Lecture (5)

Electromagnetic Radiation

(5-1) Introduction:

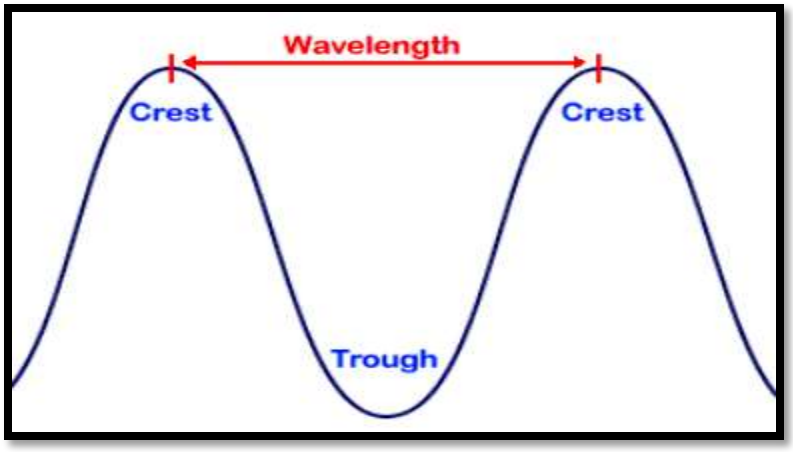
Electromagnetic (EM) radiation is a form of energy propagated through free space or through a material medium in the form of electromagnetic waves.

EM radiation is so-named because it has ***electric and magnetic fields*** that simultaneously oscillate in planes mutually perpendicular to each other and to the direction of propagation through space.

(5-2) Wavelength and Frequency:

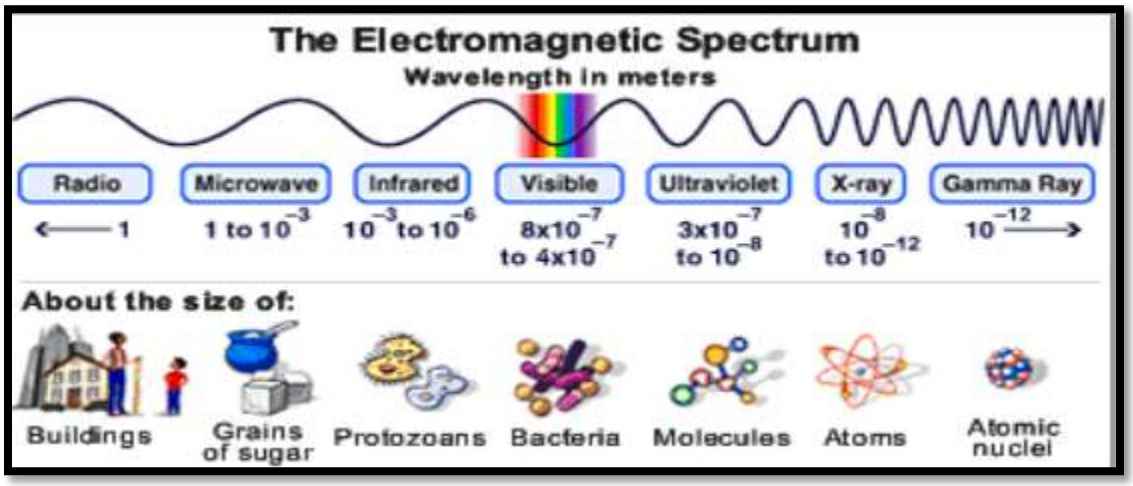
The ***wavelength*** is the distance between individual waves (e.g. from one peak to another). The wavelengths of ***visible light*** range from 400 to 700 billionths of a meter. But the entire electromagnetic spectrum extends from one billionth of a meter (for ***gamma rays***) to meters (for some ***radio 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***.



(5-3) 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.



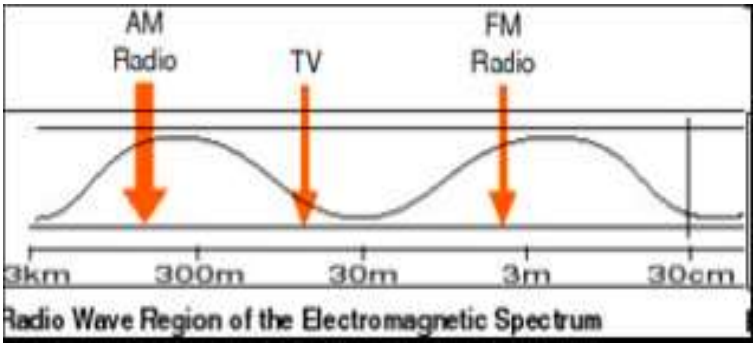
(5-4) Electromagnetic waves:

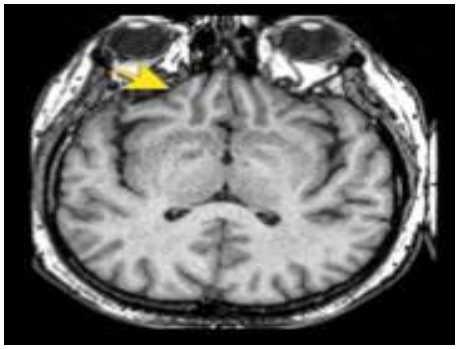
1) Radio Waves:

The waves in the electromagnetic spectrum that have the longest wavelengths and lowest frequency are called radio waves.

Uses:

- TV broadcasting
- AM and FM broadcast radio
- Heart rate monitors
- Cell phone communication
- MRI (MAGNETIC RESONACE IMAGING)
- Uses Short wave radio waves with a magnet to create an image.



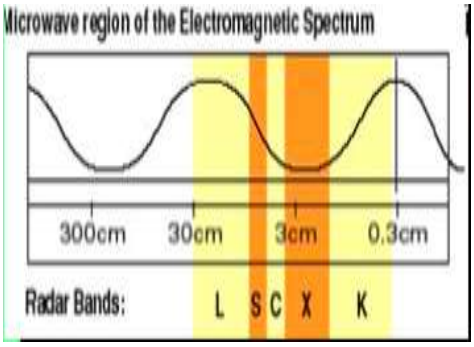


2) Microwaves:

Microwaves are the highest frequency of radio waves. Their wavelength is only a few centimeters long.

Uses:

- Microwave ovens
- Bluetooth headsets
- Broadband Wireless Internet
- Radar
- GPS

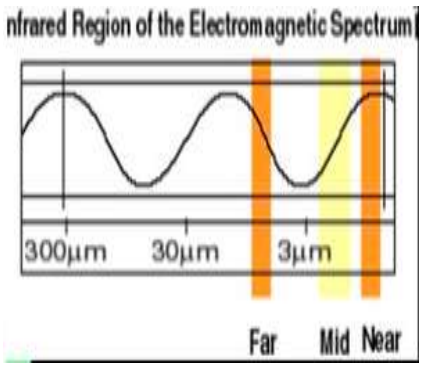


3) Infrared:

Infrared Radiation Wavelengths lies between microwaves and visible light.

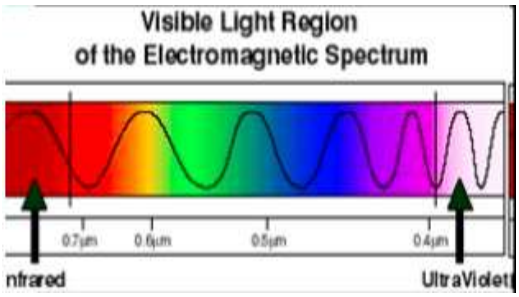
Uses:

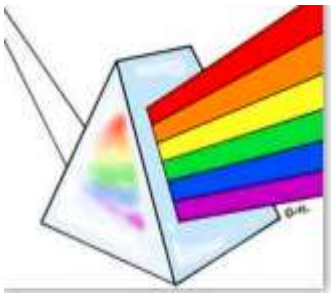
- Night vision goggles
- Remote controls
- Heat-seeking missiles



4) Visible:

Visible waves are the only electromagnetic waves that able to be detected by the human eye. We see these waves as the colors of the rainbow. Each color has a different wavelength. Red has the longest wavelength (***lowest frequency***) and violet has the shortest wavelength (***highest frequency***). When all the waves are seen together, they make white light.



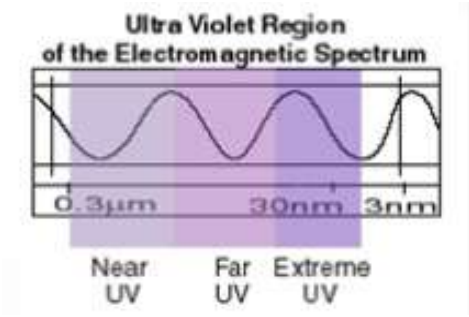


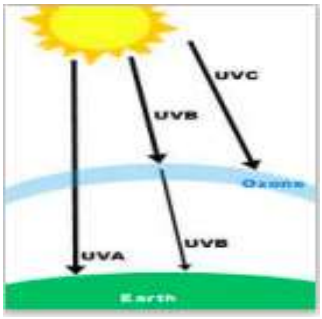
5) Ultraviolet (UV) light:

Ultraviolet is radiation with a wavelength shorter than that of visible light, in the range 10 nm to 400 nm. Though these waves are invisible to the human eye, some insects, like bumblebees, can see them.

Uses:

- Black lights
- Security images on money
- Harmful to living things
  - Used to sterilize medical equipment
  - Too much causes sun burn
  - Extremely high exposure can cause skin cancer



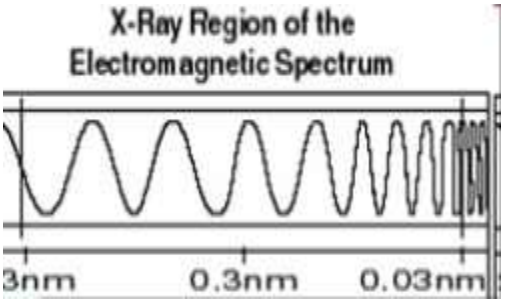


6) X- Rays:

X- Rays have smaller wavelengths and therefore higher energy than ultraviolet waves.

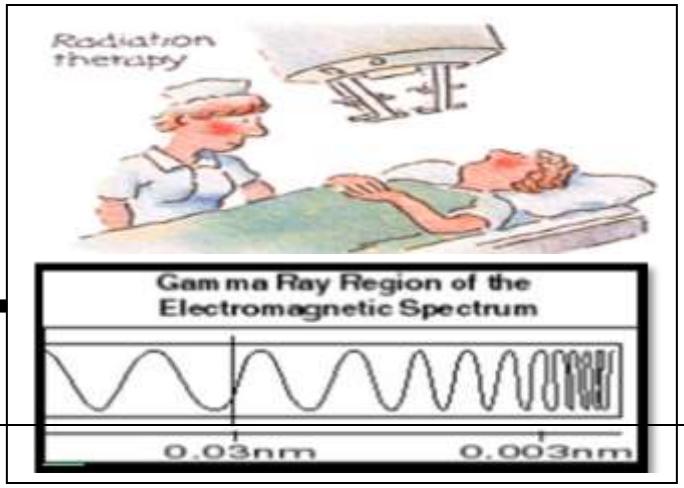
Uses:

- Medicine (Medical imaging). Because your bones and teeth are dense and absorb more X-rays then your skin does, images of your bones or teeth are left on the X-ray film while your skin appears transparent.
- Airport security
  - Moderate dose can be damaging to cells.



7) Gamma Rays:

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.

Uses:

- Sterilizes medical equipment
- Cancer treatment to kill cancer cells
- Kills nearly all living cells.