

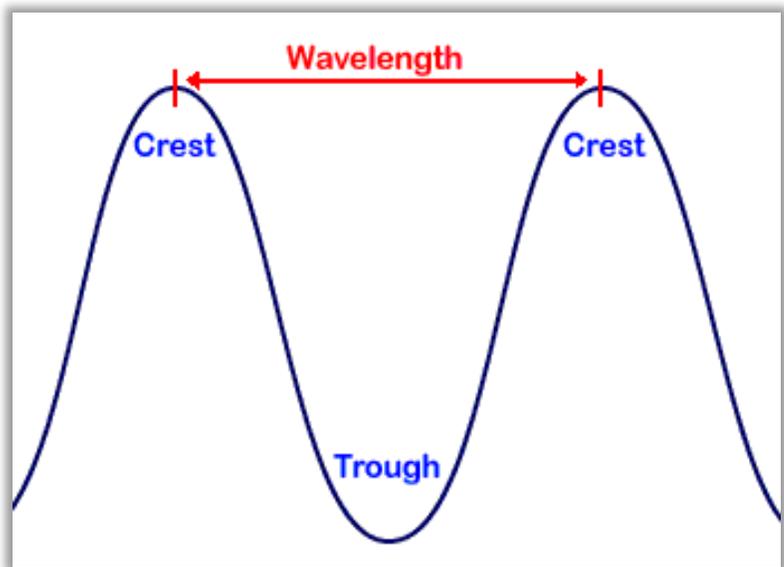
TEACHER BACKGROUND: ELECTROMAGNETIC RADIATION



When we look at the world around us we are seeing visible light waves (or visible radiation). However, there are many other forms of radiation that we cannot see with our eyes. These types include gamma rays, x-rays, ultraviolet, infrared, microwaves and radio waves. Together with visible light, all these types of radiation make up what we call the electromagnetic spectrum - the complete spectrum of radiation. Light (or radiation) is made up of vibrating waves of electrical and magnetic fields. This is where the term electromagnetic radiation comes from. Electromagnetic radiation travels in waves that have different wavelengths, energies and frequencies.

Wavelength and Frequency

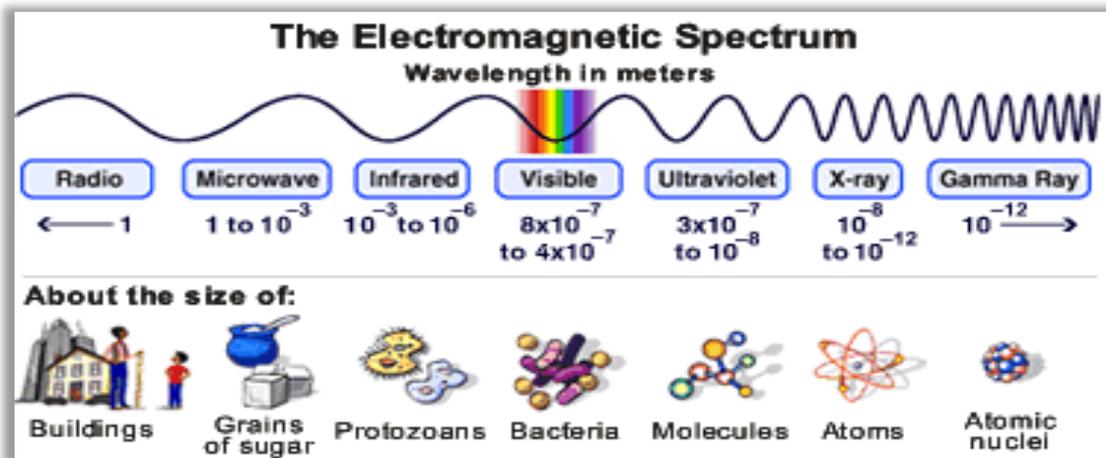
The wavelength is the distance between individual waves (e.g. from one peak to another). The wavelengths of visible light range from 400 to 700 billionths of a meter. But the entire electromagnetic spectrum extends from one billionth of a meter (for gamma rays) to meters (for some radio waves). The frequency is the number of waves which pass a point in space each second. Visible light frequencies range between 430 trillion waves per second (red) and 750 trillion waves per second (violet). The entire electromagnetic spectrum has frequencies between less than 1 billion waves per second (radio) and greater than 3 billion waves per second (gamma rays). Light waves are waves of energy and the amount of energy in a wave is proportional to its frequency. Wavelength increases, while frequency and energy decreases as we go from gamma rays to radio waves.



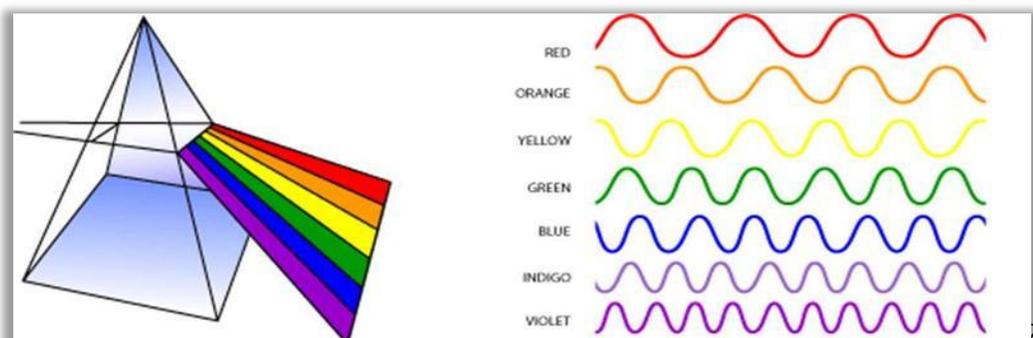
All electromagnetic radiation travels at the speed of light (186,000 miles or 300,000,000 meters per second in a vacuum). Objects in space send out electromagnetic radiation at all wavelengths - from gamma rays to radio waves. Each type of radiation (or light) brings us unique information so, to get a complete picture of the Universe, we need to study it in all of its light, using each part of the electromagnetic spectrum! Almost everything we know about the Universe comes from the study of the electromagnetic radiation emitted or reflected by objects in space.

The Electromagnetic Spectrum

The *electromagnetic* spectrum is a continuum of all electromagnetic waves arranged according to frequency and wavelength. The sun, earth, and other bodies radiate electromagnetic energy of varying wavelengths.



The *visible* spectrum is the part of the electromagnetic spectrum that can be detected by the human eye. Electromagnetic radiation in this range of wavelengths is called visible light or simply light. Remember the visible spectrum as—ROYGBIV



Electromagnetic waves

Radio Waves -- The waves in the electromagnetic spectrum that have the longest wavelengths and lowest frequency are called radio waves. Radio waves are used to transmit information from the antenna of a broadcasting station to the antenna of your radio or TV. In astronomy radio waves are used to gain information from distant stars using radio telescopes. Radio telescopes have the advantage that radio waves are not blocked by conditions of the Earth's atmosphere as light waves are.

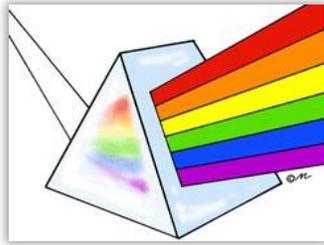


Microwaves - are the highest frequency of radio waves. Their wavelength is only a few centimeters long. While microwaves pass right through some materials others absorb them. Water and some other molecules found in food absorb microwaves and turn the energy into heat. This is what makes a microwave oven work. Glass and plastic do not absorb microwaves so they do not heat up.

Metal, however does absorb microwaves and that is why we can't put it inside a microwave oven. Short wavelength microwaves are used in radar devices. Radar works by sending out short pulses of radio waves and recording the time it takes for the reflected wave to be picked up by the receiver.

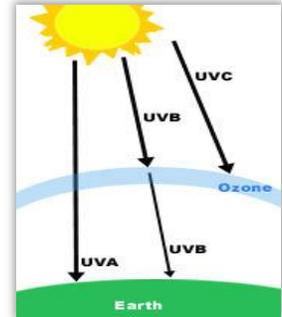
Infrared --lies between the visible and microwave portions of the electromagnetic spectrum. Shorter, near infrared waves are not hot at all - in fact you cannot even feel them. These shorter wavelengths are the ones used by your TV's remote control. Far infrared waves we experience every day in the form of heat. The heat that we feel from sunlight, a fire, a radiator or a warm sidewalk is infrared.





Visible-- waves are the only electromagnetic waves we can see. We see these waves as the colors of the rainbow. Each color has a different wavelength. Red has the longest wavelength and violet has the shortest wavelength. When all the waves are seen together, they make white light.

Ultraviolet (UV) light—is radiation with a wavelength shorter than that of visible light, but longer than X-rays, in the range 10 nm to 400 . Though these waves are invisible to the human eye, some insects, like bumblebees, can see them. It is ultraviolet waves that are responsible for causing our sunburns. UV light cannot pass through glass unless it is made of quartz.



X- Rays --have smaller wavelengths and therefore higher energy than ultraviolet waves. We usually talk about X-rays in terms of their energy rather than wavelength. X-rays are most known for their use in medicine. Because your bones and teeth are dense and absorb more X-rays than your skin does, images of

your bones or teeth are left on the X-ray film while your skin appears transparent.

Gamma Rays-have the smallest wavelengths and the most energy of any other wave in the electromagnetic spectrum. These waves are generated by radioactive atoms and in nuclear explosions. Gamma-rays can kill living cells, a fact which medicine uses to its advantage, using gamma-rays to kill cancer cells.

