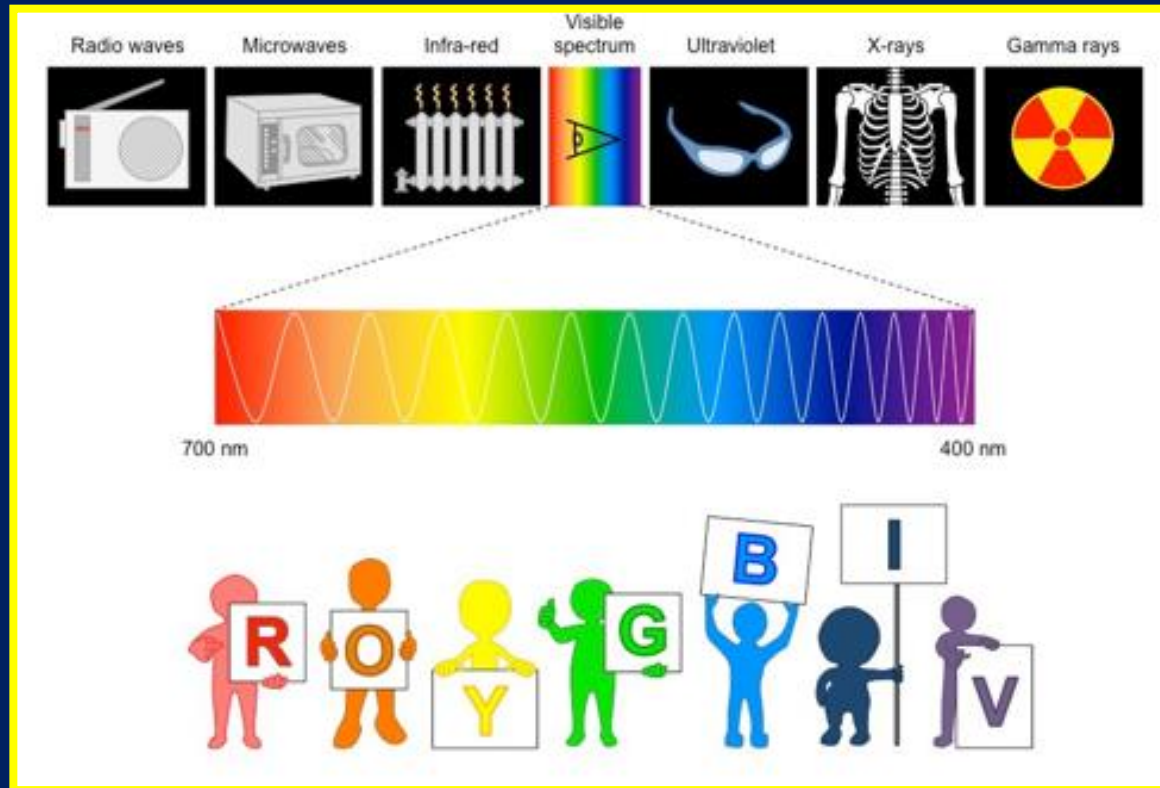


# Electromagnetic Spectrum



**Essential Standard 1.1: Explain Earth's role as a body in space.**

**Objective 1.1.3: Explain how the Sun produces energy which is transferred to the Earth by radiation.**

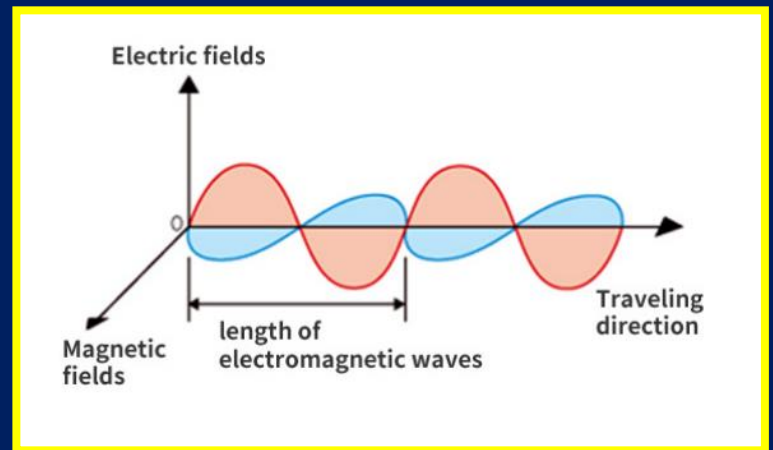
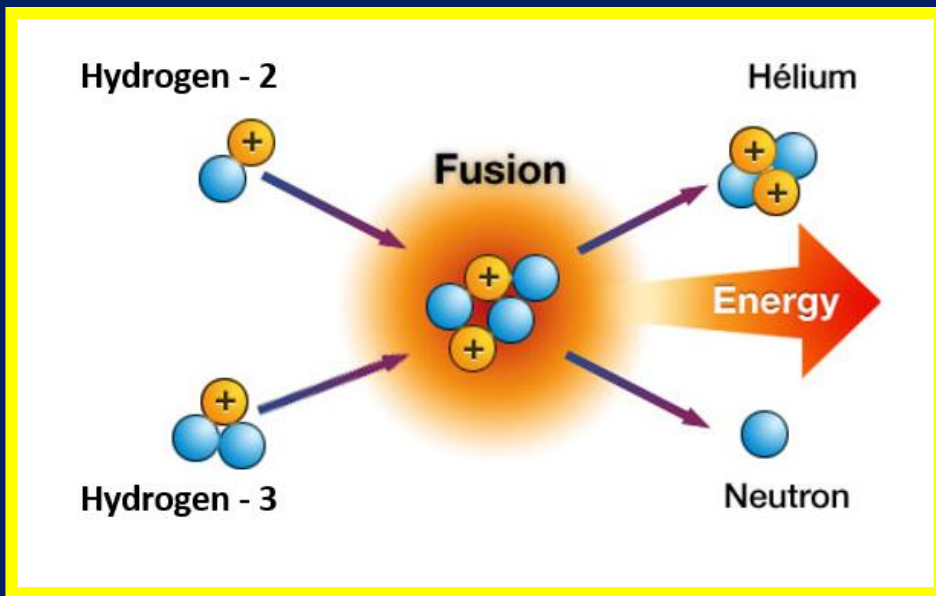
# I Can Statements

At the end of this lesson, you should be able to say, with confidence:

- I can explain how Energy from the Sun travels to Earth as radiant energy in the form of electromagnetic waves.
- I can describe various parts of the electromagnetic spectrum

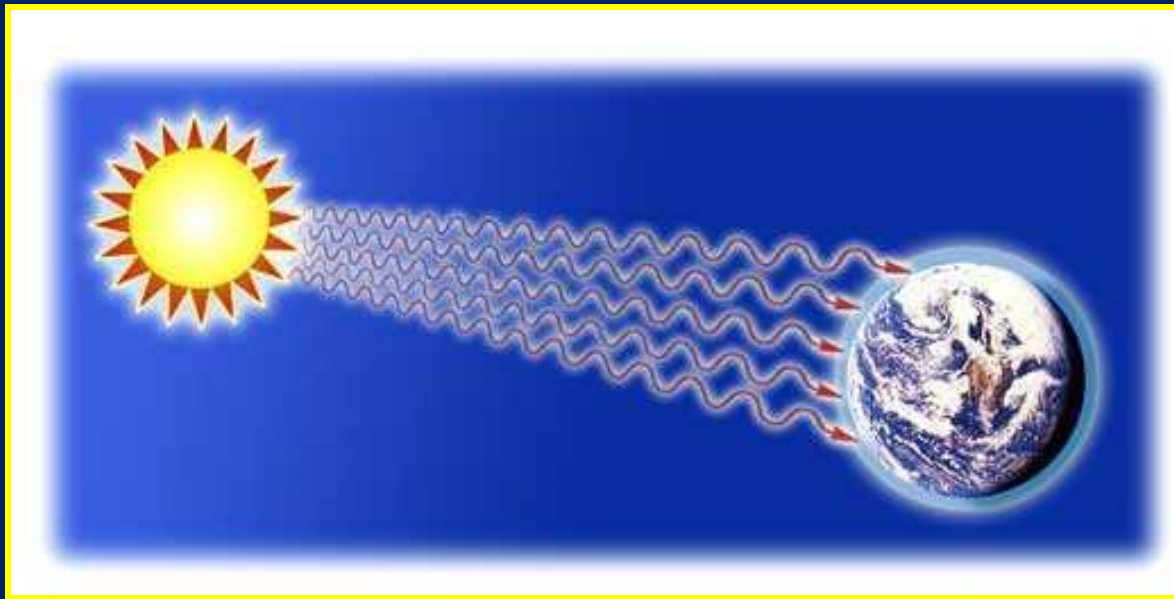
# Fusion Reactions

Every second, fusion reactions taking place inside our Sun releasing tremendous amounts of energy in the form of electromagnetic waves.



# Speed

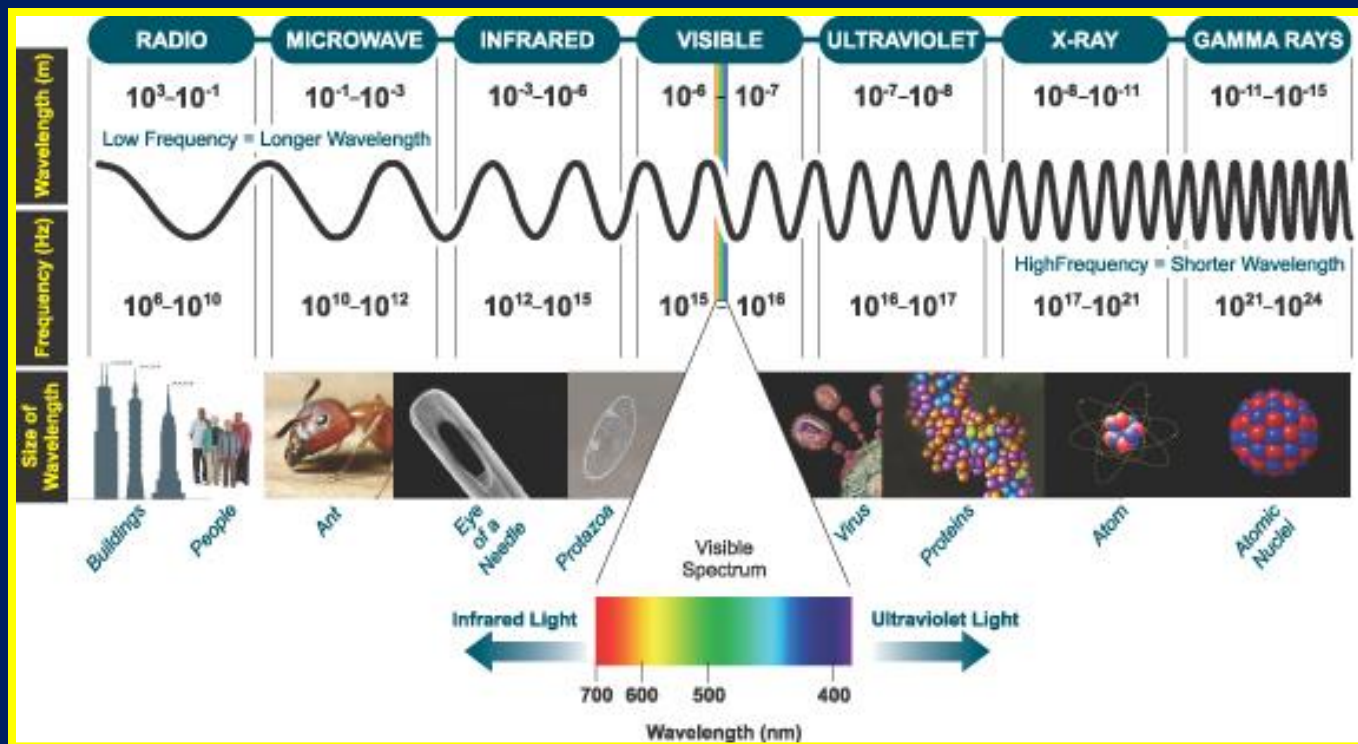
Electromagnetic waves can transfer energy at the speed of 186,000 miles per second, through the vacuum of space.



Light takes  
8 minutes  
to reach  
Earth

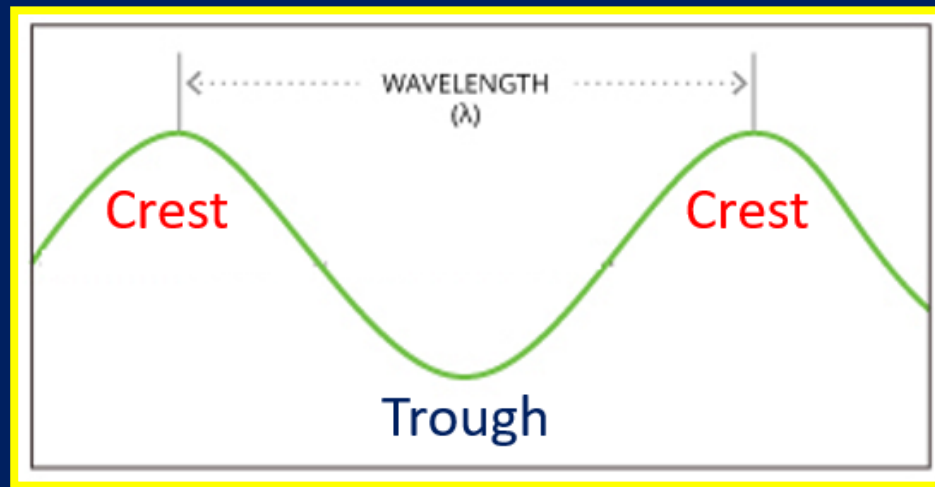
# Types of Energy Released

The type of energy released by electromagnetic waves can vary according to wave's wavelength and frequency.



# Wavelength

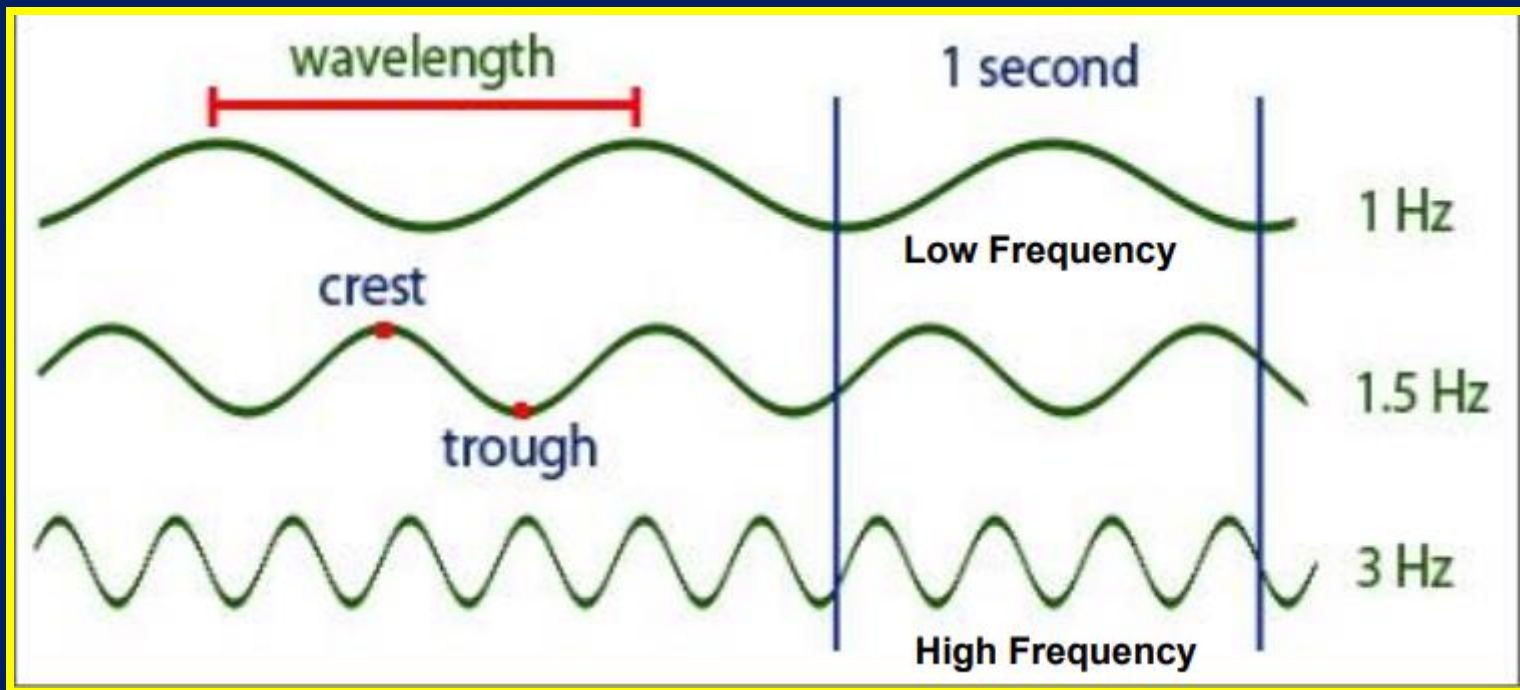
All electromagnetic waves have high points called crests and low point called troughs.



The distance from the crest of one wave to the crest of another wave is called a wavelength.

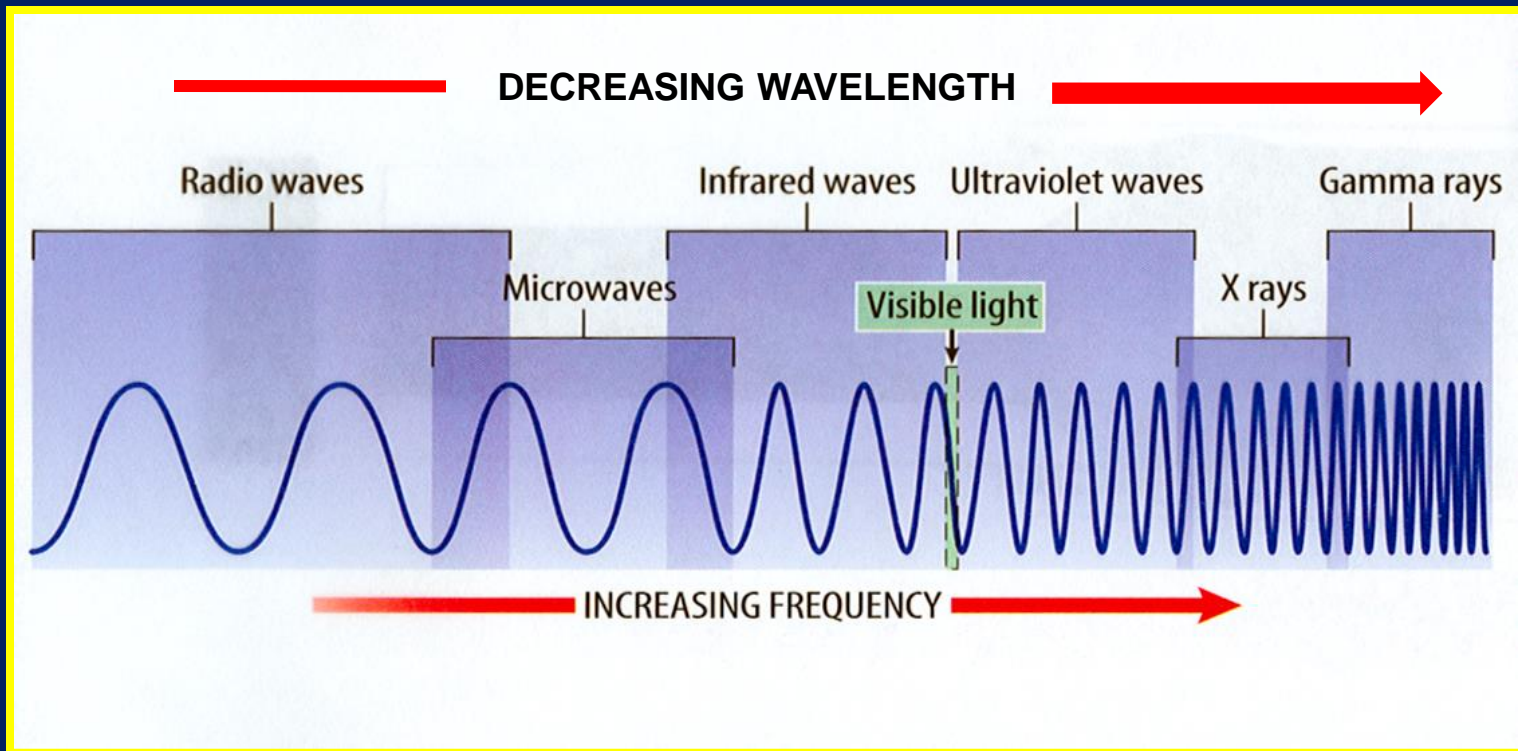
# Frequency

Wave frequency is defined as the number of wavelengths that pass a single point within one second.



# Inverse Relationship

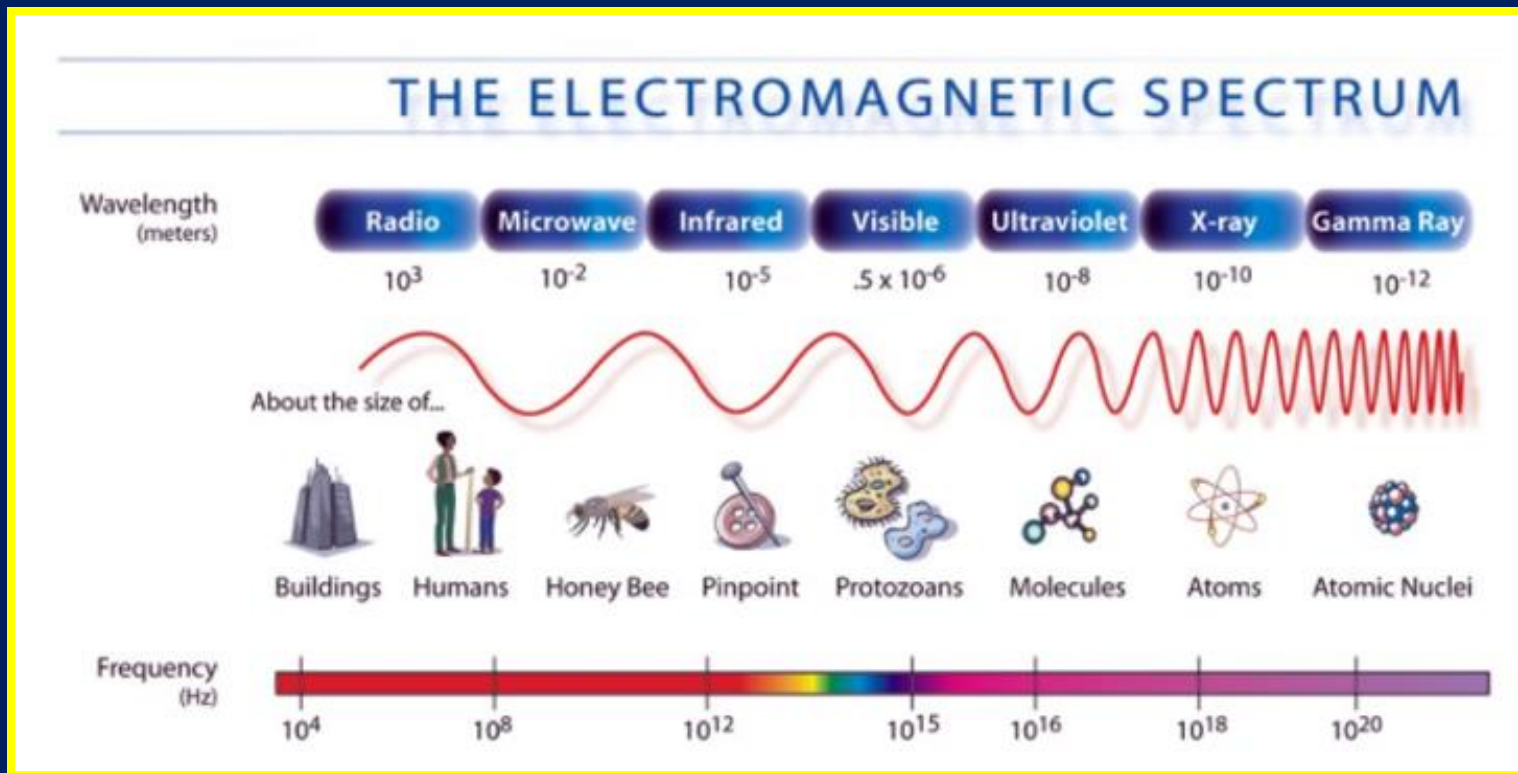
As the wavelength decreases and the frequency of the wave increases.





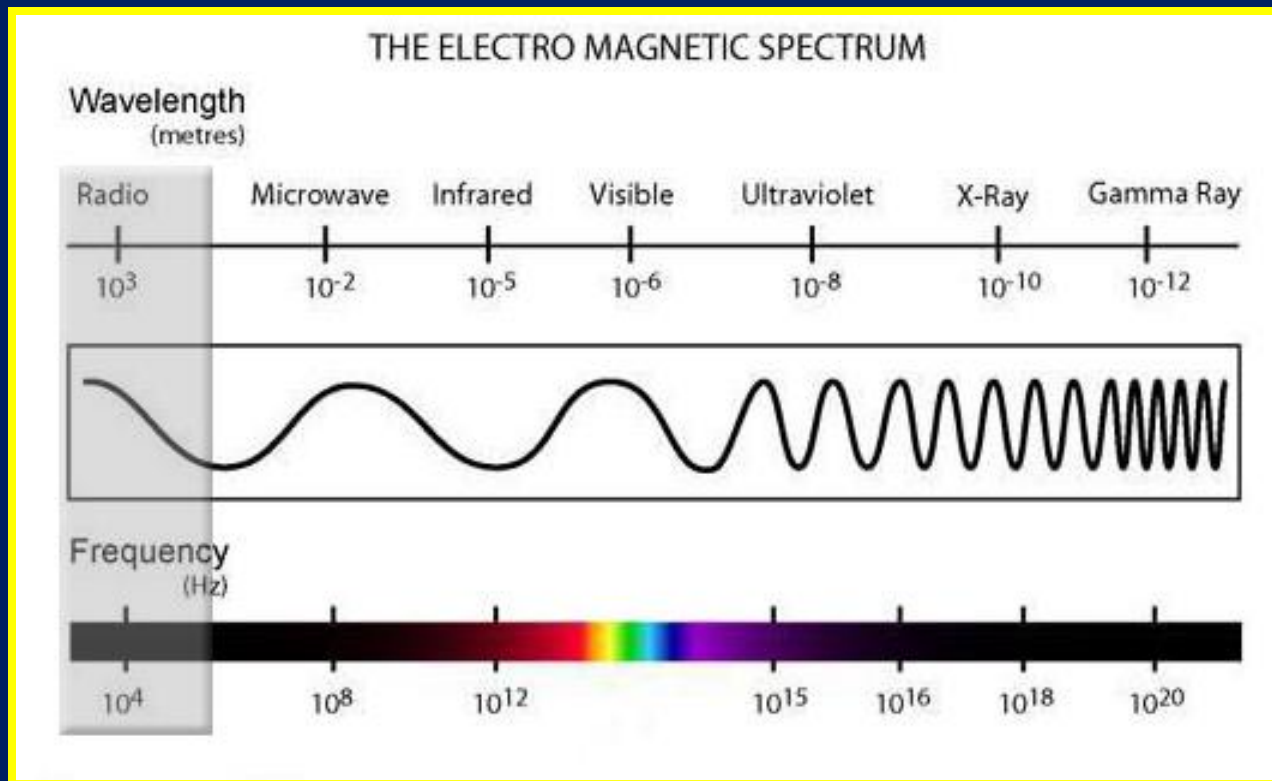
# Electromagnetic Spectrum

The entire range of electromagnetic wavelengths and frequencies is known as the electromagnetic spectrum.



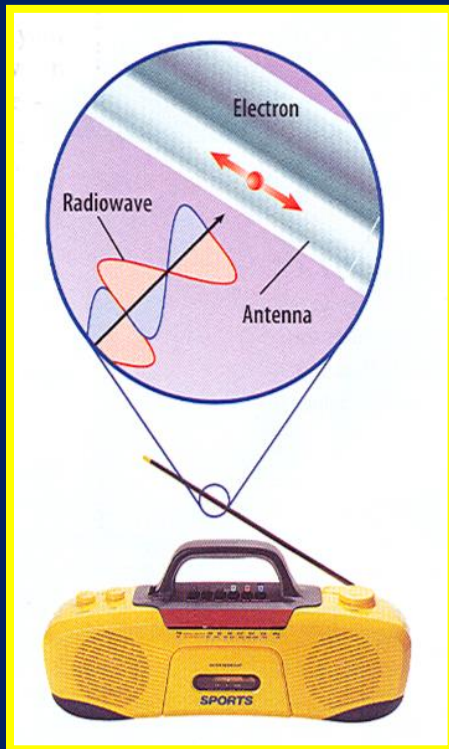
# Radio Waves

Radio waves have the lowest frequency and the longest wavelengths which range between 100 km and 1 m.



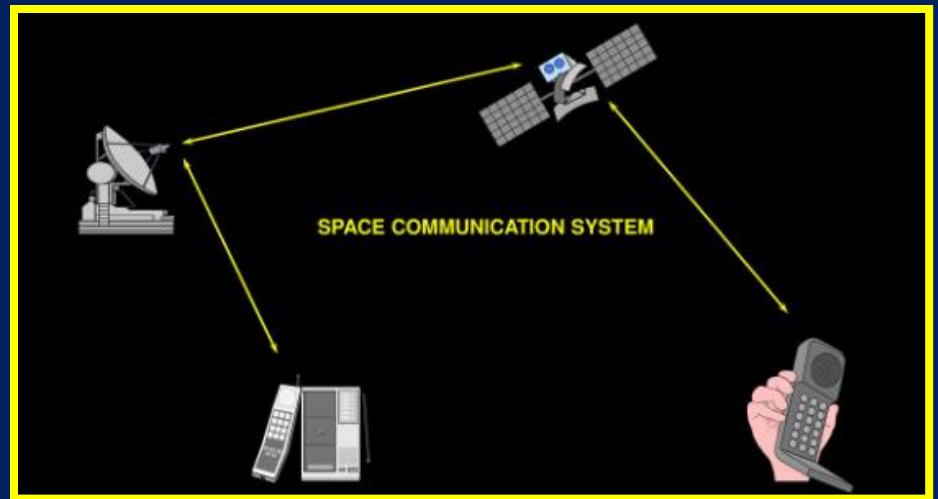
# Radio Waves

Radio waves are not used to transmit radio signals, they are also used for cell phones and TVs.



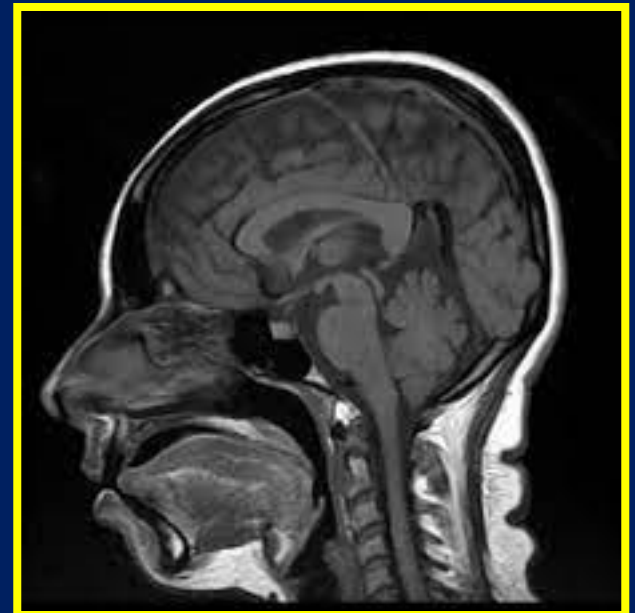
# Radio Waves

Radio waves are also used for Radar guns and satellite communications in Space.



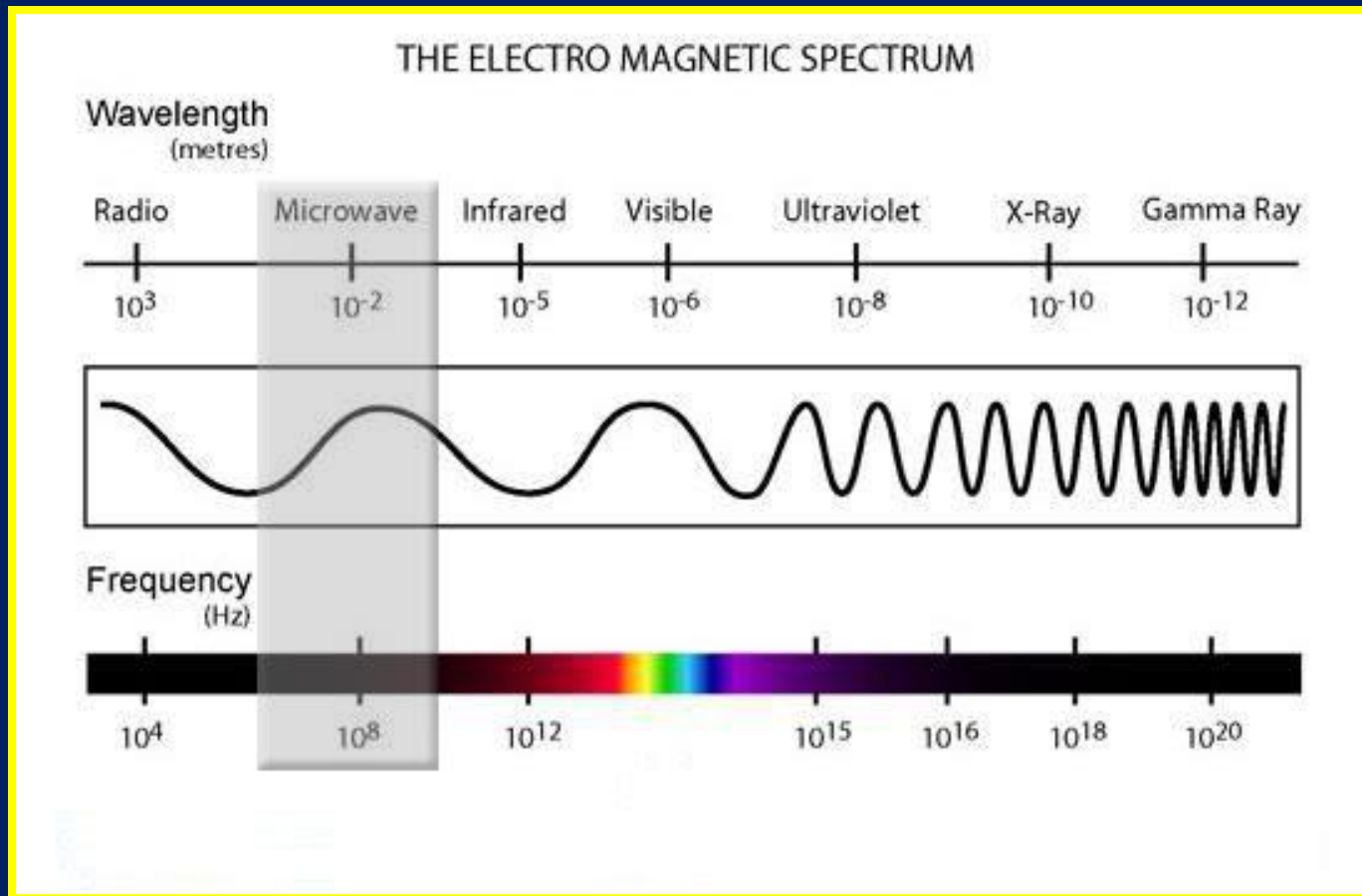
# MRI

Medical Resonance Imaging, MRI, also uses radio waves to create a “map” of different tissues in the body.



# Microwaves

Microwaves have wavelengths between 1 meter and 1 millimeter.



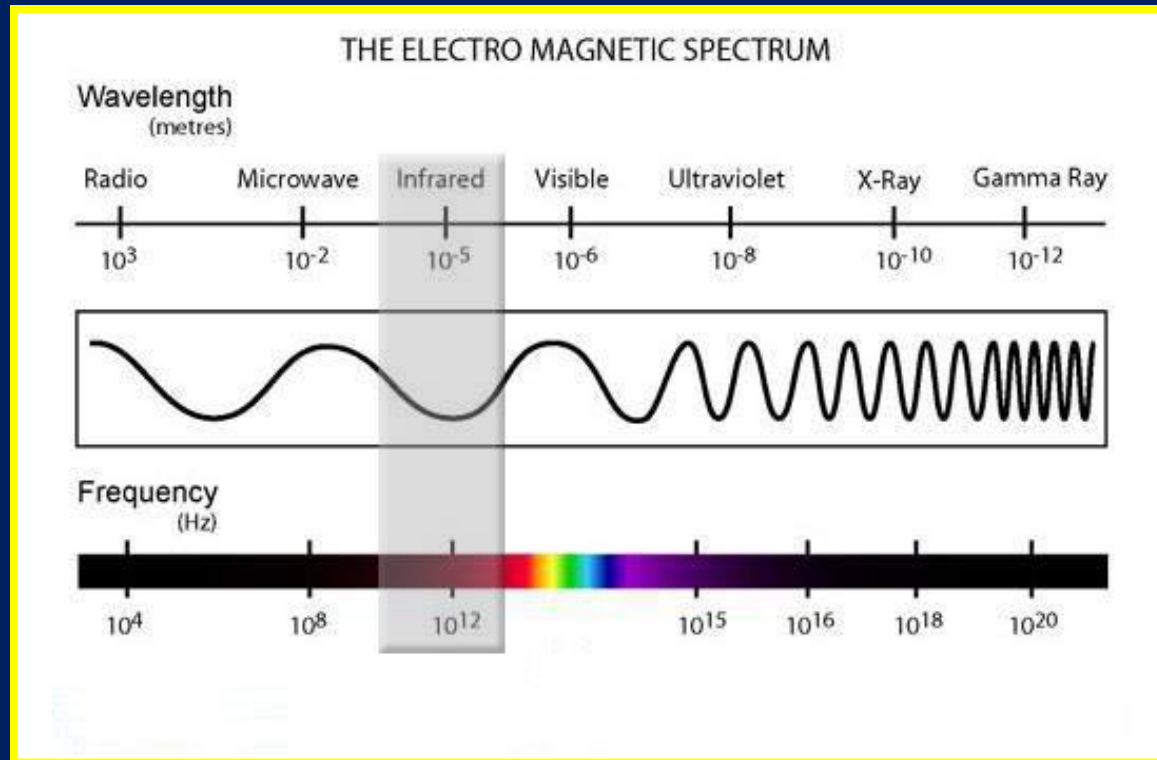
# Microwave Ovens

Microwave ovens emit microwaves that cause the atoms within the food to vibrate and generate heat through friction.



# Infrared Waves

Infrared waves, also known as heat waves, have wavelengths between 1 millimeter and 750 nanometers.





# Infrared Waves

Although humans cannot see infrared waves, some snakes can see infrared waves and use body heat to detect prey.



# Infrared Cameras

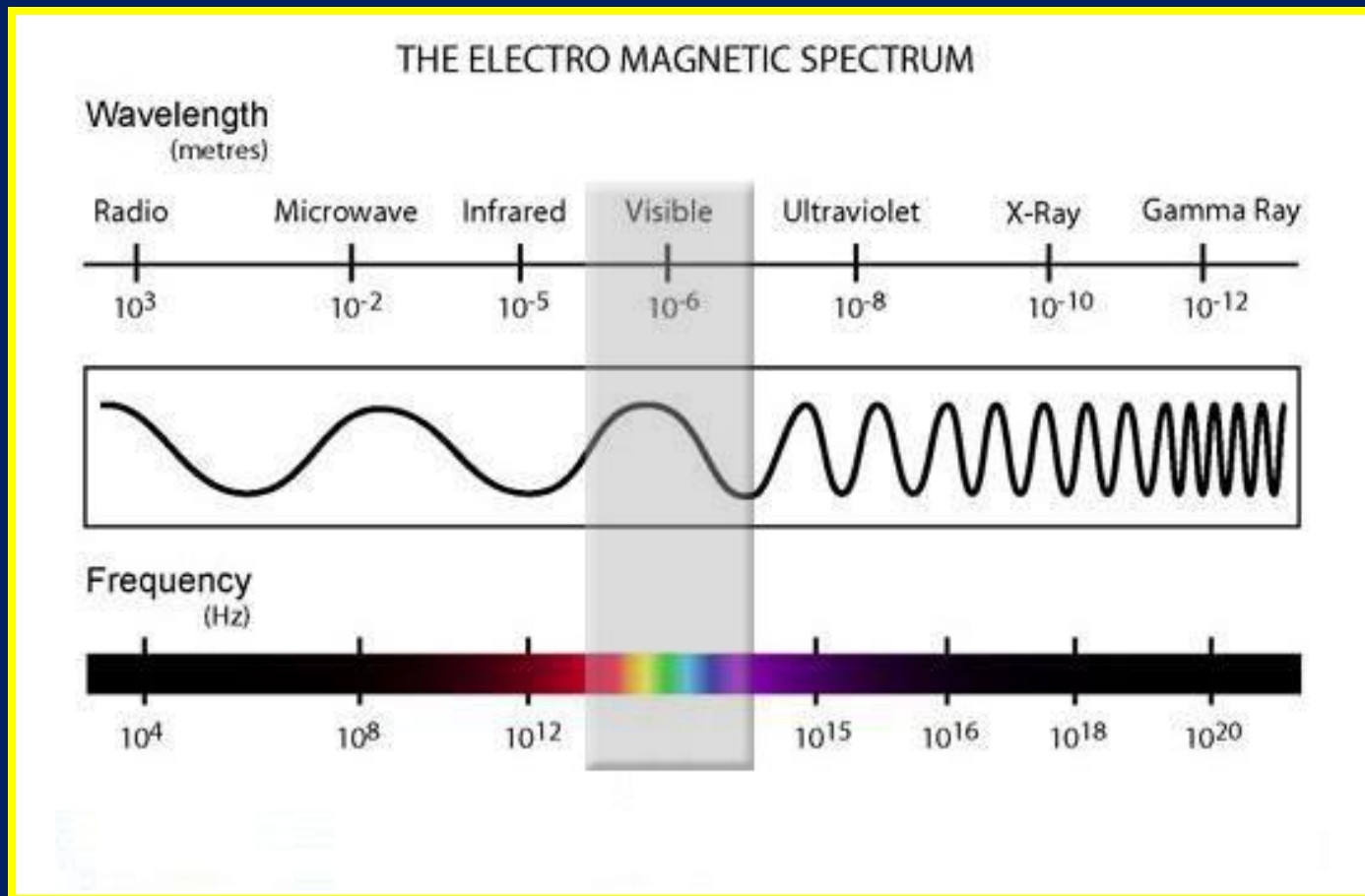
Infrared cameras use infrared waves.



On infrared images, red is hot and blue is cold.

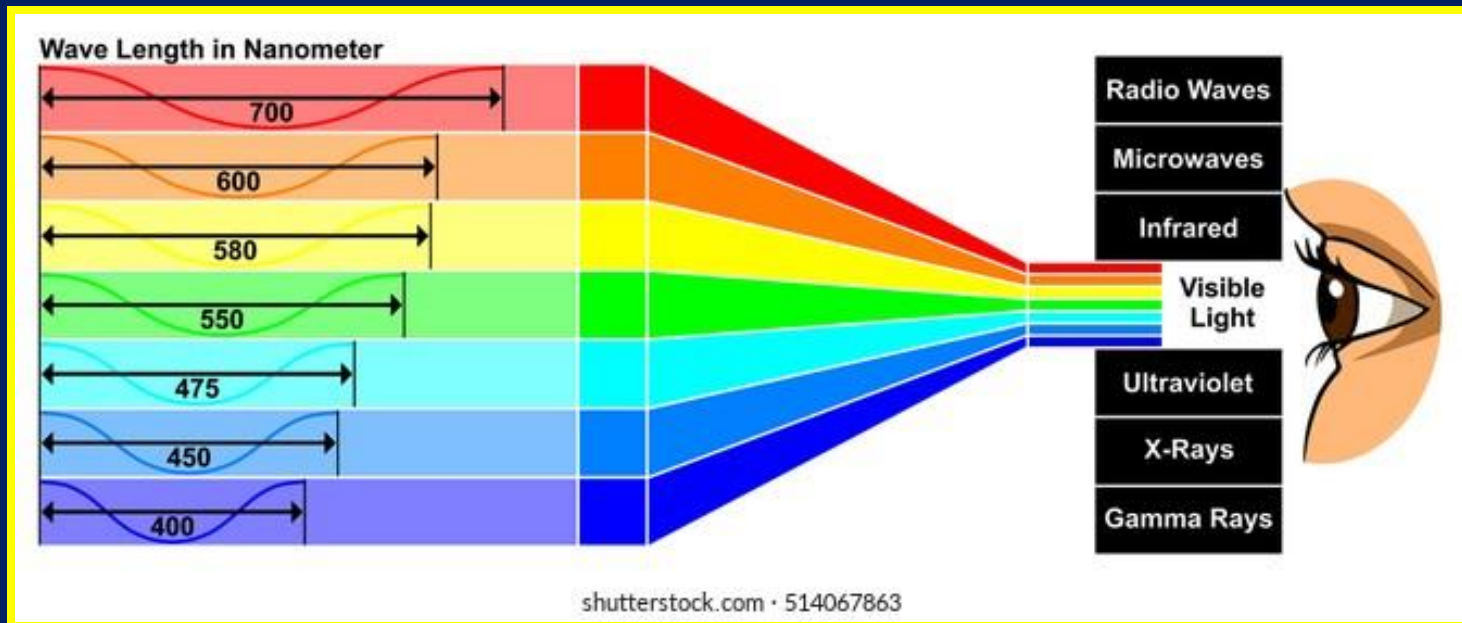
# Light Waves

Light waves have wavelengths ranging between 390 and 750 nanometers.



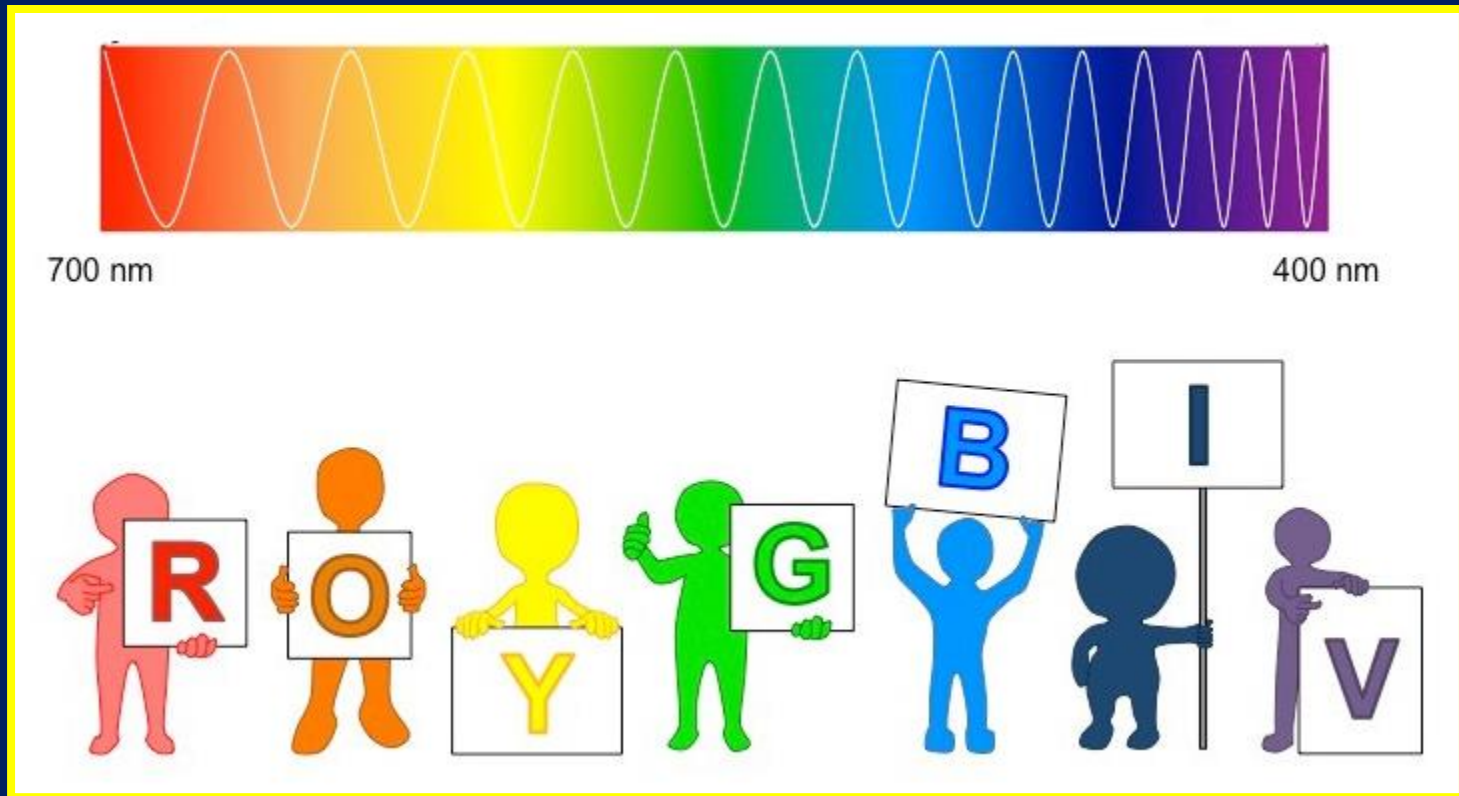
# Visible Light Waves

Light waves are also called visible waves because they are the only part of the electromagnetic spectrum that are visible to the human eye.



# Colors of Light Waves

Different wavelengths of visible light waves emit different colors of light.



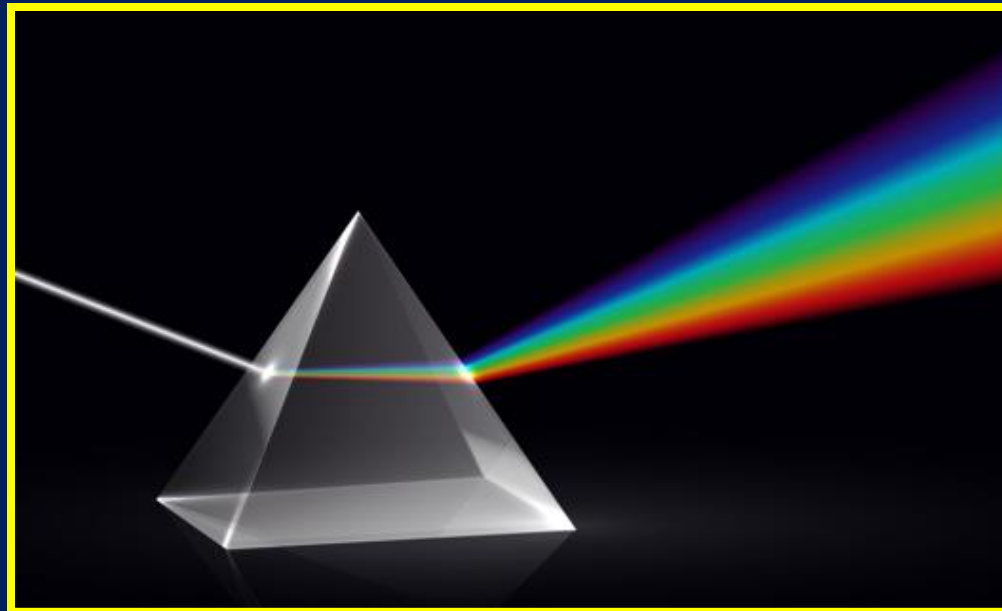
# White Light

When all the different wavelengths of light are combined, we see white light.



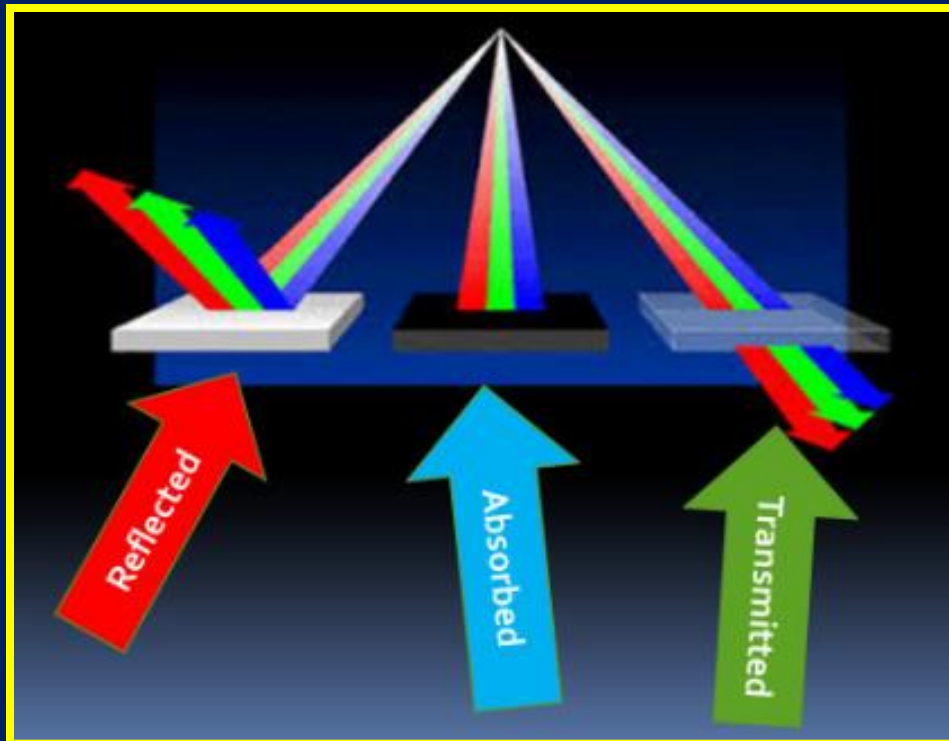
# Colored Light

When light waves travel through certain substances, the different colored wavelengths of light separate, allowing us to see the different colors.



# Visible Light Waves

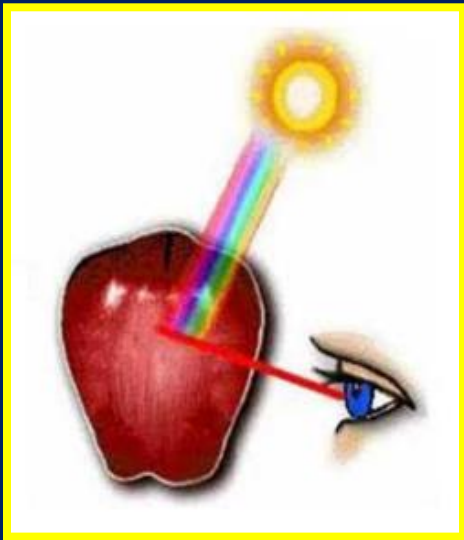
When light waves strike an object, light waves can be reflected, absorbed, or transmitted.





# Visible Light Waves

When light waves strike an object, we cannot see the absorbed colors of the light.

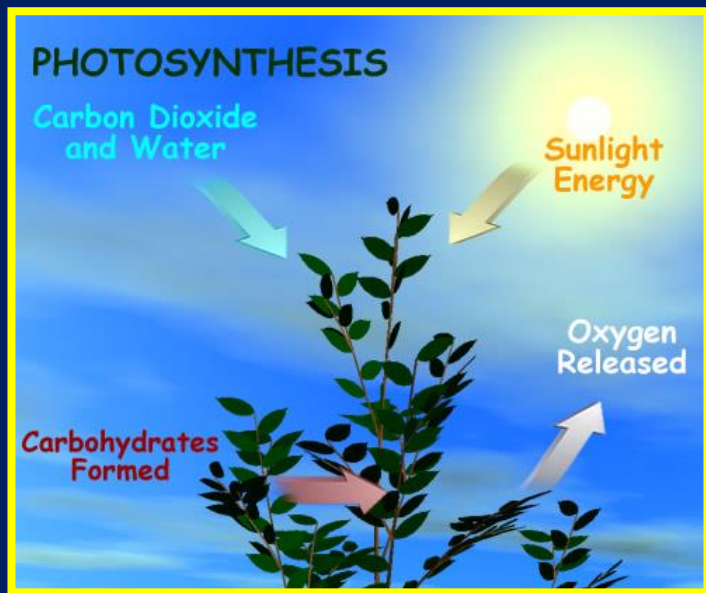


We can only see the reflected light, so the objects appear to be the color of the reflected light.

Visible light waves are responsible for us being able to see light and colors on Earth.

# Photosynthesis

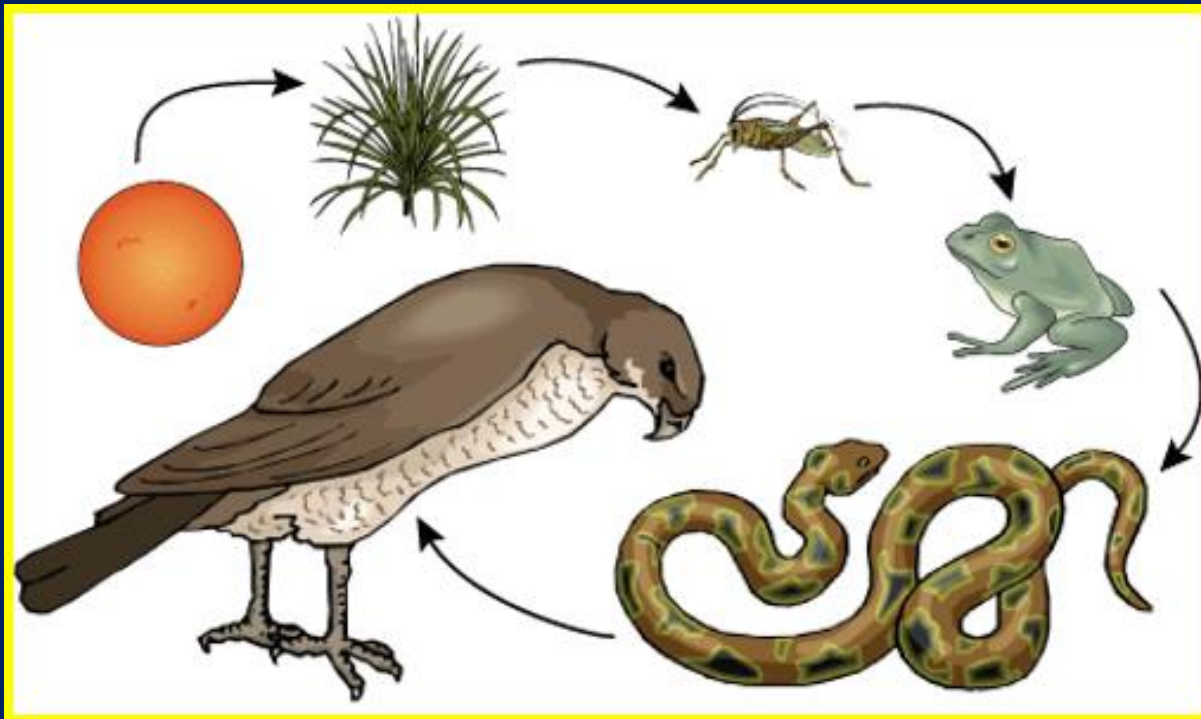
During photosynthesis, plants use the energy from sunlight to convert  $\text{CO}_2$  and  $\text{H}_2\text{O}$  into  $\text{O}_2$  and chemical energy in the form of carbohydrates or sugar.



The oxygen produced during photosynthesis is released into the atmosphere, allowing animals to breathe.

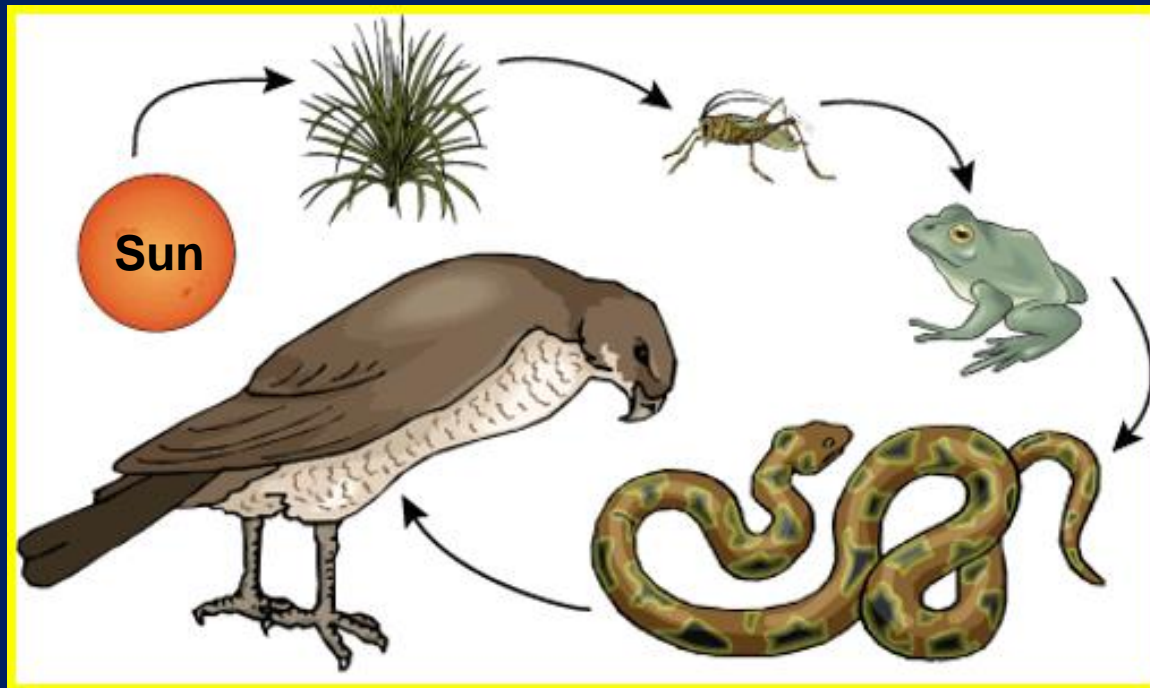
# Chemical Energy

The chemical energy, produced during photosynthesis, is then passed up the food chain.



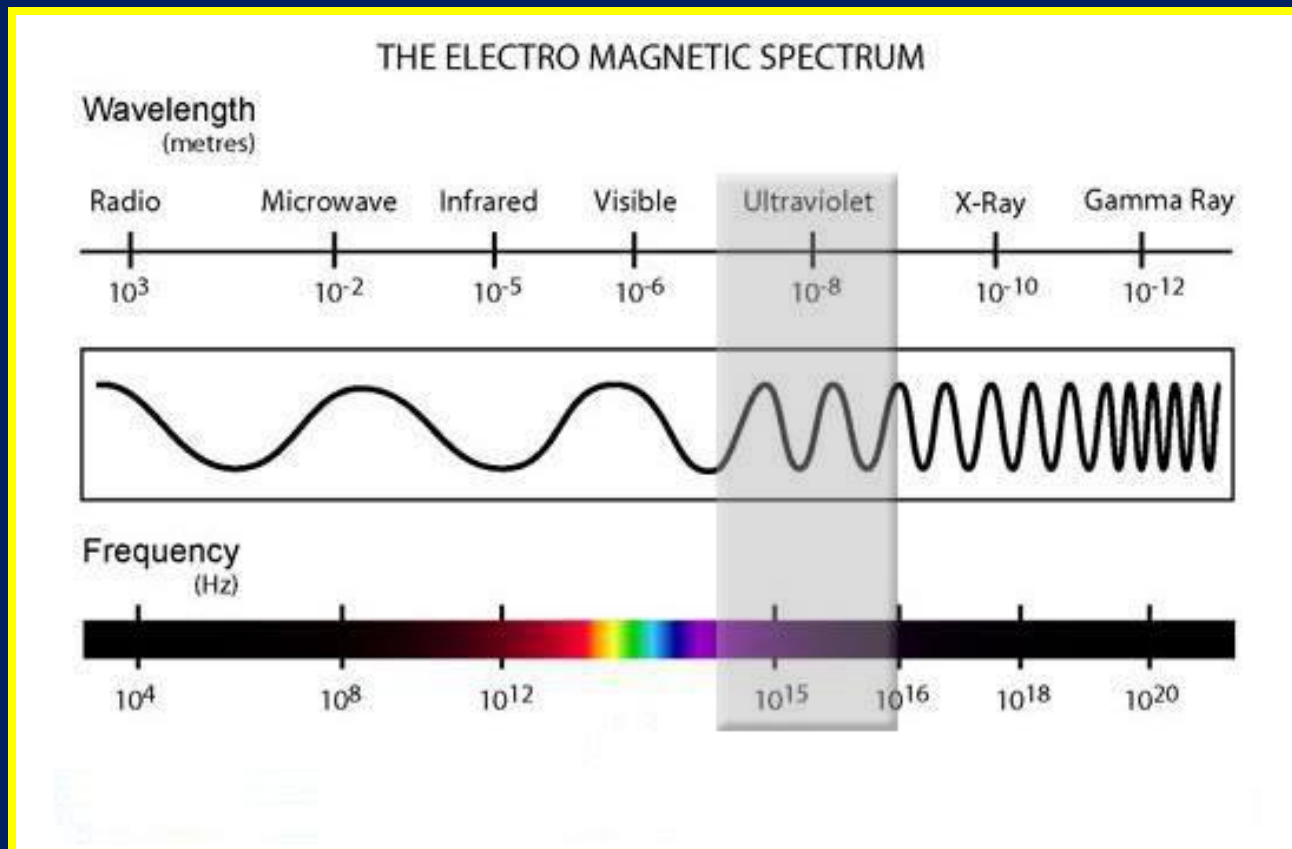
# Food Chain

Sugar and starches are passed up the food chain to animals, as they consume plants or animals that previously ate plants.



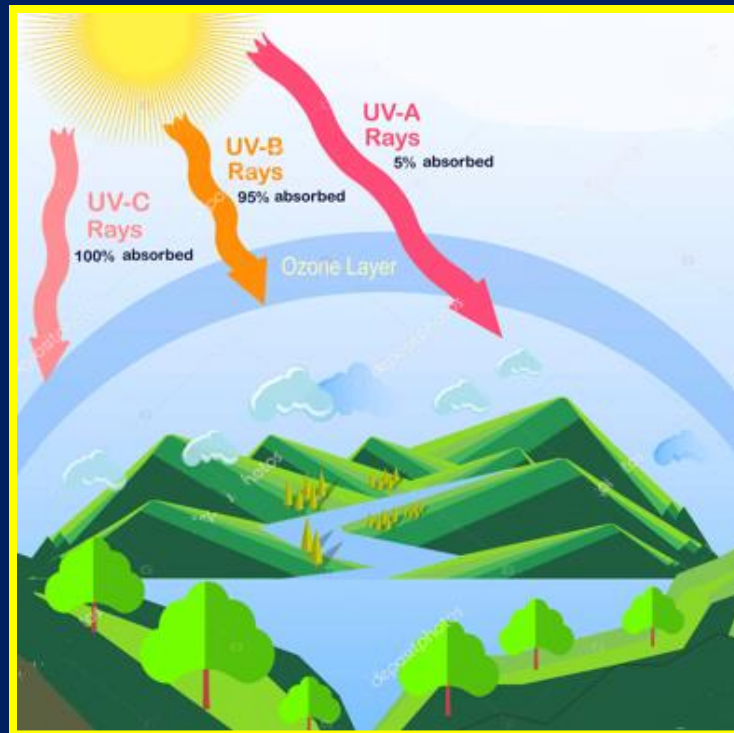
# Ultraviolet Waves

Ultraviolet waves range in wavelengths between 100 and 400 nanometers.



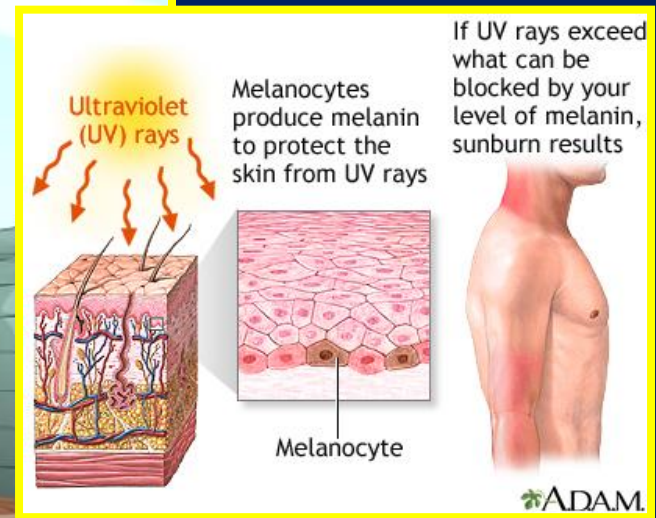
# Ultraviolet Waves

The atmosphere absorbs 100 % of the smaller UV-C rays, 95% of the medium sized UV-B rays, but only 5% of UV-A rays.



# UV-B Rays from the Sun

UV-B rays affects the surface of the skin and is the primary culprit for sunburns.



# UV-A Rays from the Sun

UV-A rays penetrate more deeply causing long term damage like freckles, moles, wrinkles, and skin cancer.





# Sunscreen

You can protect against sun damage from both UV-A and UV-B rays by using broad spectrum sunscreen.



# Man-made Sources of UV Rays

Man-Made sources of ultraviolet rays include welding equipment and tanning beds.



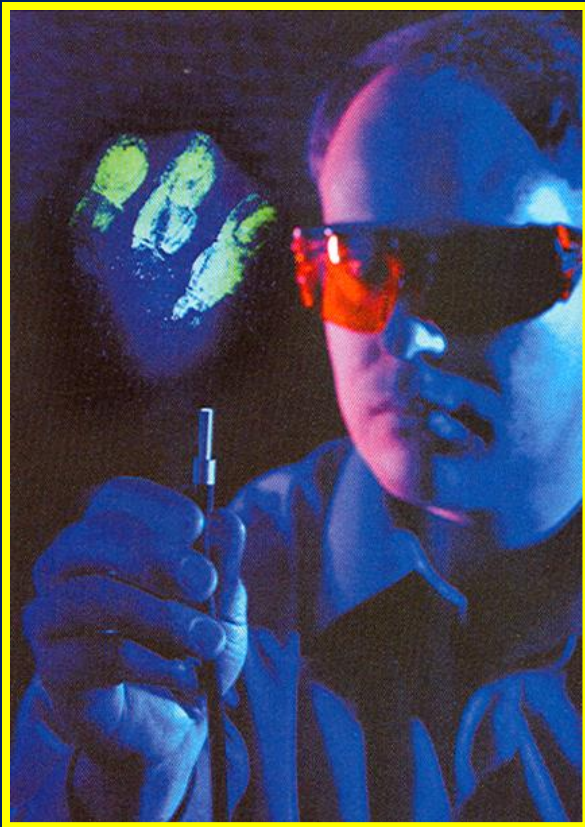
# Beneficial UV Rays

Ultraviolet light is often used to kill bacteria and viruses at waste treatment plants.



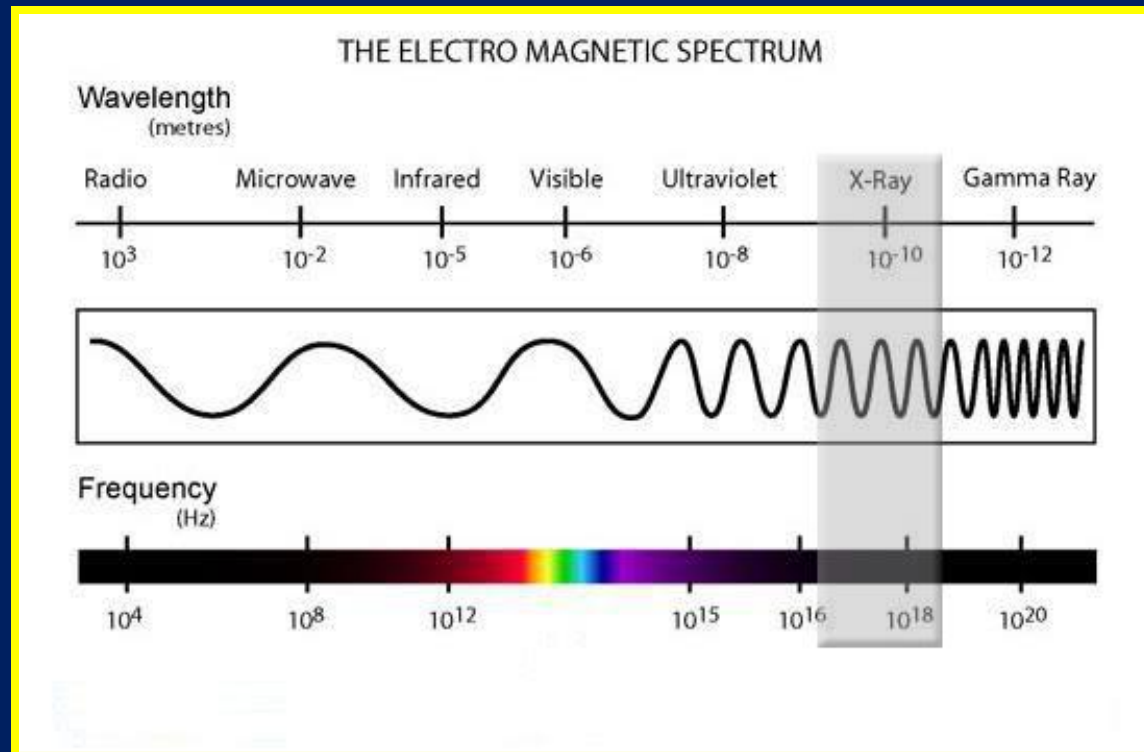
# Fluorescent Materials

Fluorescent materials absorb UV waves from black lights and emit visible light.



# X Rays

X Rays have high frequencies and short wavelengths ranging between 10 and 0.1 nanometers.



# X Rays

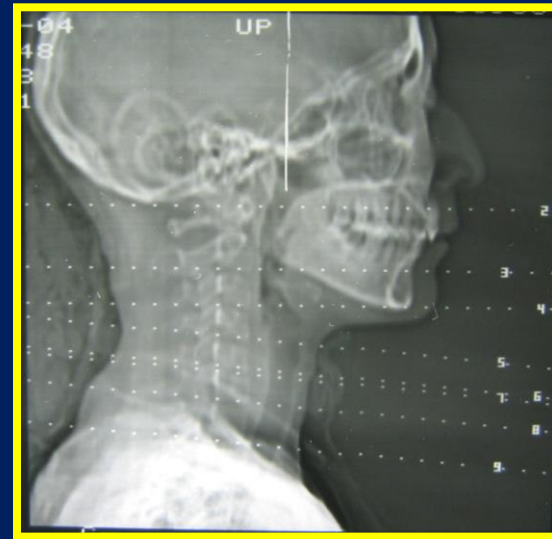
X Rays from the Sun are unable to penetrate Earth's atmosphere.



Astronauts in space wear protective clothing to protect against X rays, UV rays, and gamma rays.

# X Rays

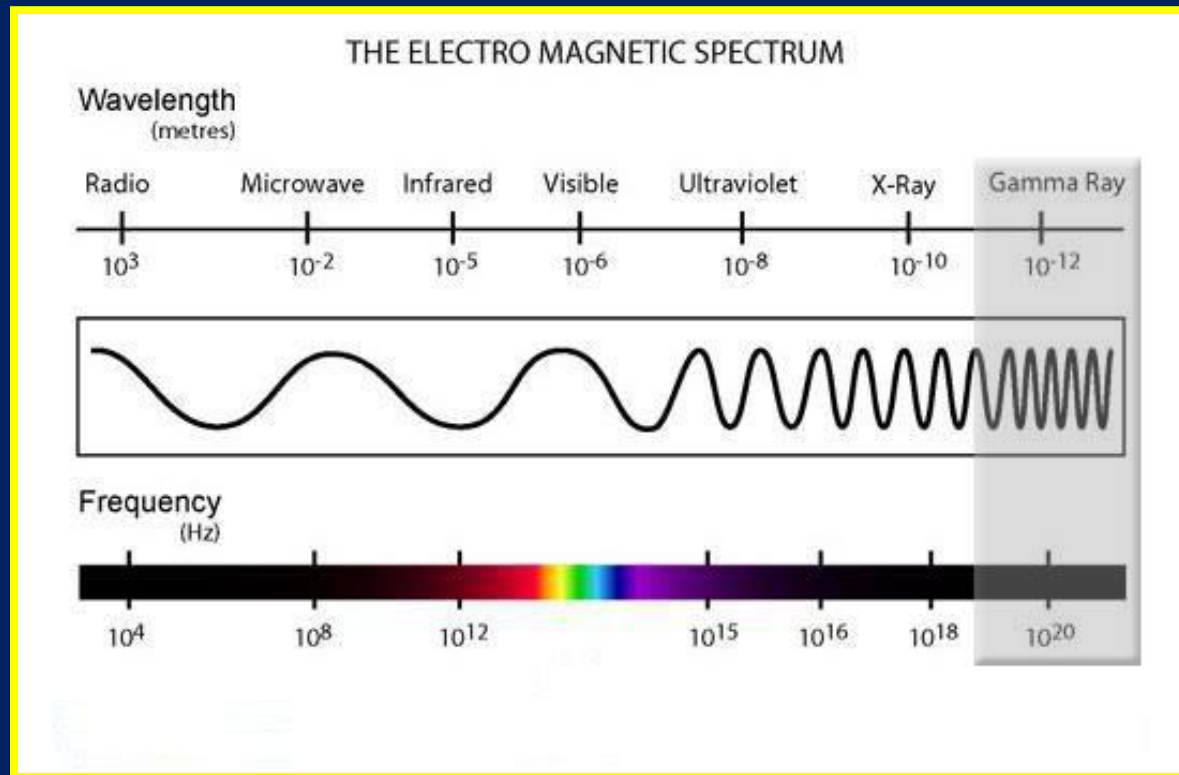
X Rays are used in the medical field to examine internal structures in the body.



Lead aprons are often used to limit exposure to X Rays.

# Gamma Rays

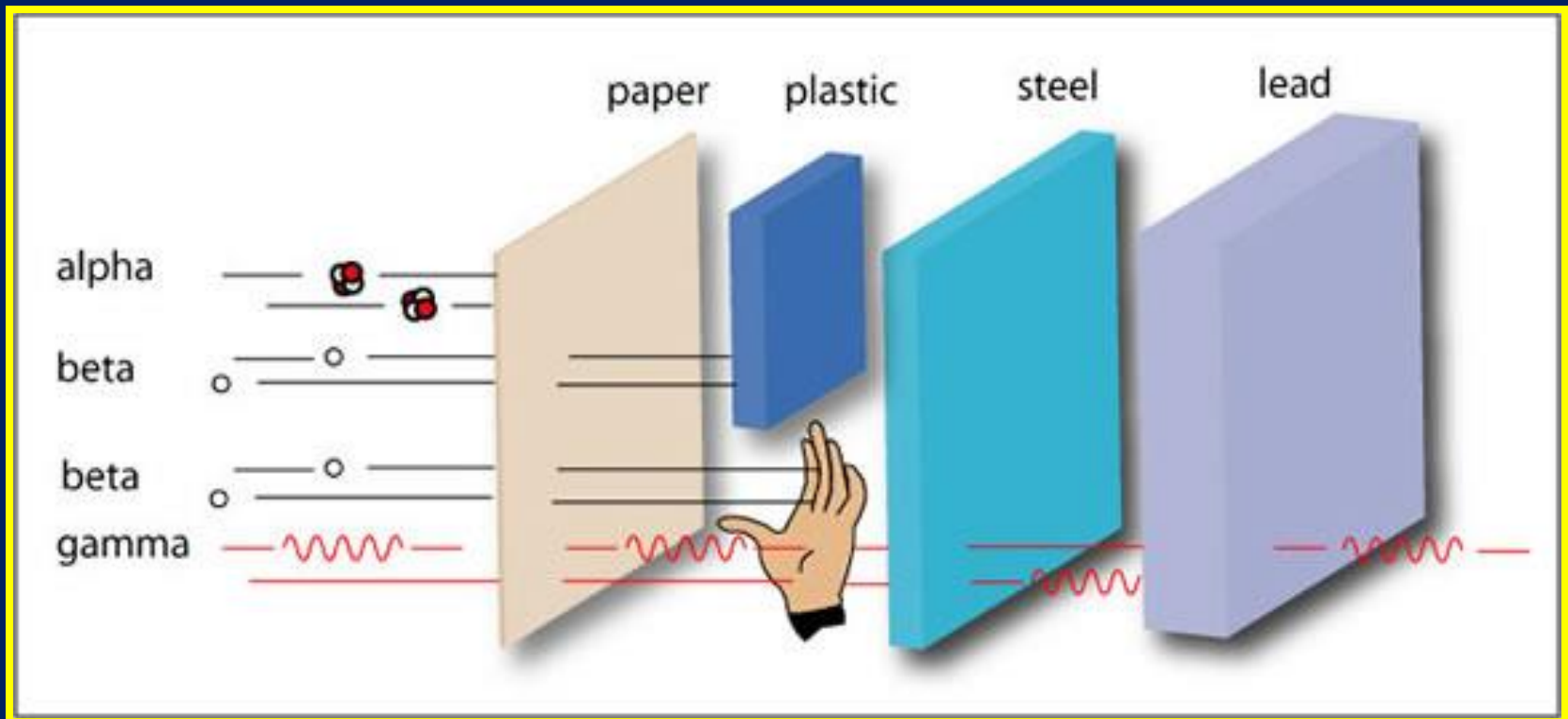
Gamma rays have the highest frequencies and the shortest wavelengths of all the electromagnetic waves.





# Gamma Rays

Gamma rays are so small that they can penetrate most substances, including lead.



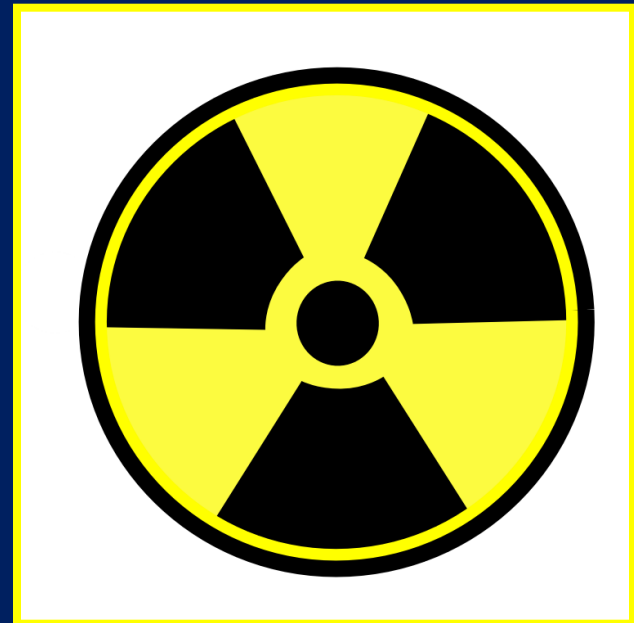
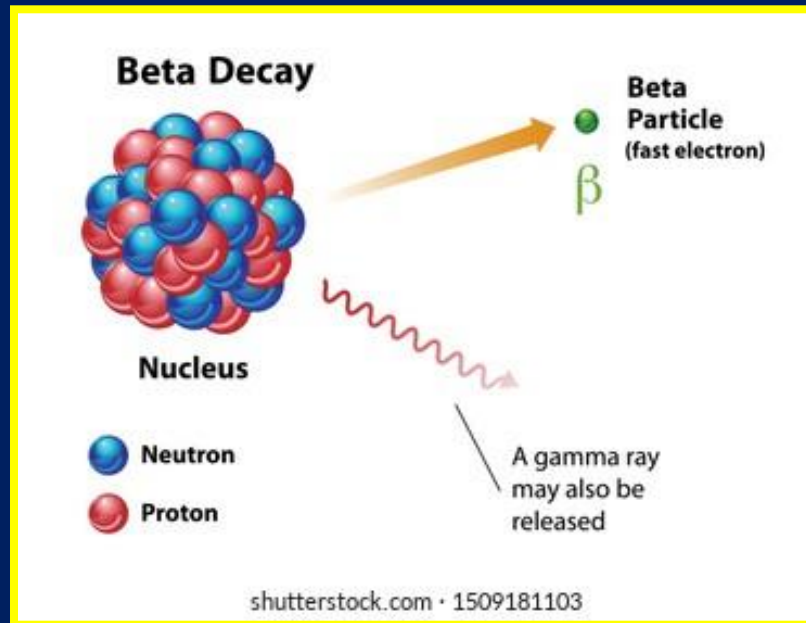
# Gamma Rays

The Sun emits gamma rays during solar flare events, but luckily for us, they are unable to penetrate Earth's atmosphere.



# Gamma Radiation

On Earth, gamma rays are emitted from radioactive material and during nuclear fission reactions in nuclear bombs and at nuclear power plants.



# Gamma Radiation Syndrome

Short term exposure to large amounts of Gamma Rays can cause 3<sup>rd</sup> degree burns, hair loss, vomiting, and even death.



Long term exposure to smaller amounts of Gamma Rays can damage DNA resulting in tumors, cancer, and birth defects.

# The End

