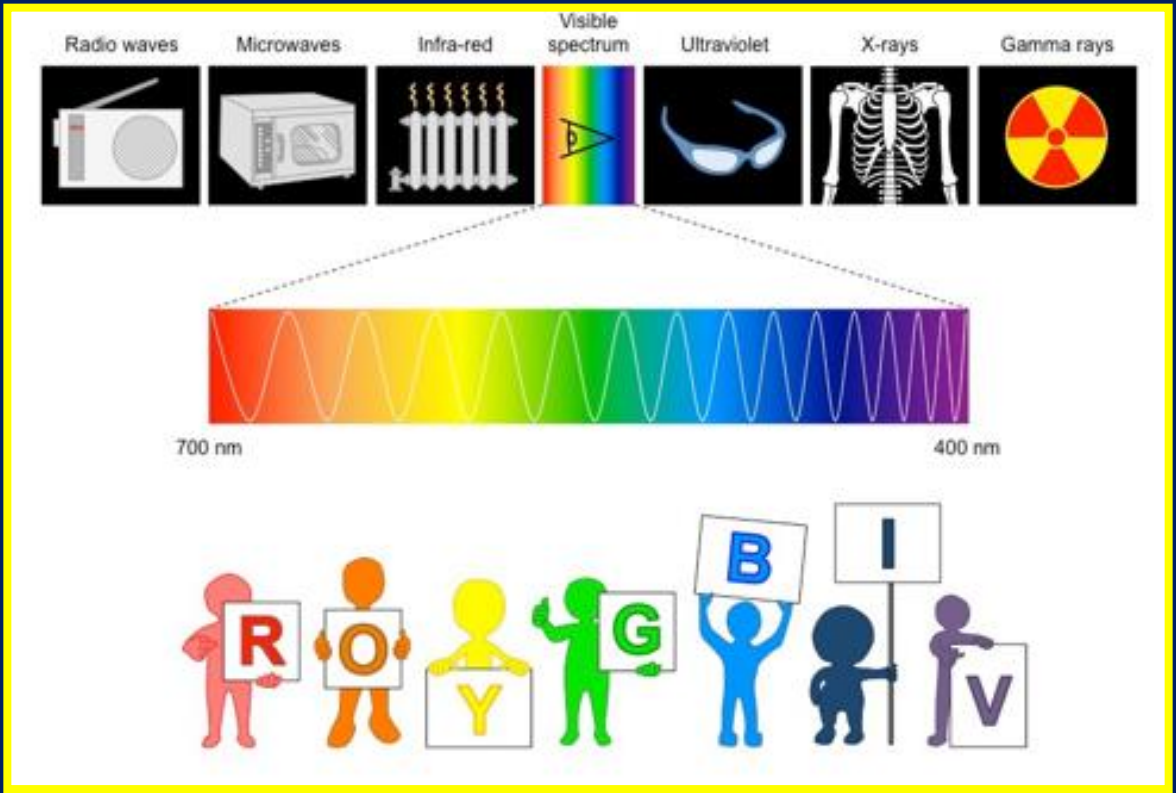
Electromagnetic Spectrum



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.

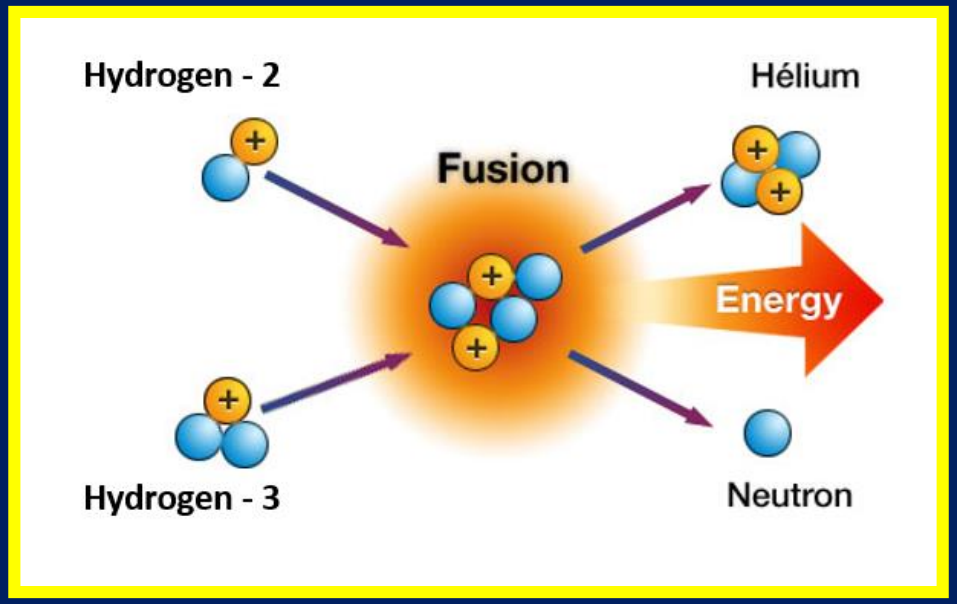
I Can Statements

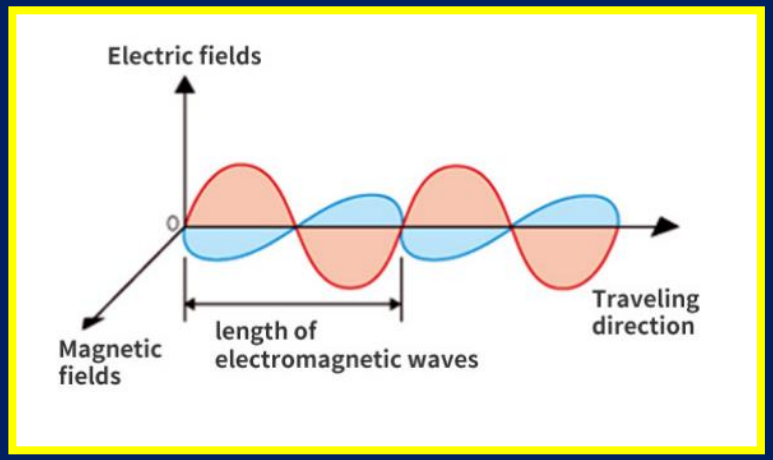
At the end of this lesson, you should be able to say, with confidence:

- 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
- I can explain how infrared waves are responsible for heating Earth's atmosphere.
- I can explain how plants use light energy to produce chemical energy in the form of food during photosynthesis.

Fusion Reactions

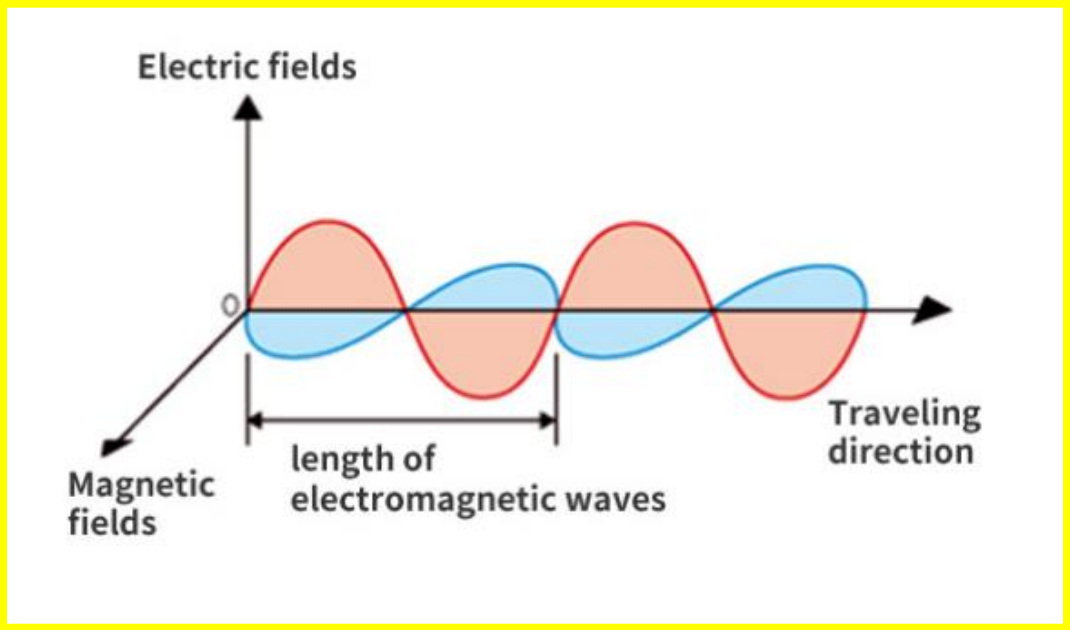
Every second, fusion reactions taking place inside our Sun releasing tremendous amounts of energy in the form of electromagnetic waves.





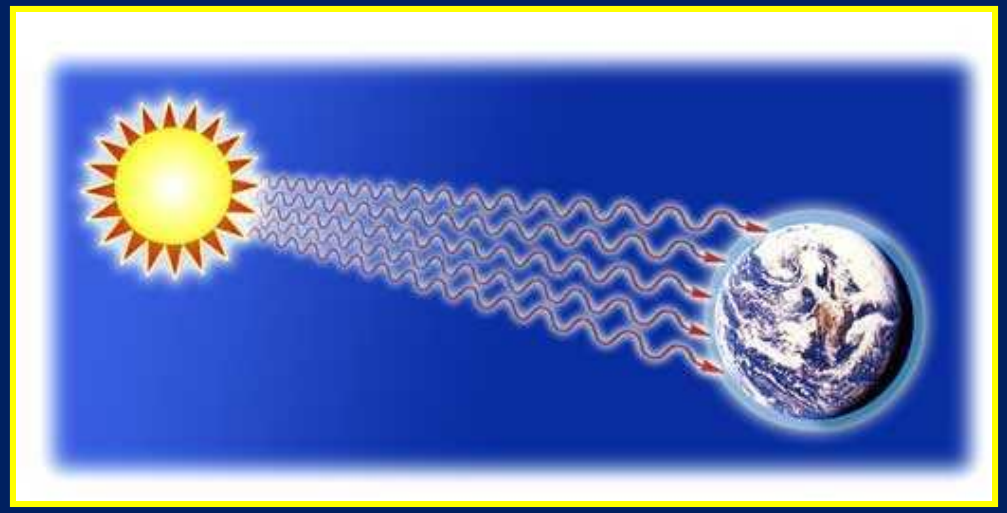
Speed of Light

Electromagnetic waves consist of alternating electrical and magnetic fields that transfer energy at the speed of light, or 300,000 km/s.



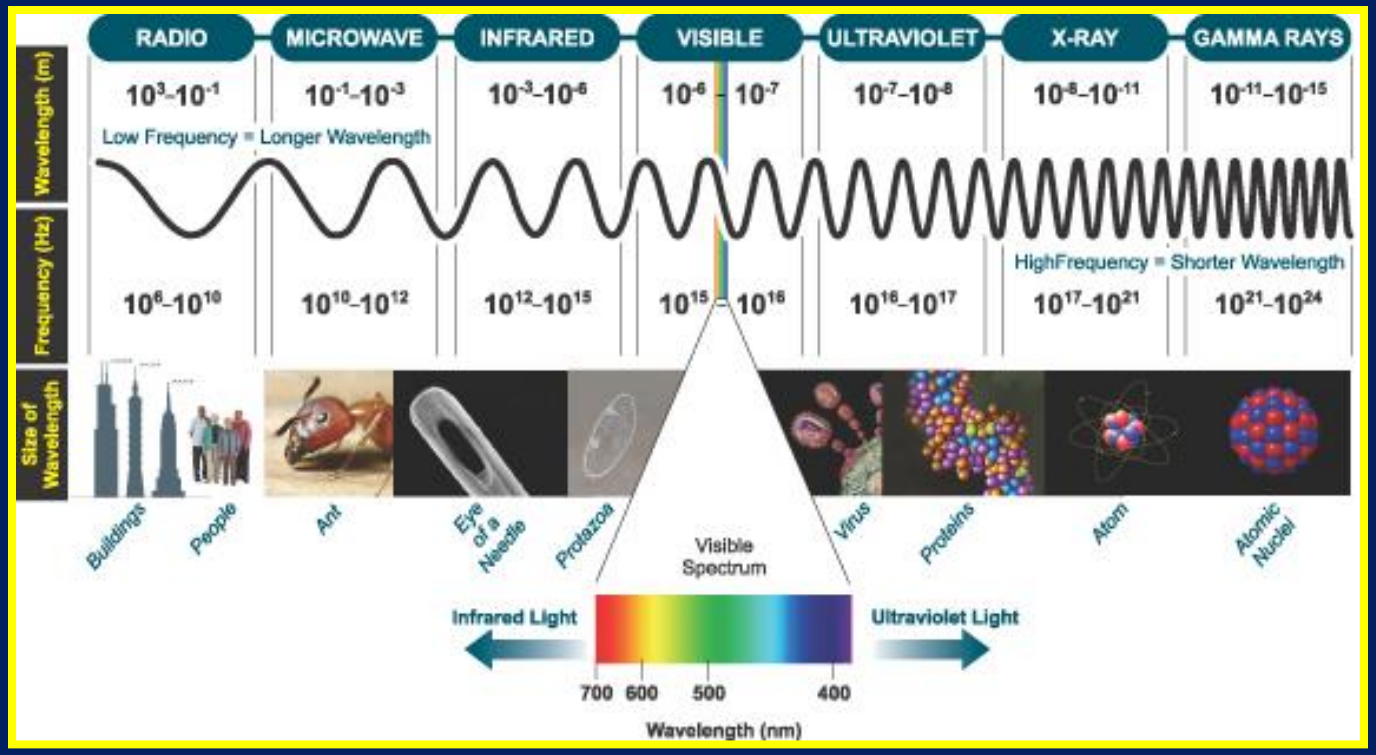
Vacuum of Space

Since electromagnetic waves rely upon electrical and magnetic fields, they do not require atoms in order to transfer energy, so they are able to travel through the vacuum of space.



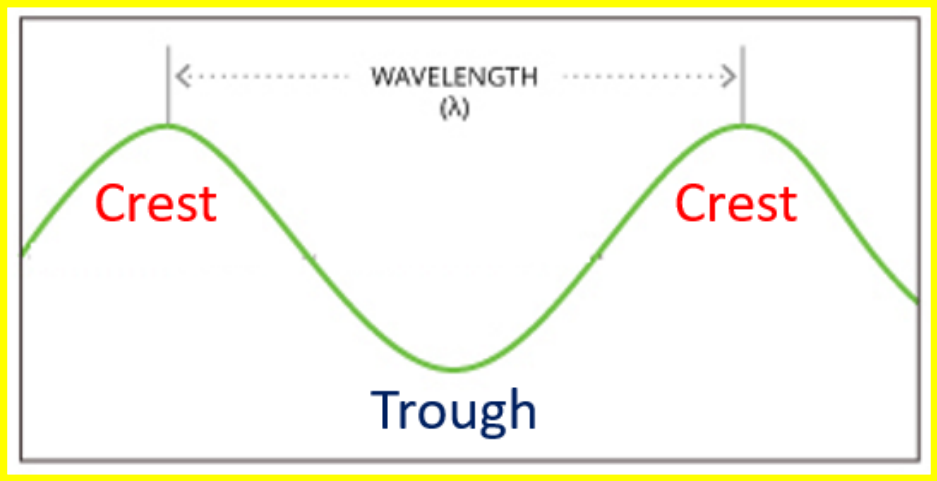
Types of Energy Released

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



Wavelength

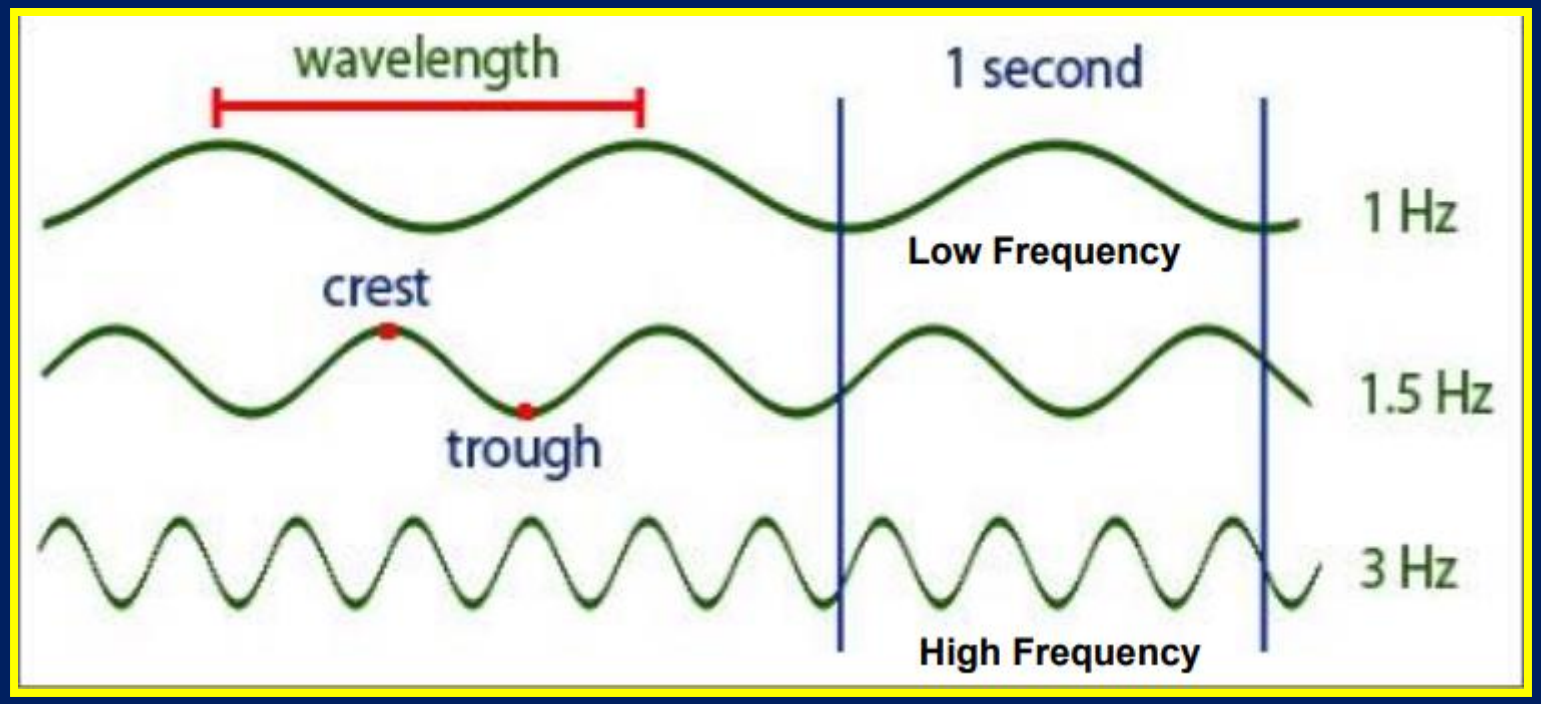
All electromagnetic waves have high points called crests and low point called troughs.



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

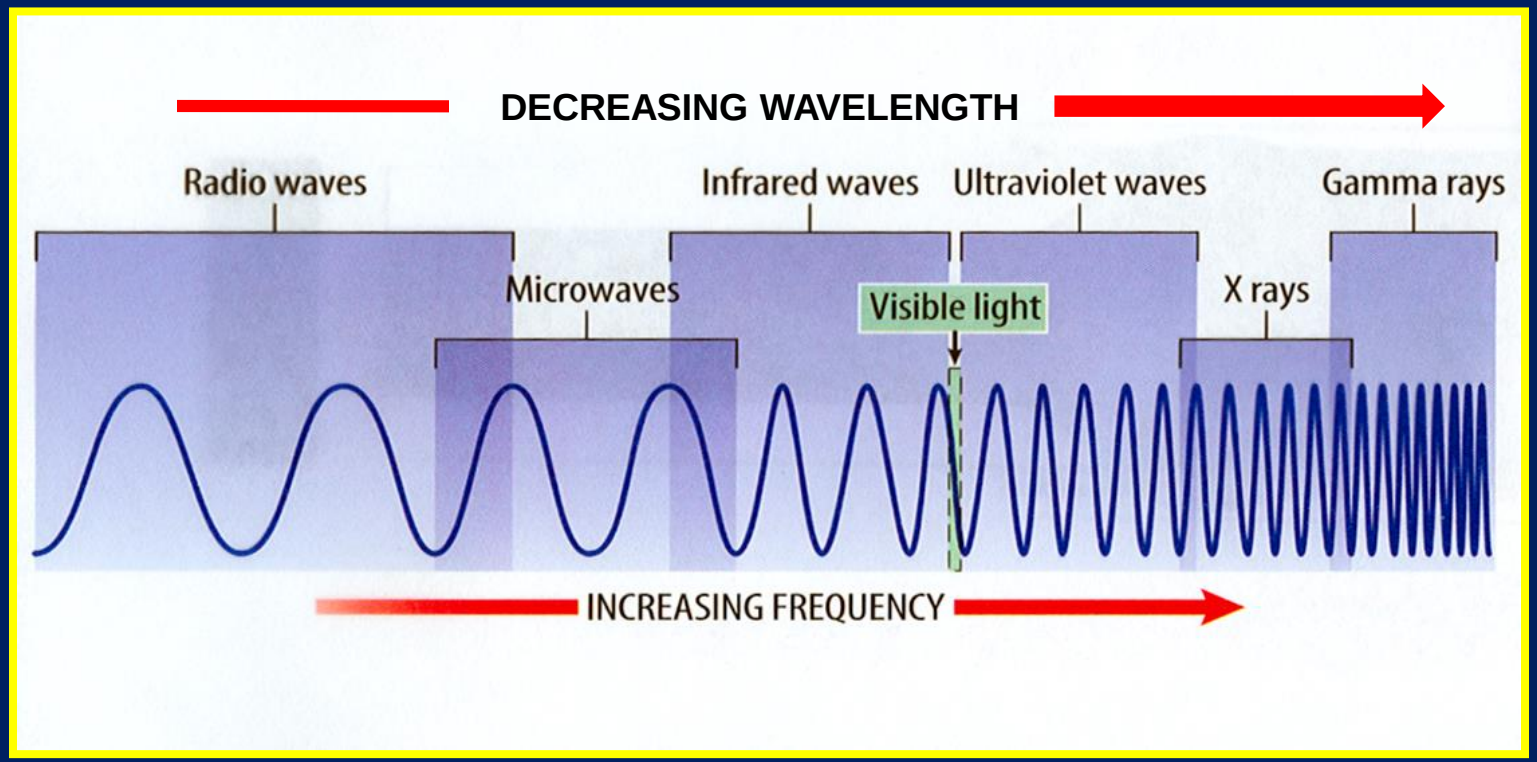
Frequency

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



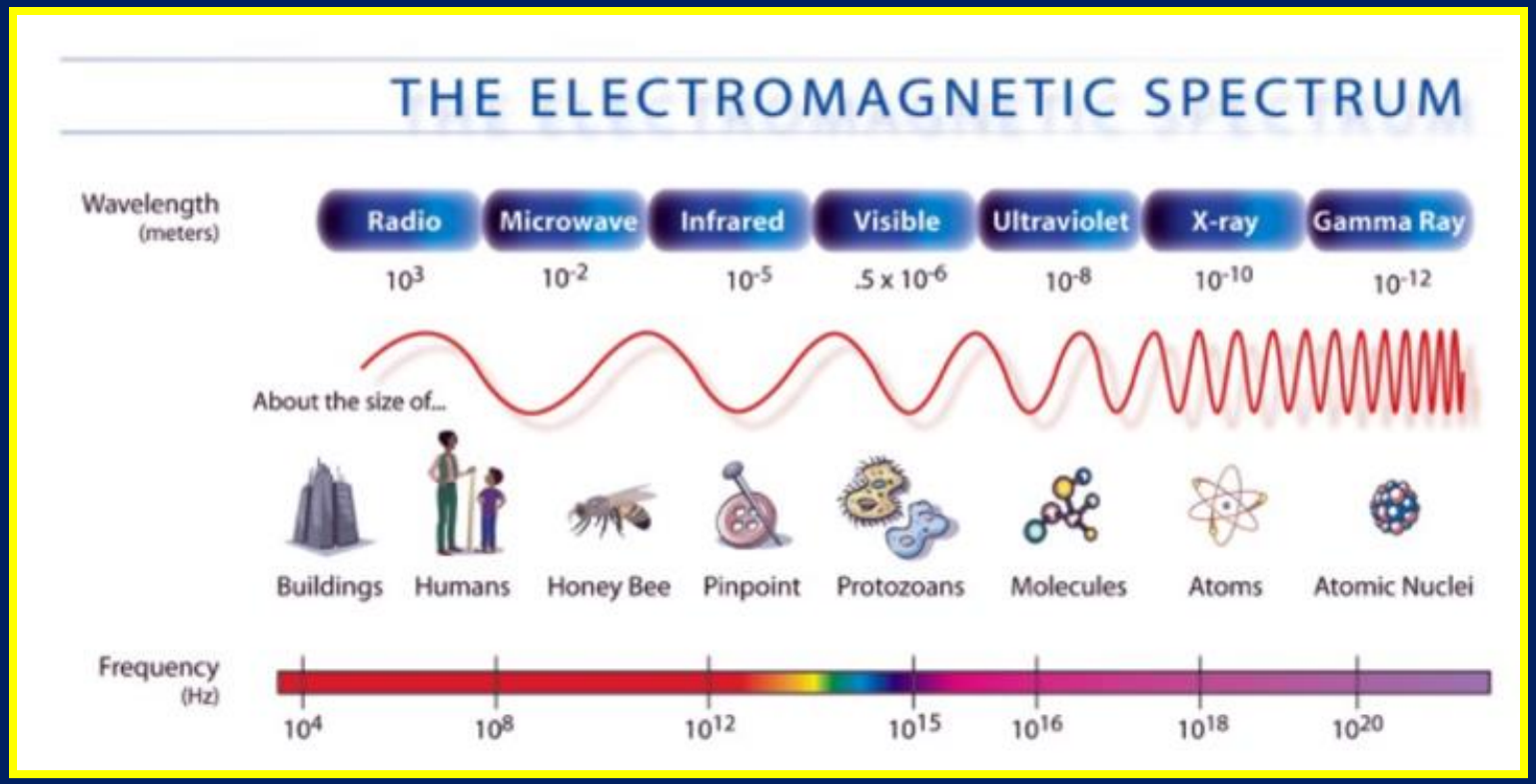
Inverse Relationship

As the energy of wave increases, the wavelength decreases but the frequency of the wave increases.



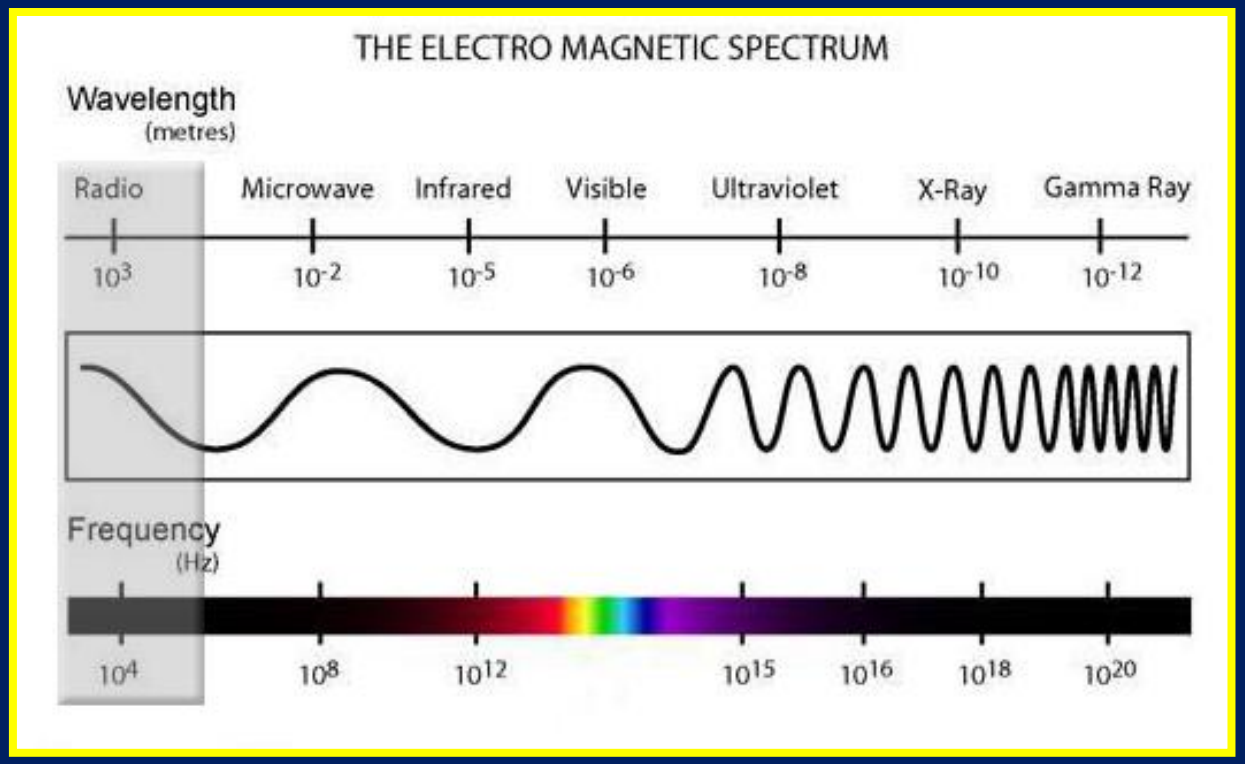
Electromagnetic Spectrum

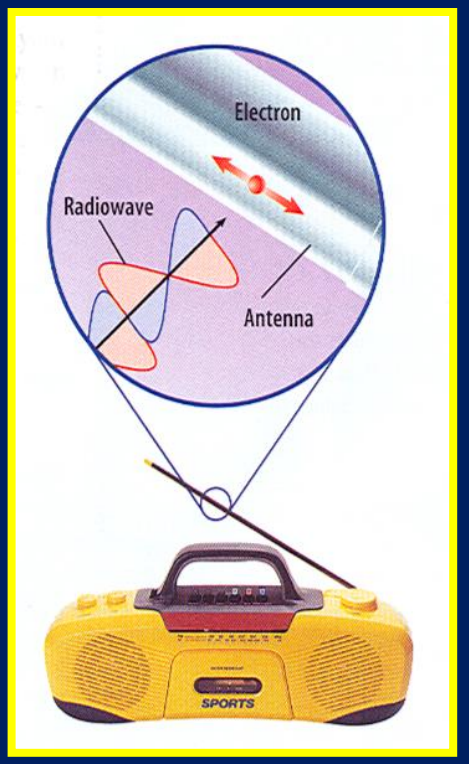
The entire range of electromagnetic wavelengths and frequencies is known as the electromagnetic spectrum.



Radio Waves

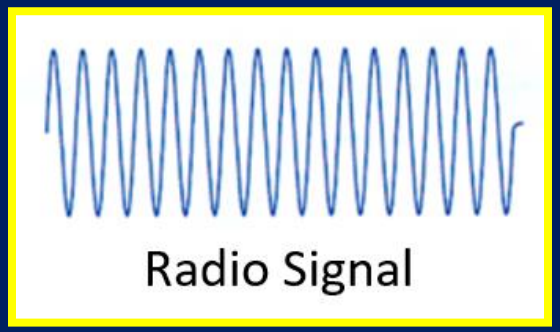
Radio waves have the lowest frequency and the longest wavelengths which range between 100 km and 1 m.





Radio Signals

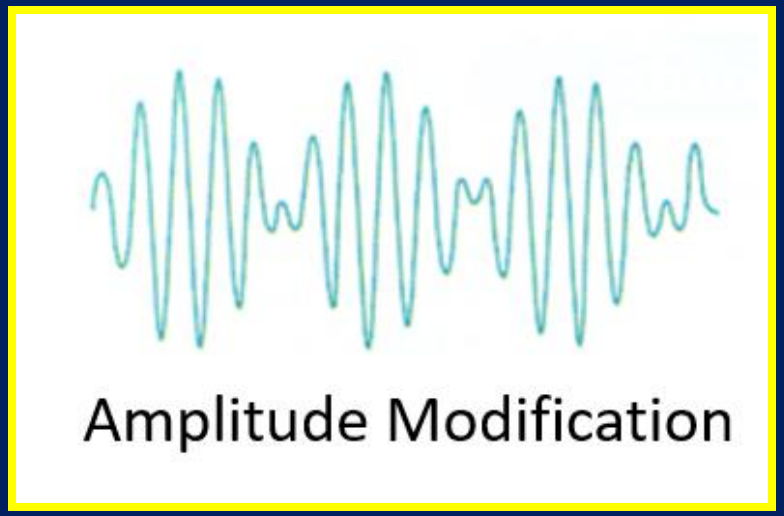
At radio stations, microphones turn sound into electronic signals that are sent out from radio towers.



Each radio station is assigned its own frequency.

AM Radio Stations

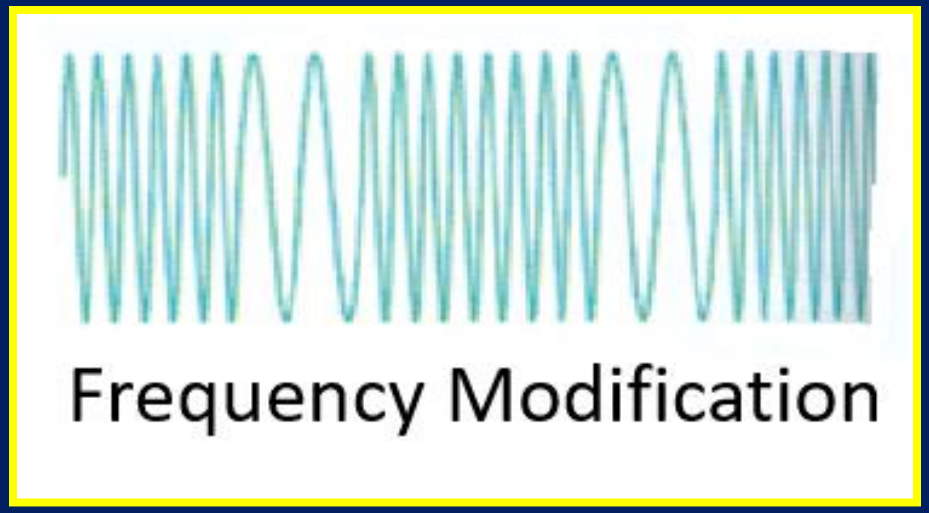
AM radio stations broadcast information by varying the amplitude or height of the radio waves.



AM radio waves work best for talk radio programs.

FM Radio Stations

FM radio stations broadcast information by varying the frequency of the radio waves.



AM radio waves work best for broadcasting music.

Televisions

Televisions use AM radio waves for video and FM radio waves for audio that are transmitted using satellite dishes or cables.

Cell Phones

Cell Phones use radio waves that are transmitted to cell towers and sent back out to other cell phones.

Cell towers are several kilometers apart and the area each one covers is called a cell.

Radar

Radar stands for RAdio Detecting And Ranging.

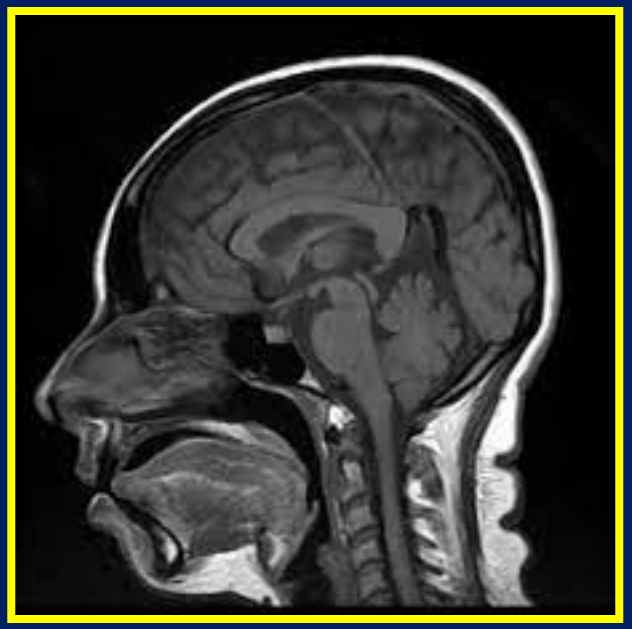
With radar, radio waves are transmitted towards an object and the time it takes for the wave to reflect and return is measured to determine distance and speed.

Very Large Array

The Very Large Array, located in New Mexico, are a group of 27 antennas that pick-up radio signals from space.

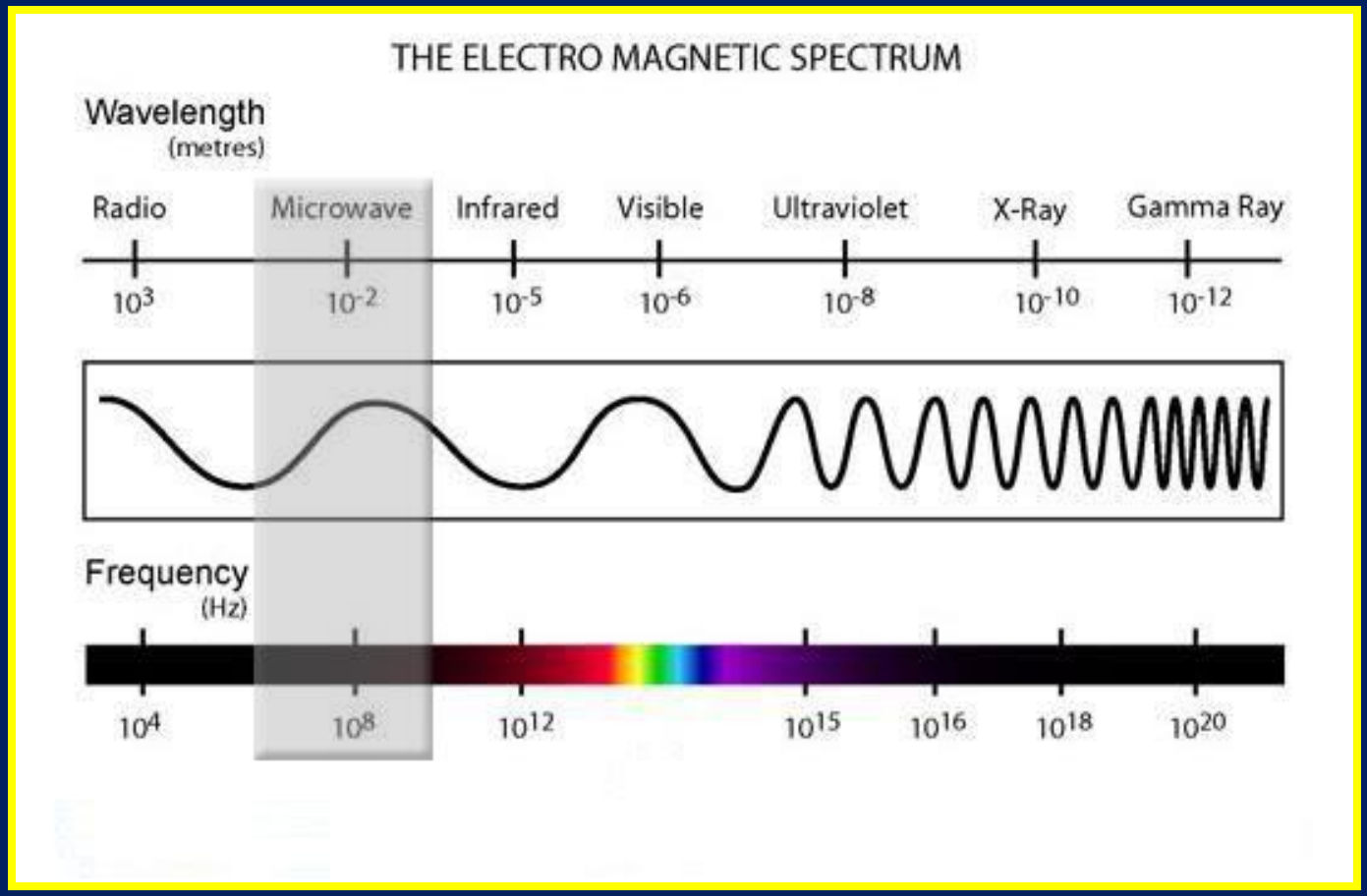
MRI

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



Microwaves

Microwaves have wavelengths between 1 meter and 1 millimeter.

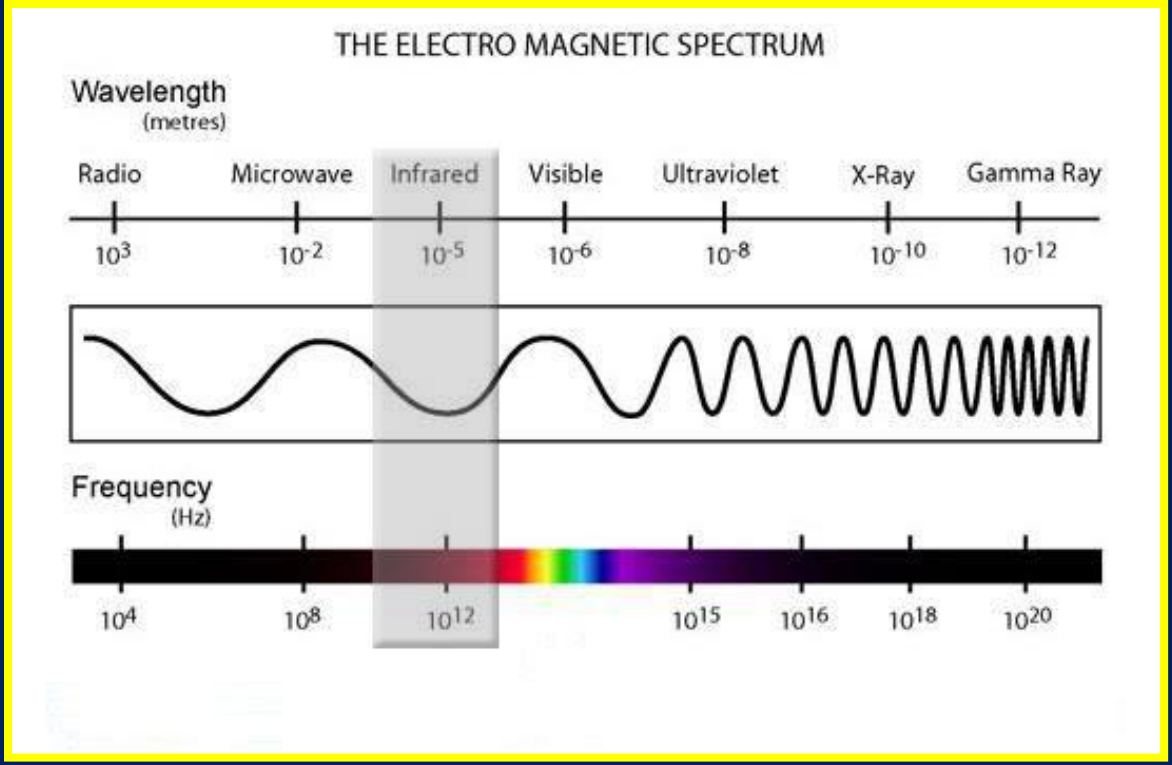


Microwave Ovens

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

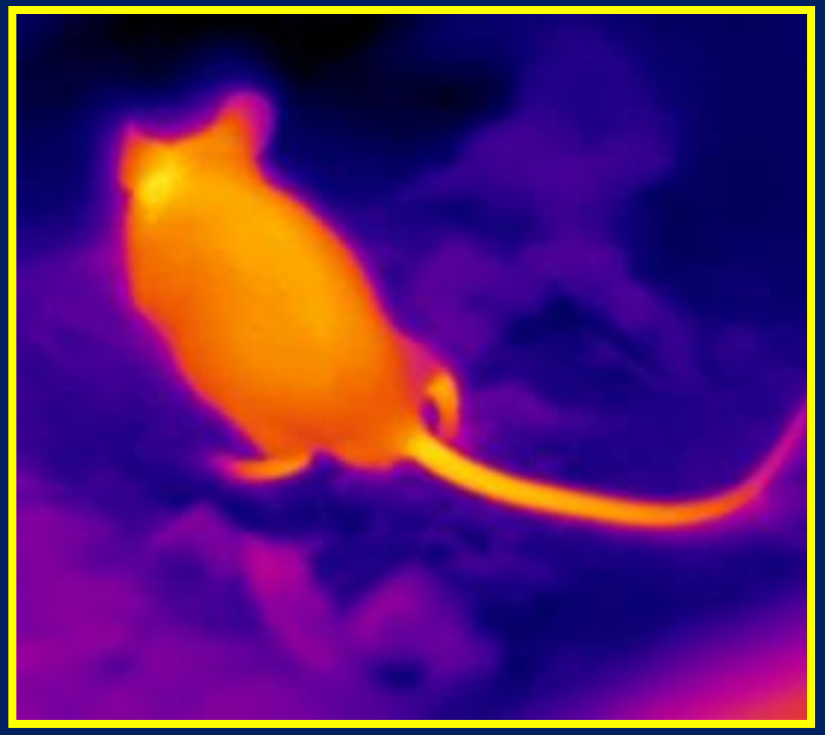
Infrared Waves

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.



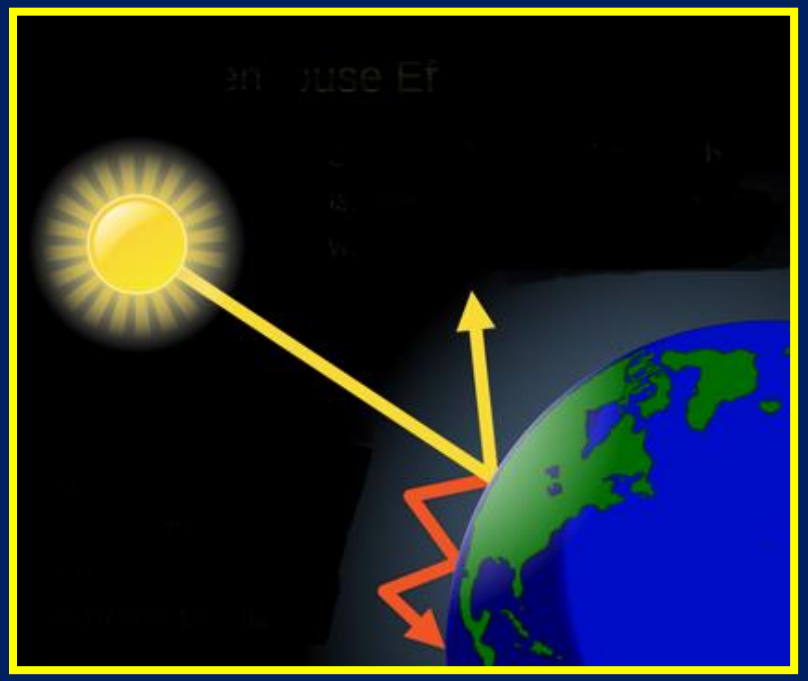
Infrared Cameras

Infrared cameras use infrared waves.

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

Infrared Radiation

Light waves from the Sun are absorbed by surfaces, water, and air on Earth.

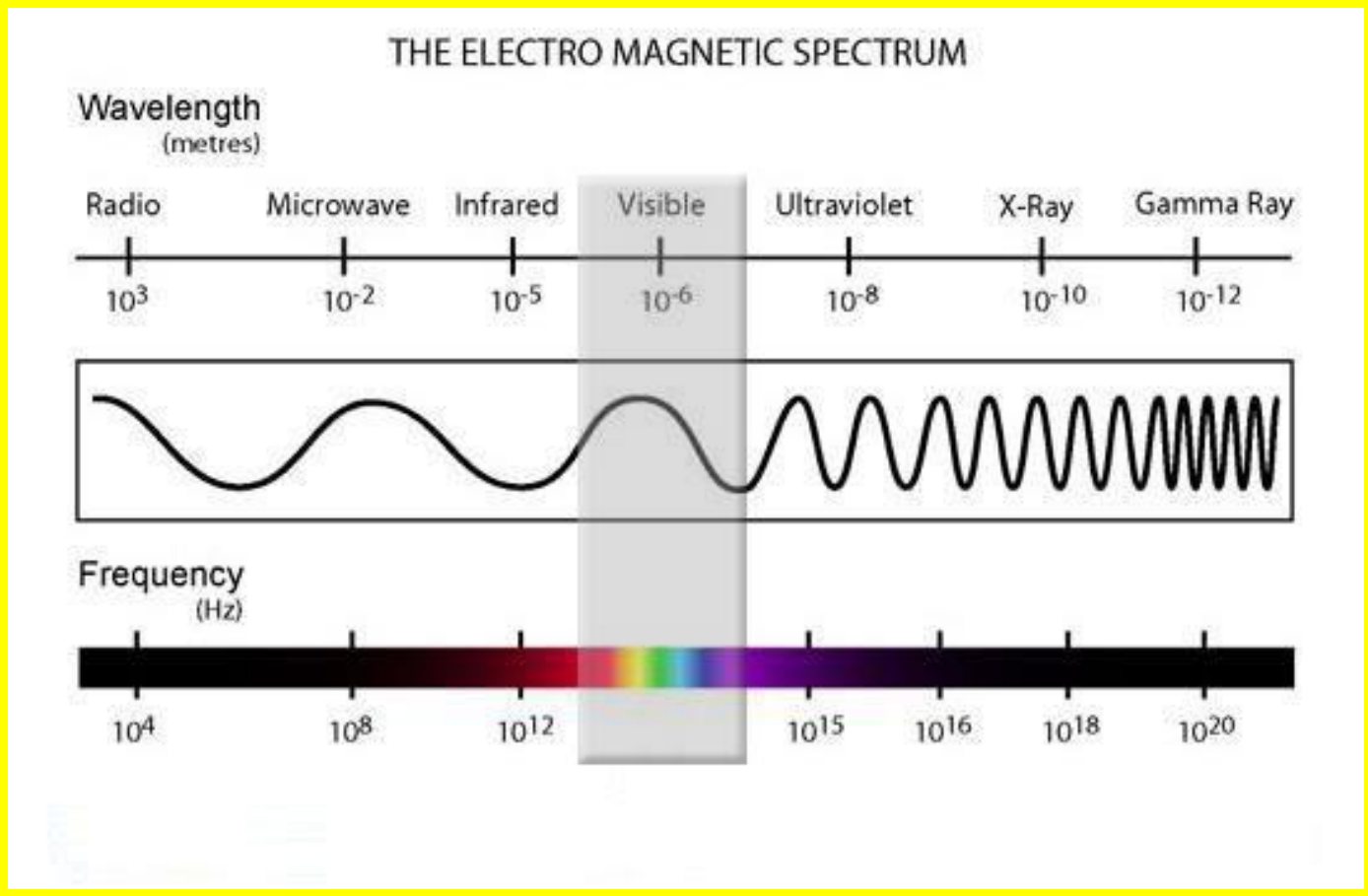


Once absorbed, they are converted and transmitted as infrared waves or heat waves.

Infrared radiation is responsible for warming Earth's surface and atmosphere.

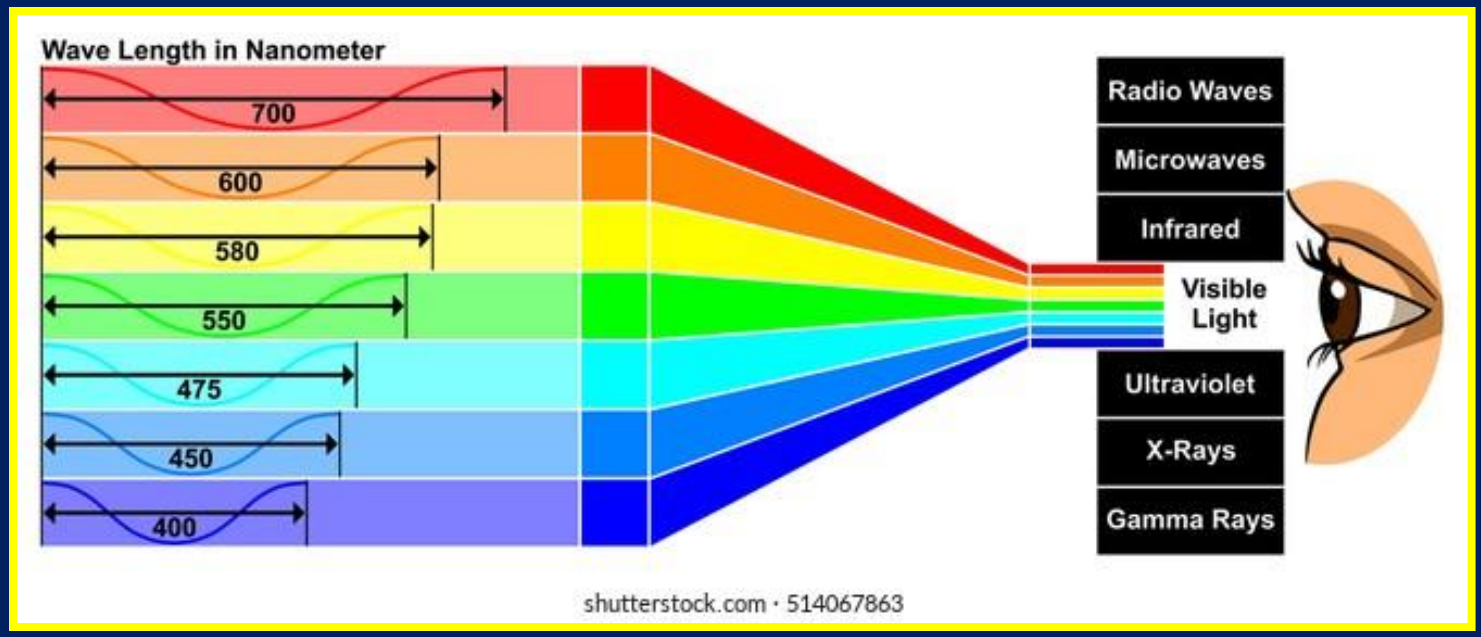
Light Waves

Light waves have wavelengths ranging between 390 and 750 nanometers.



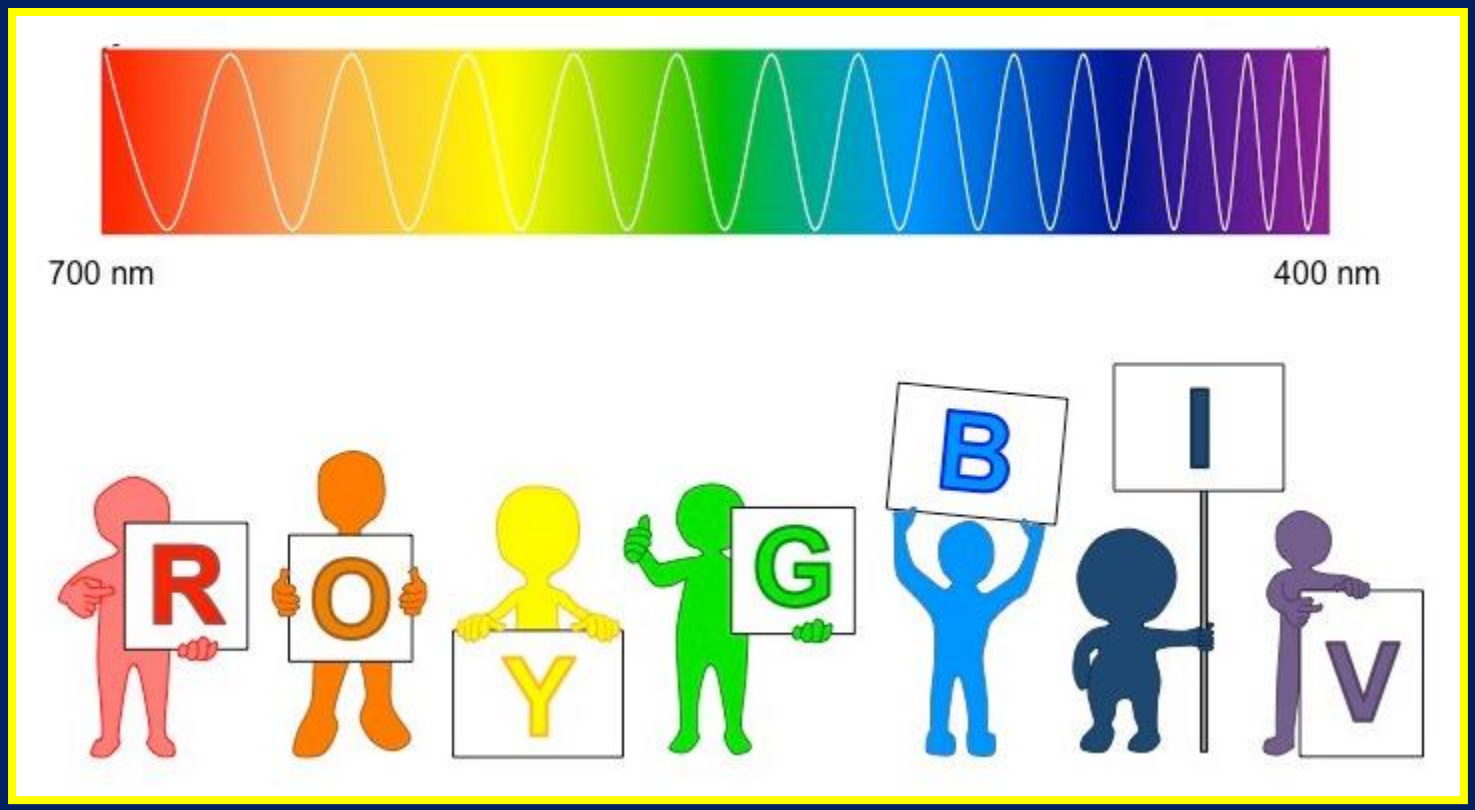
Visible Light Waves

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.

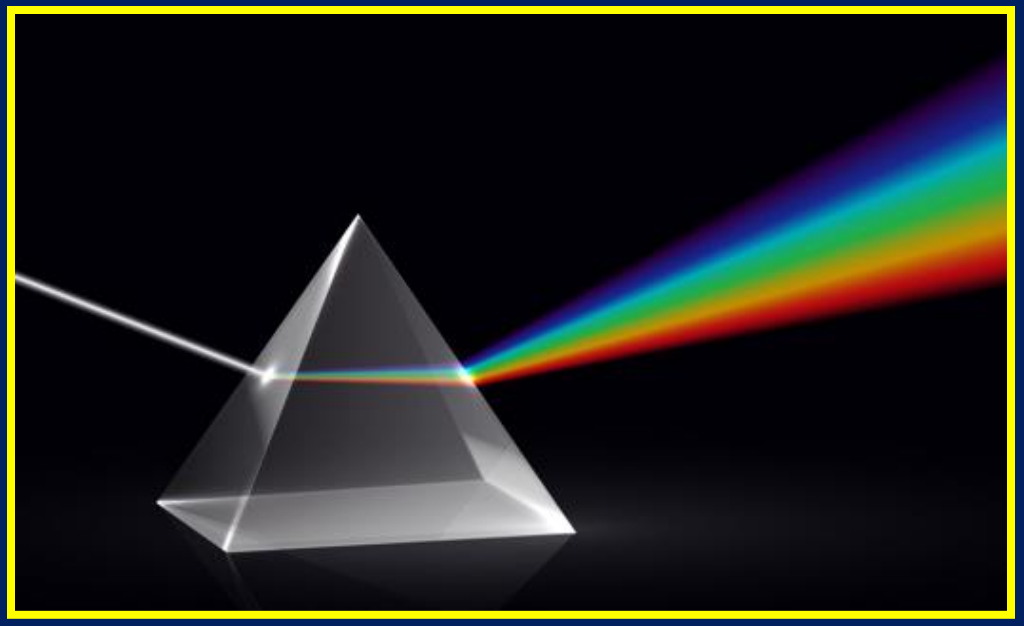


White Light

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

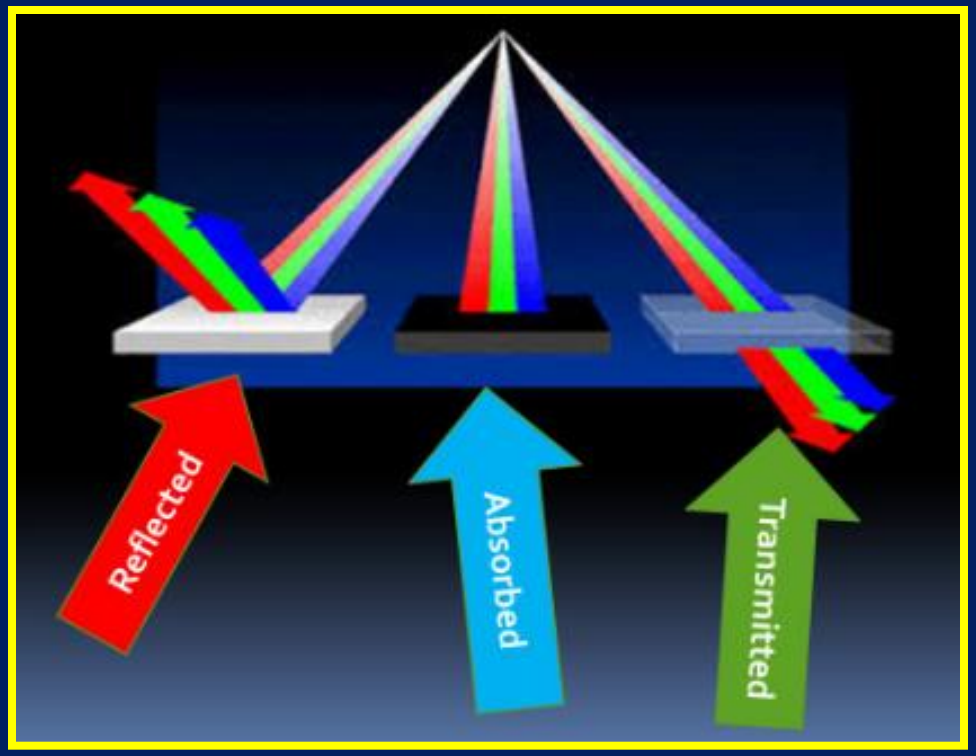
Colored Light

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



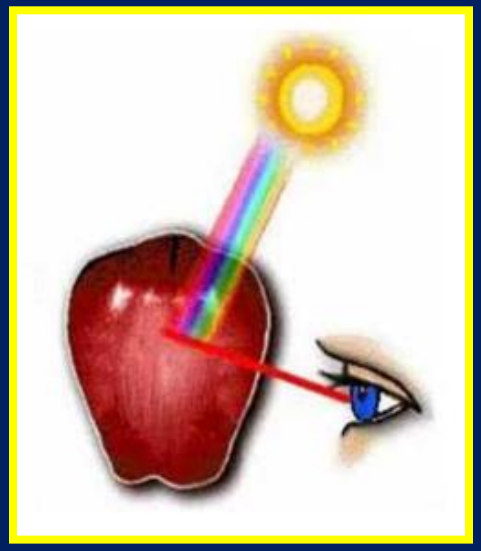
Visible Light Waves

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.

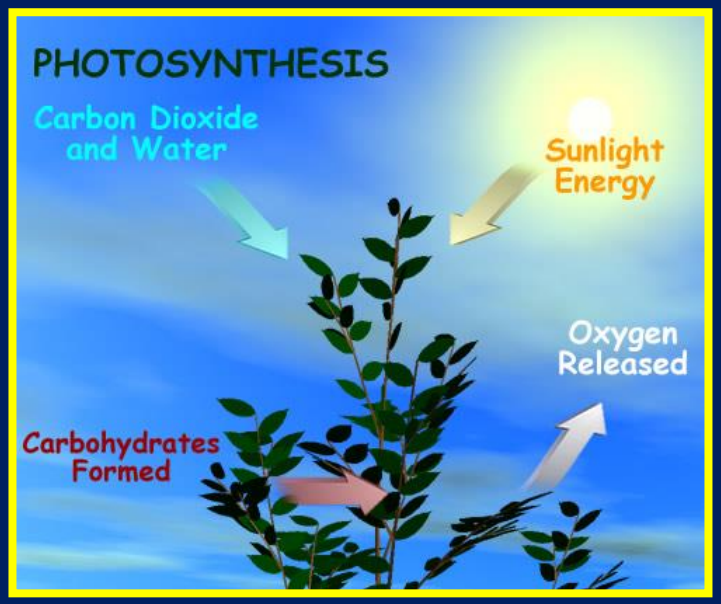


We can only see the reflected light, so the objects appear to be the color of the reflected light.

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

Photosynthesis

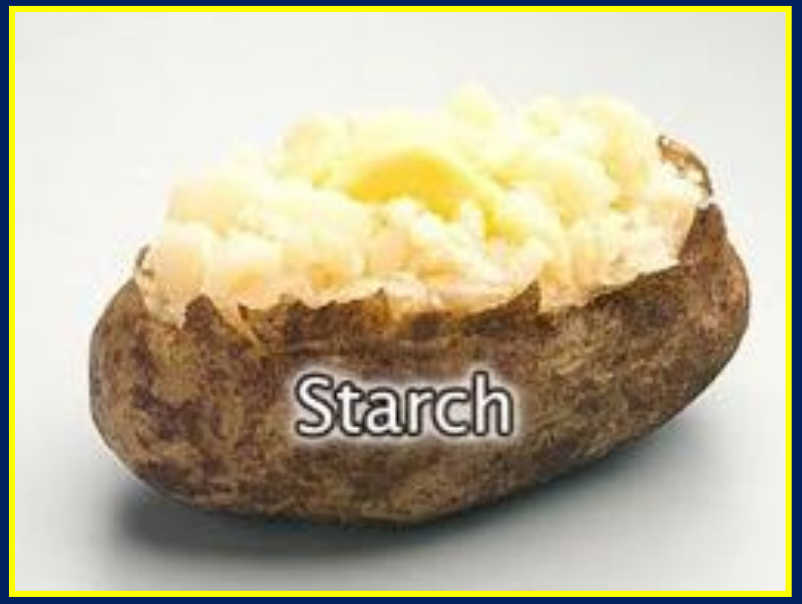
During photosynthesis, plants use the energy from sunlight to convert CO_2 and H_2O into O_2 and chemical energy in the form of carbohydrates or sugar.



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

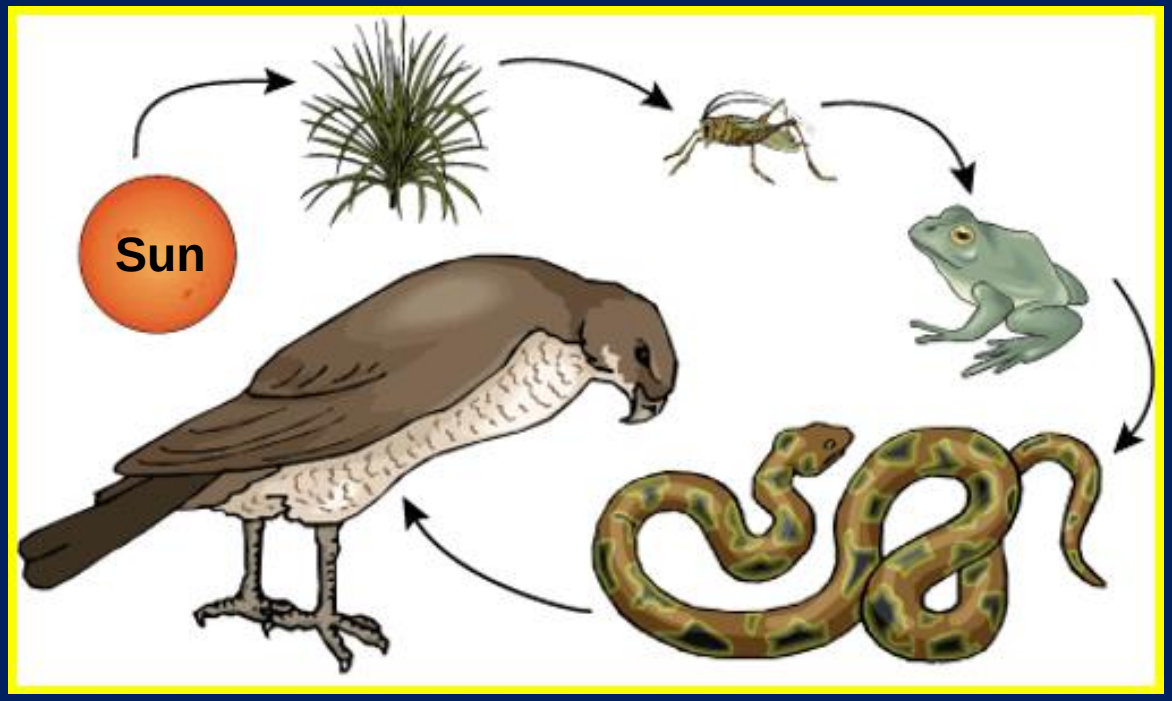
Carbohydrates

Plants use the glucose sugar, produced during photosynthesis, for quick energy or store it in the form of starch.



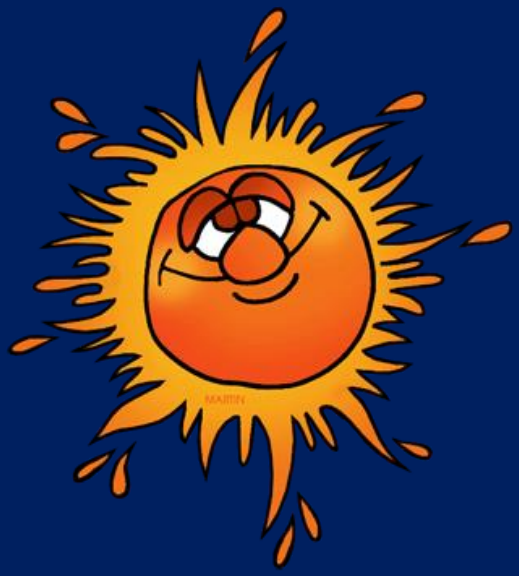
Food Chain

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



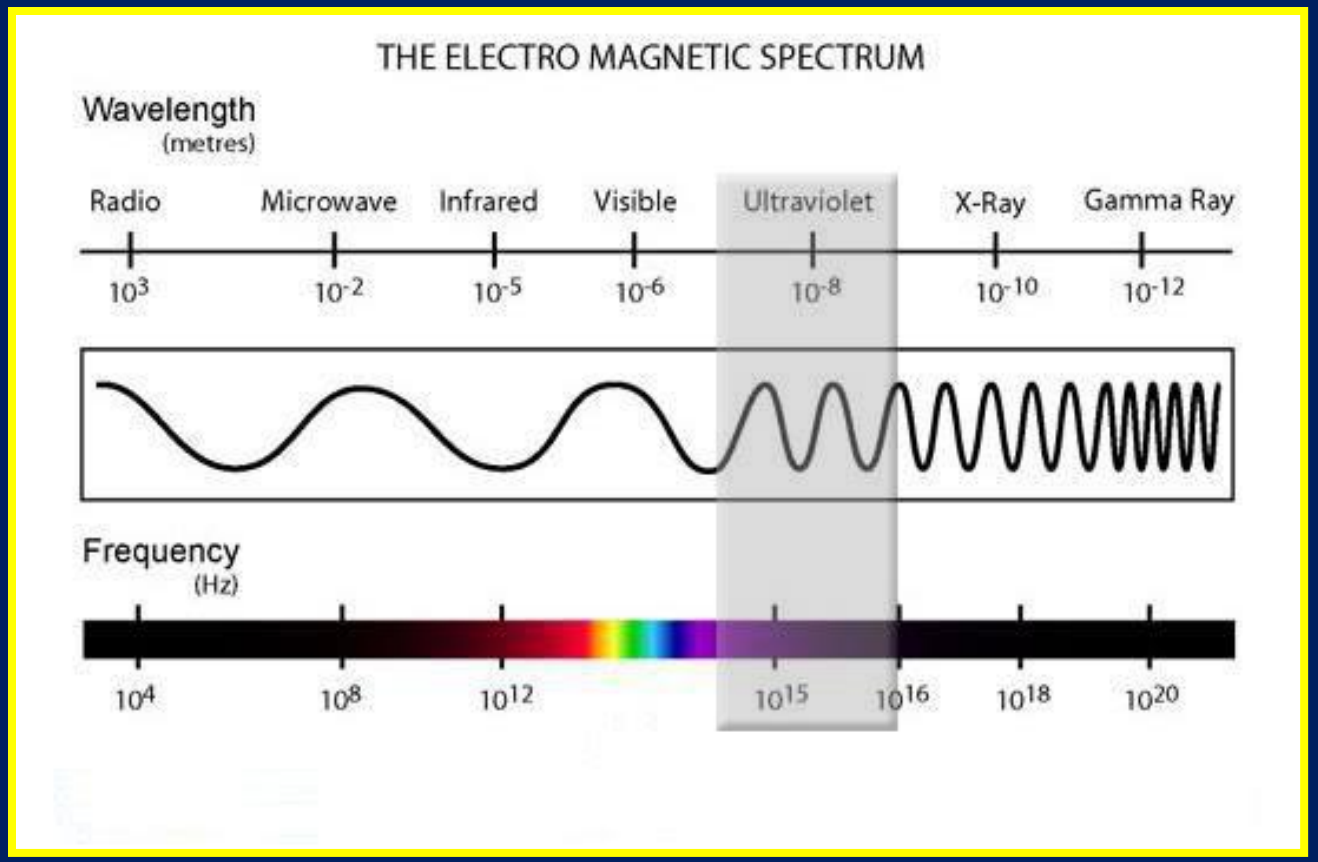
Energy from the Sun

When you eat food, your body uses the energy from the sugar and starches to power your body.



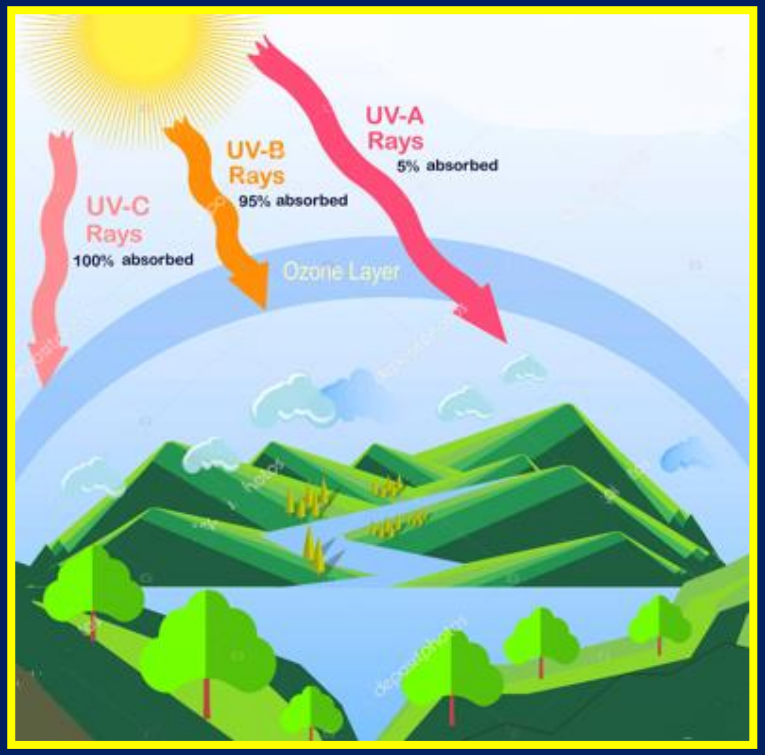
Ultraviolet Waves

Ultraviolet waves range in wavelengths between 100 and 400 nanometers.



Ultraviolet Waves

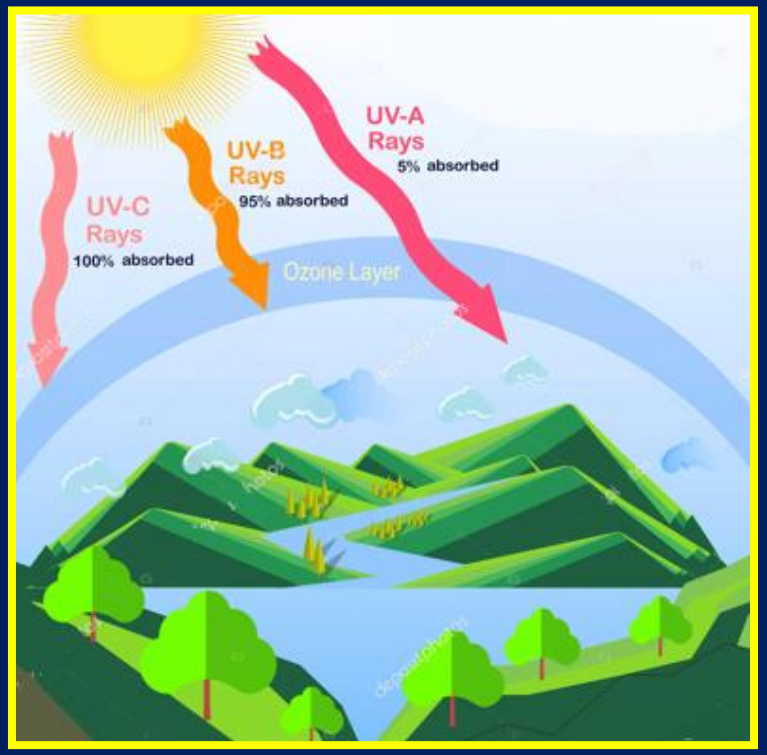
Shorter wavelengths of ultraviolet waves, UV-C rays, are absorbed by the atmosphere and do not reach Earth's surface.



95% of medium sized ultraviolet waves, UV-B, are absorbed by Earth's Ozone Layer.

Ultraviolet Waves

95% of the longest wavelengths of ultraviolet waves, UV-A rays reach Earth's surface.



Sun Damage

Both UV-A and UV-B rays can penetrate skin cells, causing sun damage to the skin and can even result in skin cancer.

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

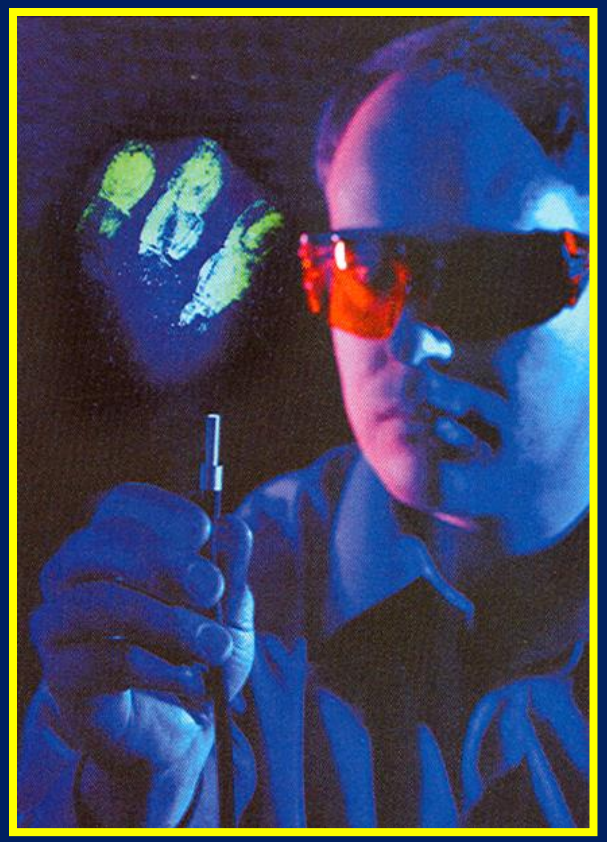
Man-Made sources of ultraviolet rays include welding equipment and tanning beds.

Beneficial UV Rays

Ultraviolet light is often used to kill bacteria and viruses.

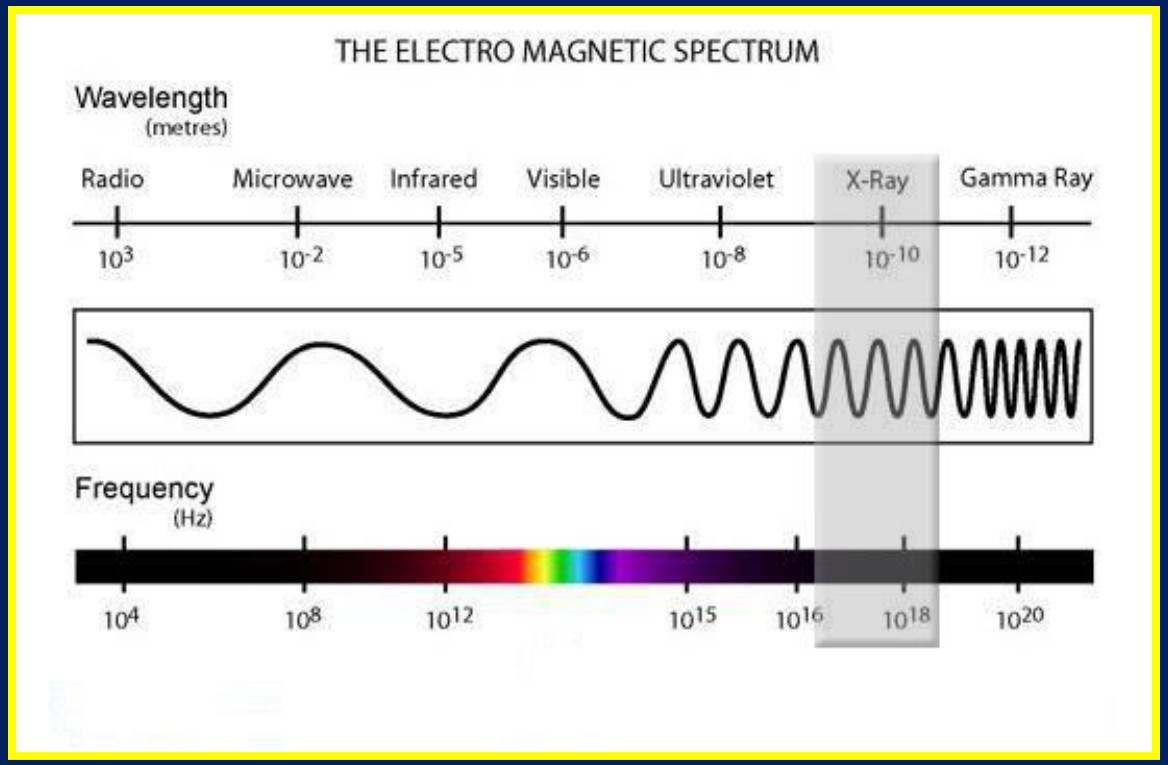
Beneficial UV Rays

Fluorescent materials absorb UV waves and emit visible light.



X Rays

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



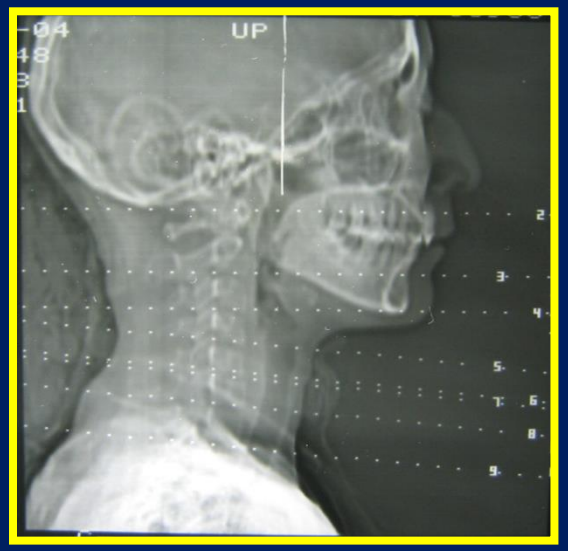
X Rays

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

Astronauts in space wear protective clothing to protect against X Rays.

X Rays

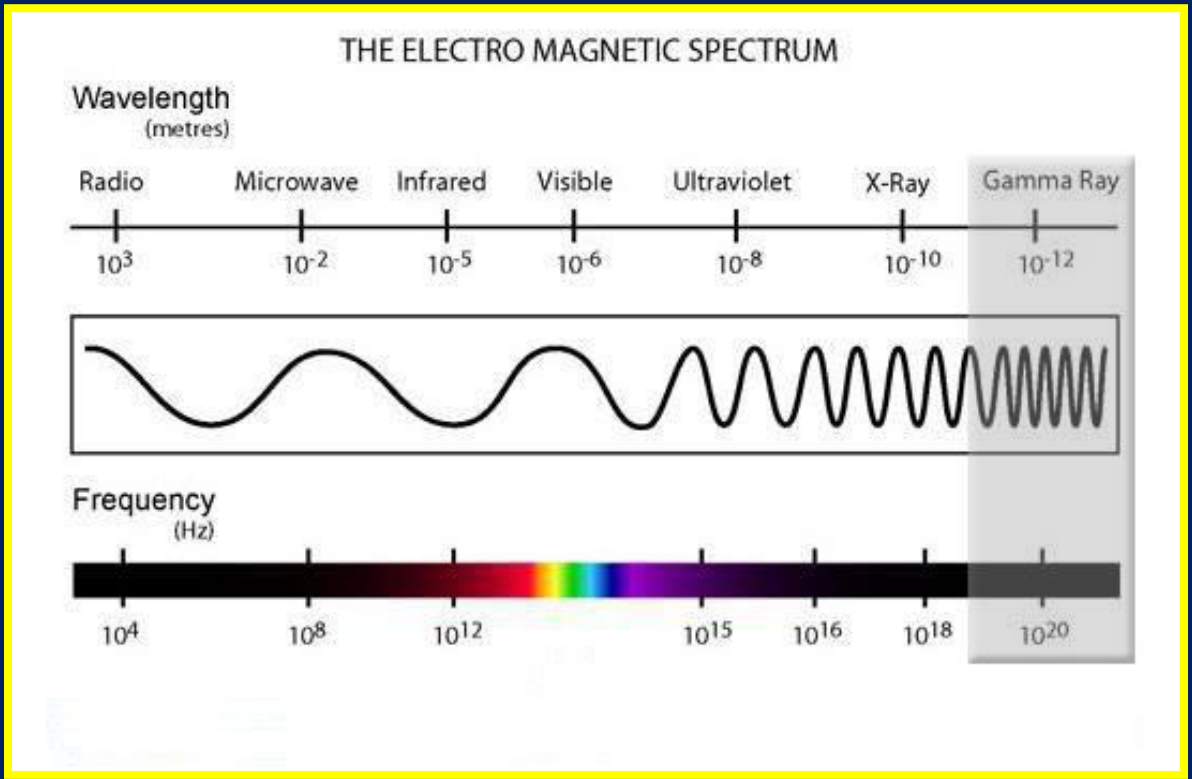
X Rays are used in the medical field to examine internal structures in the body.



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

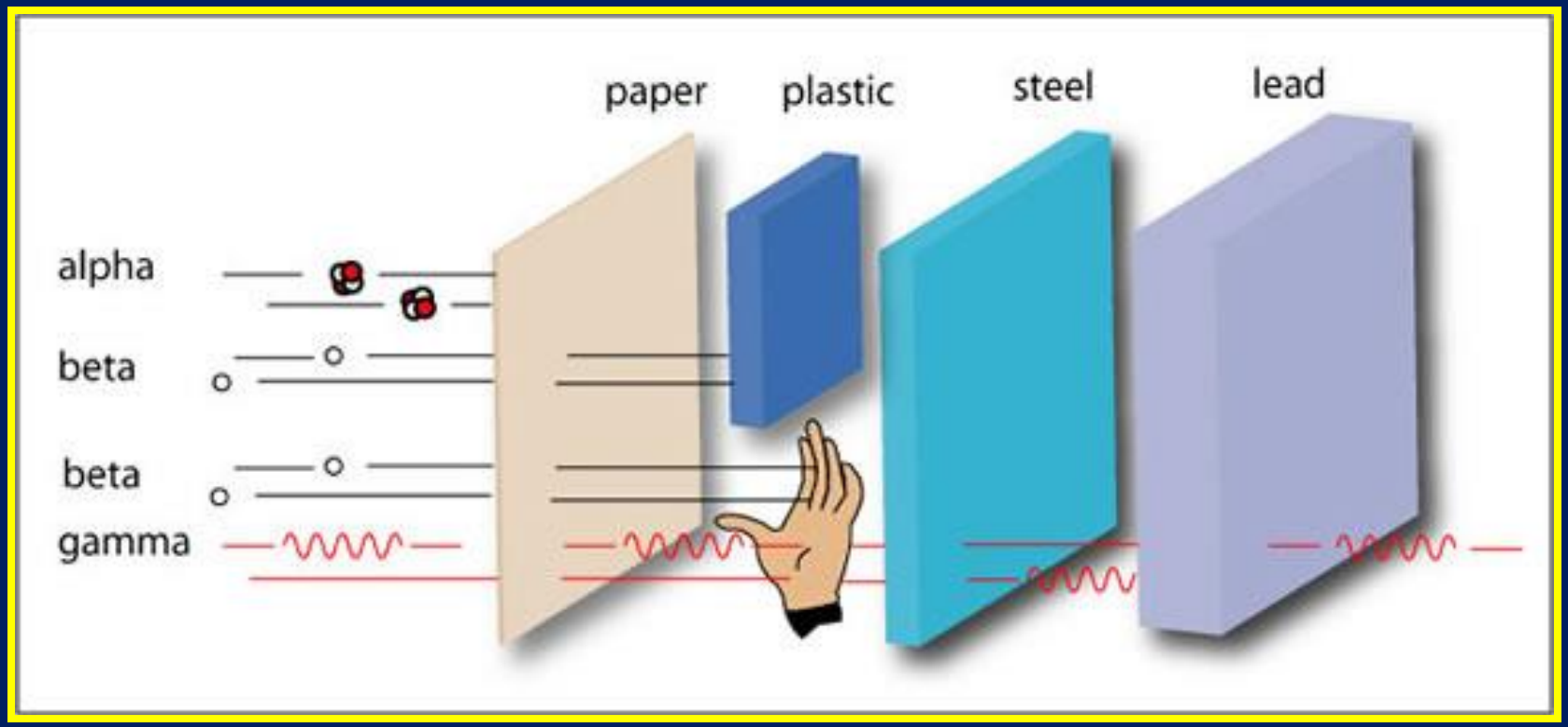
Gamma Rays

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.

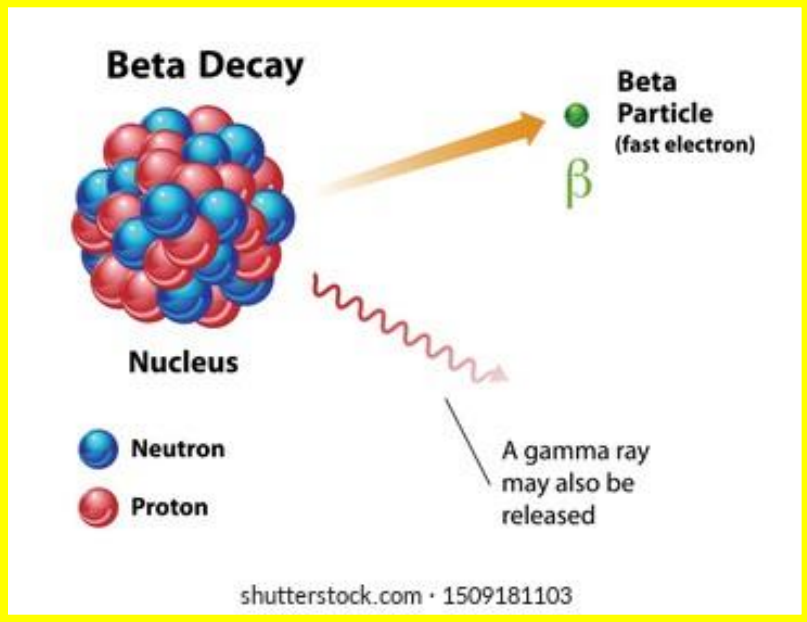


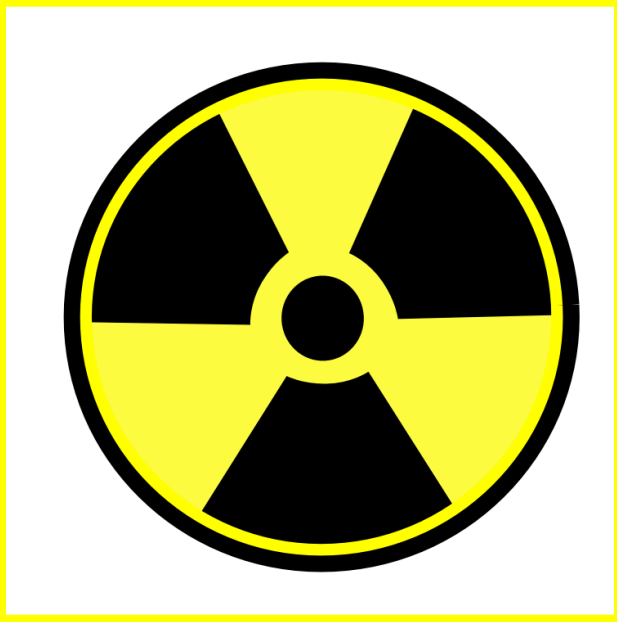
Gamma Rays

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 Gamma Rays can cause 3rd degree burns, hair loss, vomiting, and even death.

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

The End