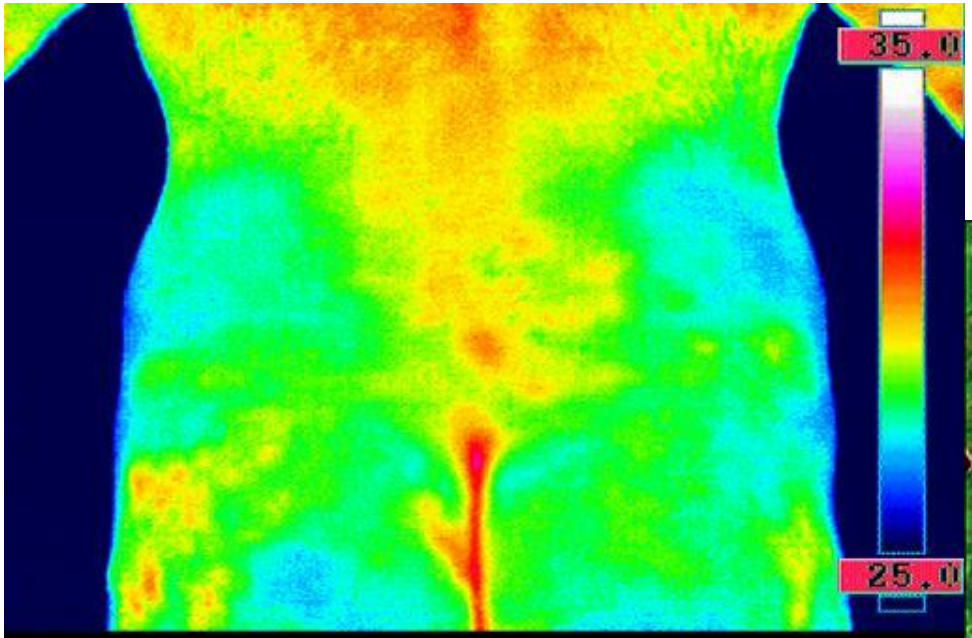
Microwave ovens use a specific frequency that is strongly absorbed by water molecules in food.

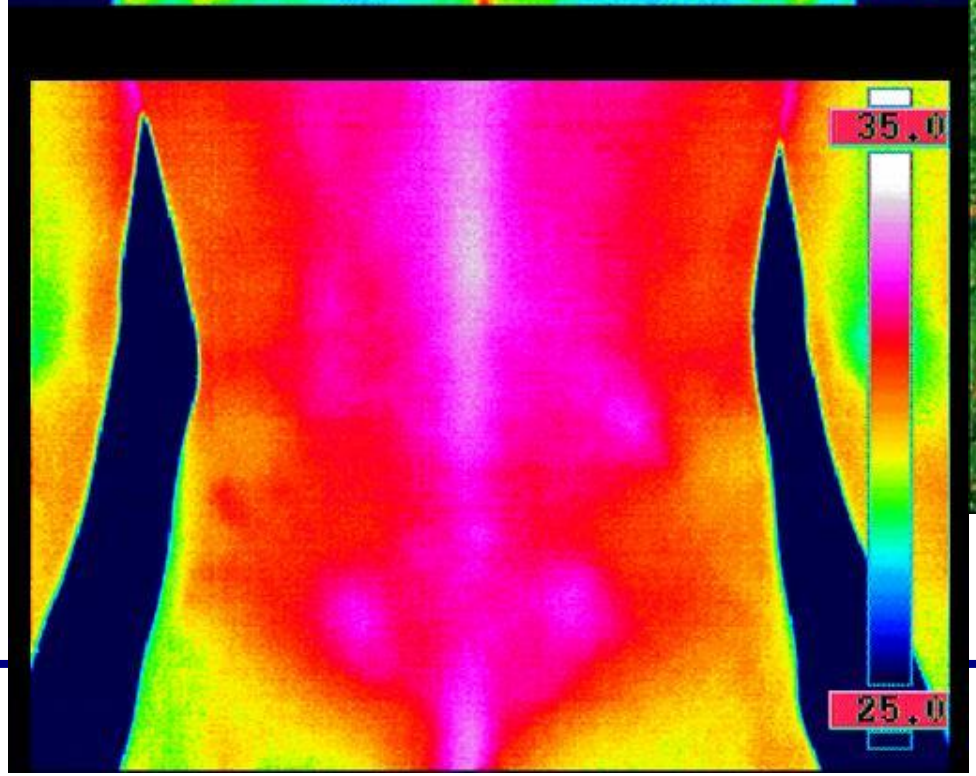
3. Infrared Waves: longer wavelength and lower energy and frequency.

- Infrared means below red
- Also called heat radiation
- Ex. Remote controls, computer, heat lamps, motion sensors



Infrared Radiation

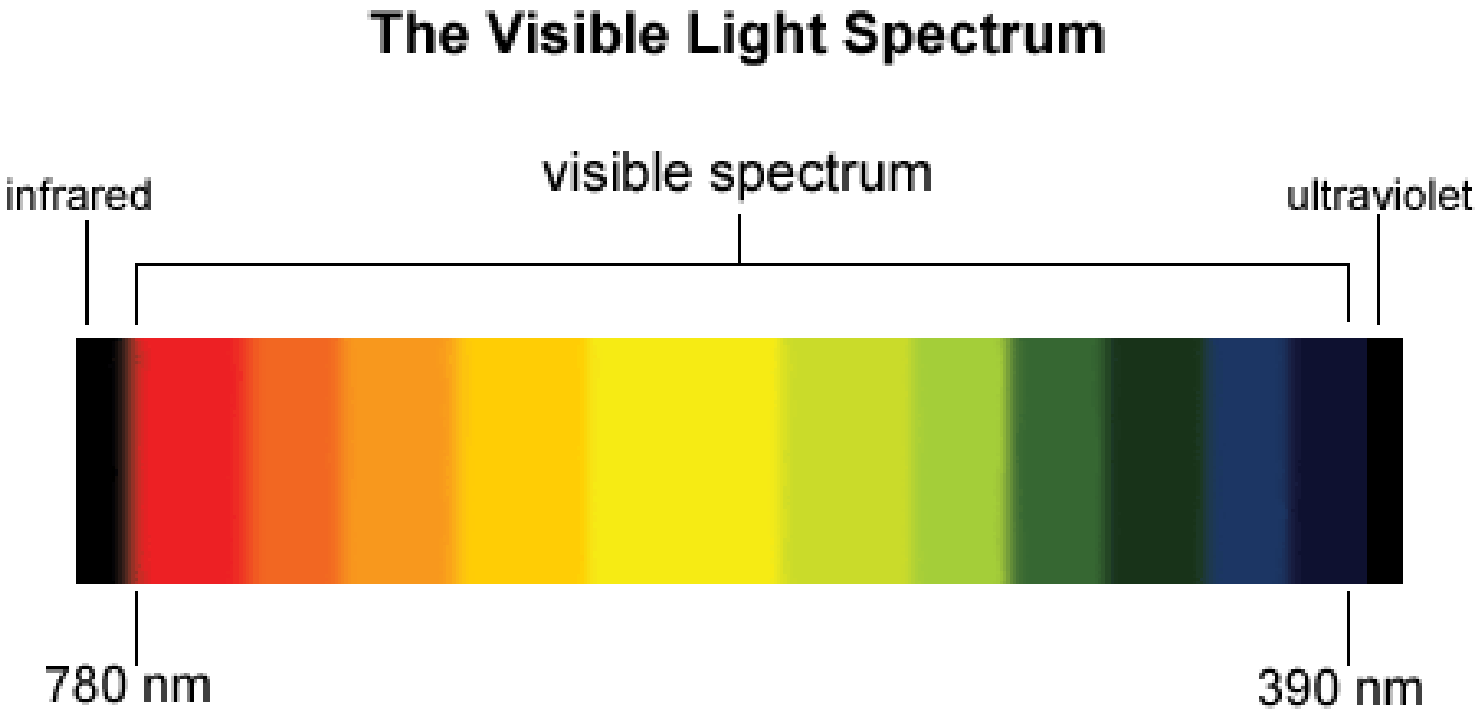




LANDSAT Image of Fire

4. Visible Light Spectrum

- Can be continually detected by our eyes.

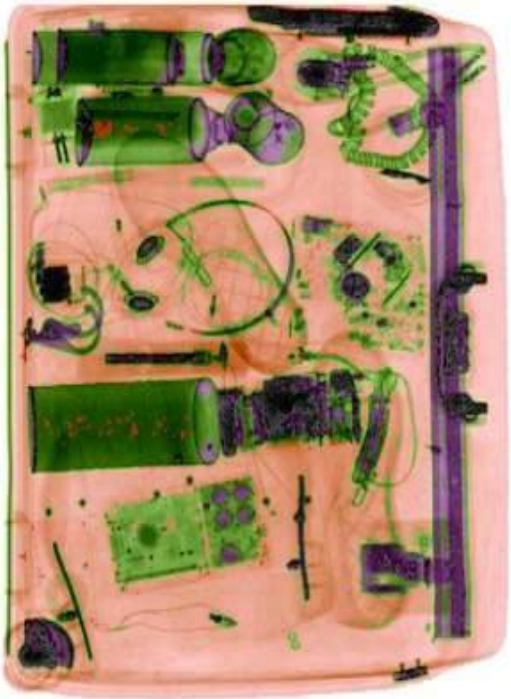


5. Ultraviolet Waves: shorter wavelength and higher energy and frequency.

- Very energetic
- Have the ability to kill bacteria in food and water and medical supplies.
- Ex. Sun, detect fingerprints

6. X-Rays: have a shorter wavelength, and higher energy and frequency than UV.

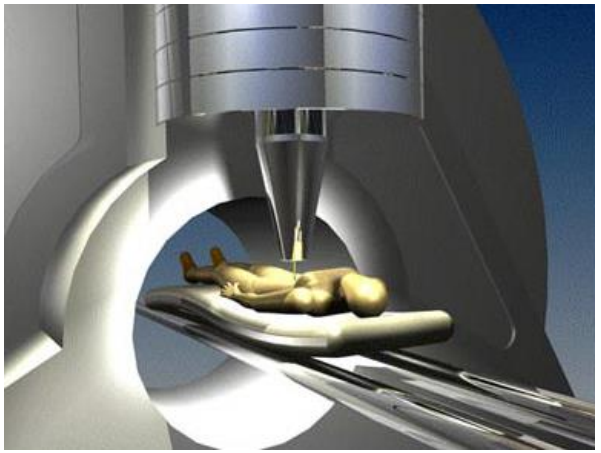
- Used to photograph teeth, bones and the inside of machines, security screening



7. Gamma Rays: have the highest energy and frequency and the shortest wavelength.

- Result from nuclear reactions.
- Produced by the hottest regions of the universe.

Gamma Rays:
Nuclear Explosion



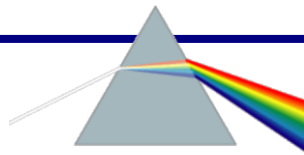
Gamma Rays:
Medical Treatment

Electromagnetic Radiation... A Safety Concern?

Generally, higher energy electromagnetic radiation is more harmful to humans.

The Earth's atmosphere is able to protect us from some of the more dangerous electromagnetic radiation present in space, making the Earth a safe place for humans.

Changes to present conditions may comprise our safety.



Positive and Negative Effects to Exposure to Electromagnetic Radiation

	X-Rays	Ultraviolet	Radio Waves
Positive Effects	Medical detection	Used to treat jaundice in babies	Improved tele-communication
Negative Effects	Over-exposure can lead to cancer	Skin cancer	Uncertain of long-term exposure

Brain Tumors and Cell phones

- Cellular phones operate with RF (Radio Frequencies); a form of electromagnetic energy located on the electromagnetic spectrum between FM radio waves and the waves used in microwave ovens, radars and satellites