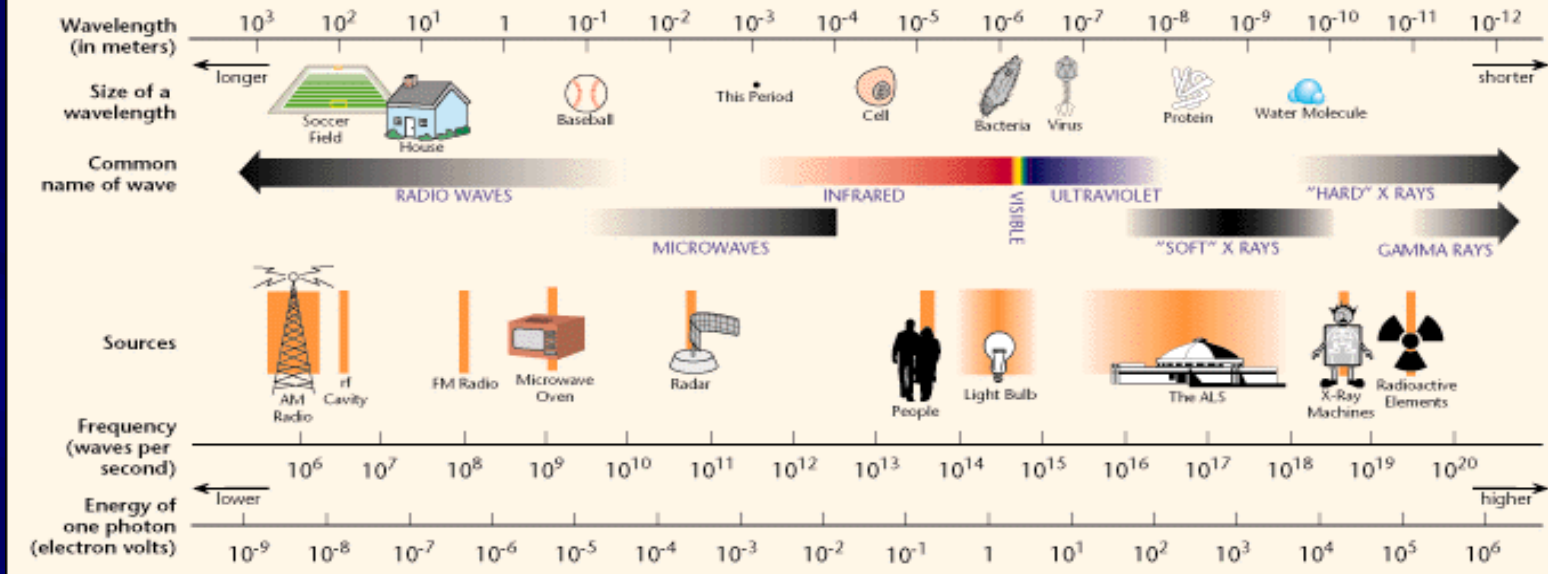


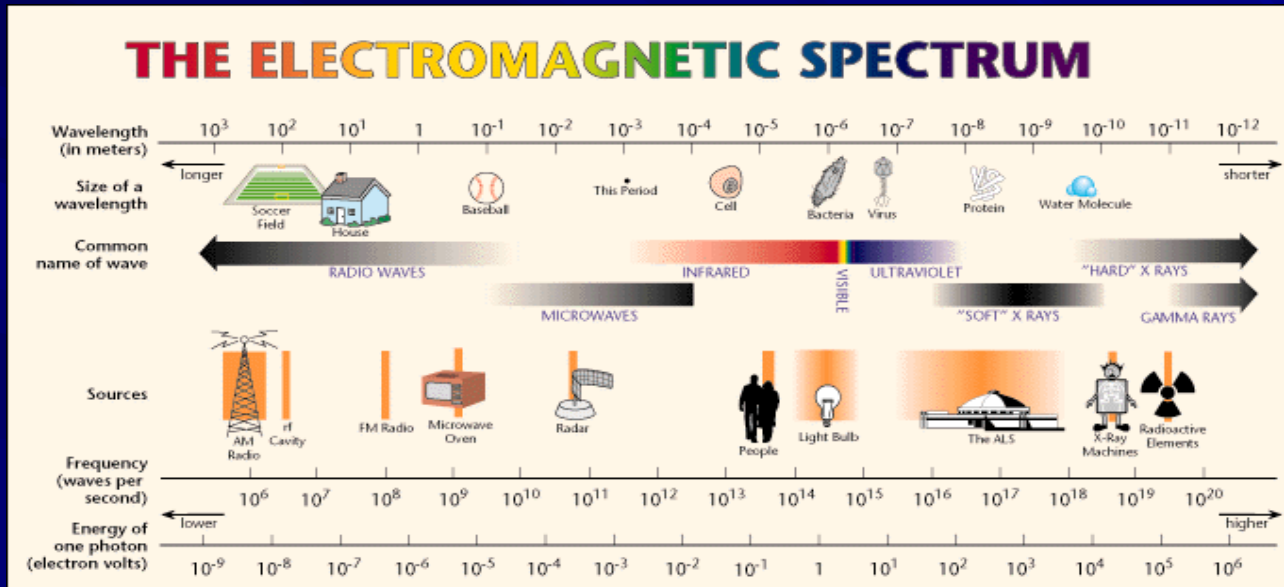
# THE ELECTROMAGNETIC SPECTRUM



# The Electromagnetic Spectrum

# The Electromagnetic Spectrum

- The EM spectrum is the ENTIRE range of EM waves in order of increasing frequency and decreasing wavelength.



- As you go from left → right, the **wavelengths get smaller** and the **frequencies get higher**. This is an **inverse relationship** between wave size and frequency. (As one goes up, the other goes down.) This is because the speed of ALL EM waves is the speed of light (300,000 km/s).

# Things to Remember

- The higher the frequency, the more energy the wave has.
- EM waves **do not require media** in which to travel or move.
- EM waves are considered to be **transverse waves** because they are made of vibrating electric and magnetic fields at right angles to each other, and to the direction the waves are traveling.
- Inverse relationship between wave size and frequency: as **wavelengths get smaller, frequencies get higher**.

# The Waves (in order...)

**Radio waves:** Have the longest wavelengths and the lowest frequencies; wavelengths range from 1000s of meters to .001 m

- Used in: RADAR, cooking food, satellite transmissions

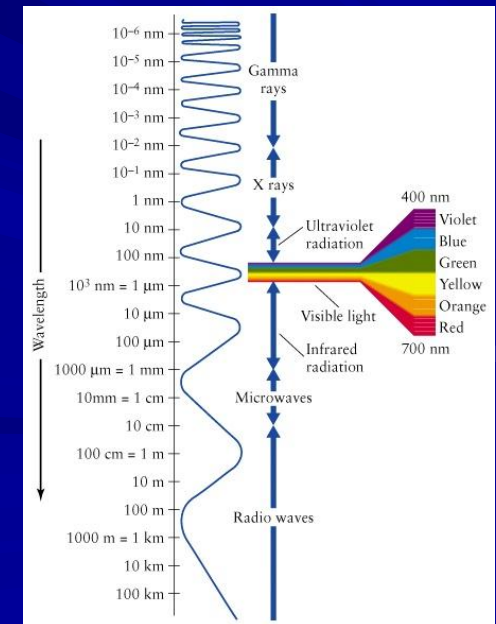


**Infrared waves** (heat): Have a shorter wavelength, from .001 m to 700 nm, and therefore, a higher frequency.

- Used for finding people in the dark and in TV remote control devices

**Visible light:** Wavelengths range from 700 nm (red light) to 30 nm (violet light) with frequencies higher than infrared waves.

- These are the waves in the EM spectrum that humans can see.
- Visible light waves are a very small part of the EM spectrum!

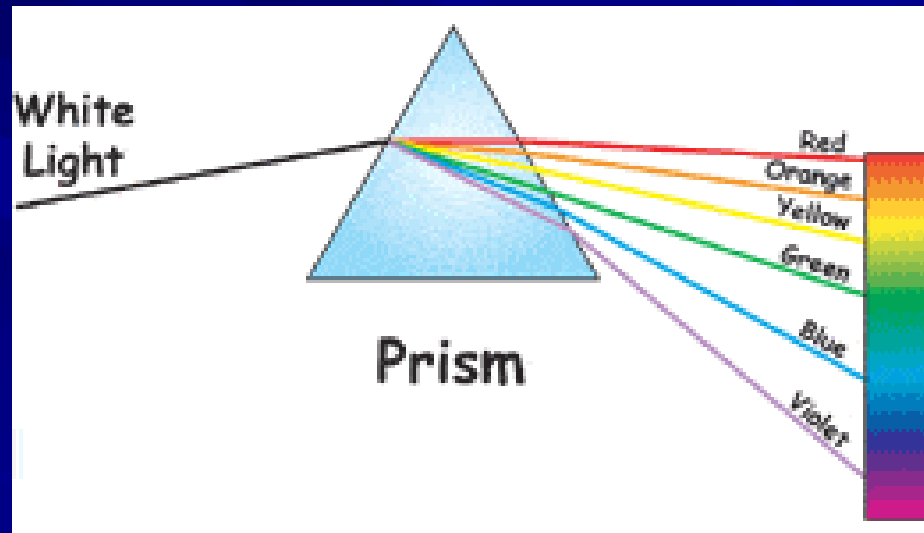


## Visible Light

# Remembering the Order

### ■ ROY G. BV

- red
- orange
- yellow
- green
- blue
- violet



**Ultraviolet Light:** Wavelengths range from 400 nm to 10 nm; the frequency (and therefore the energy) is high enough with UV rays to penetrate living cells and cause them damage.



- Although we cannot see UV light, bees, bats, butterflies, some small rodents and birds can.
- UV on our skin produces vitamin D in our bodies. Too much UV can lead to sunburn and skin cancer. UV rays are easily blocked by clothing.
- Used for sterilization because they kill bacteria.

**X-Rays:** Wavelengths from 10 nm to .001 nm.

These rays have enough energy to penetrate deep into tissues and cause damage to cells; are stopped by dense materials, such as bone.



- Used to look at solid structures, such as bones and bridges (for cracks), and for treatment of cancer.



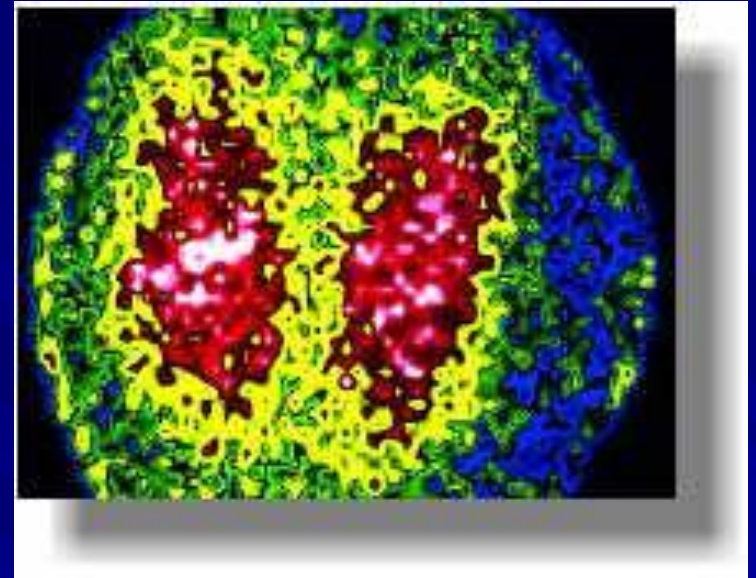
**Gamma Rays:** Carry the most energy and have the shortest wavelengths, less than one trillionth of a meter ( $10^{-12}$ ).

- Gamma rays have enough energy to go through most materials easily; you would need a 3-4 ft thick concrete wall to stop them!



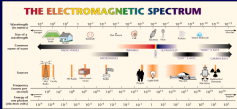
- Gamma rays are released by nuclear reactions in nuclear power plants, by nuclear bombs, and by naturally occurring elements on Earth.
- Sometimes used in the treatment of cancers.

## Gamma Rays



- This picture is a “scintigram” →
- It shows an asthmatic person’s lungs.
- The patient was given a slightly radioactive gas to breath, and the picture was taken using a gamma camera to detect the radiation.
- The colors show the air flow in the lungs.

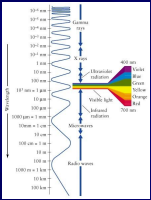
# Image Sources



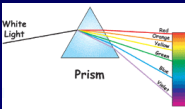
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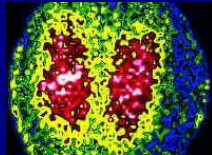
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Andy Darvill, Broadoak Community School, Radioactivity Uses  
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