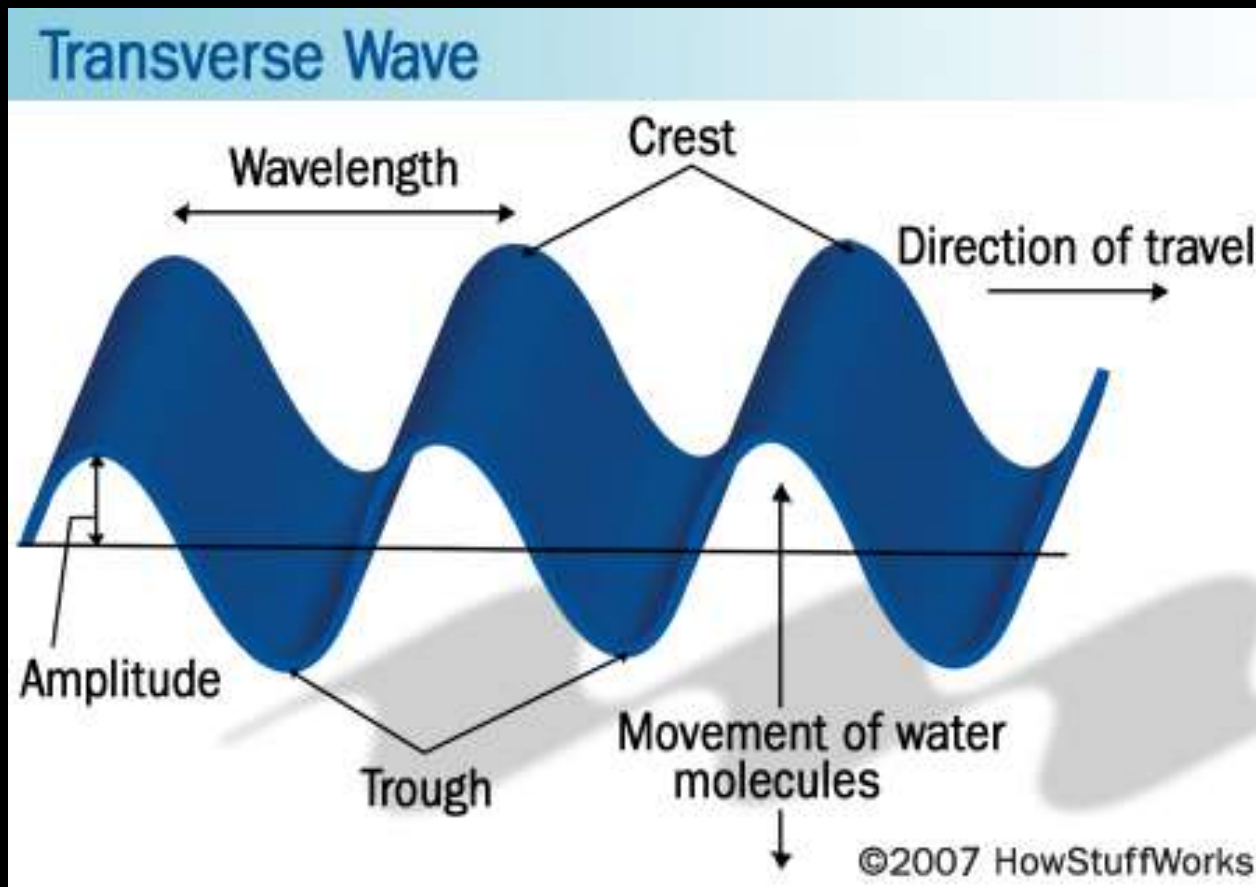


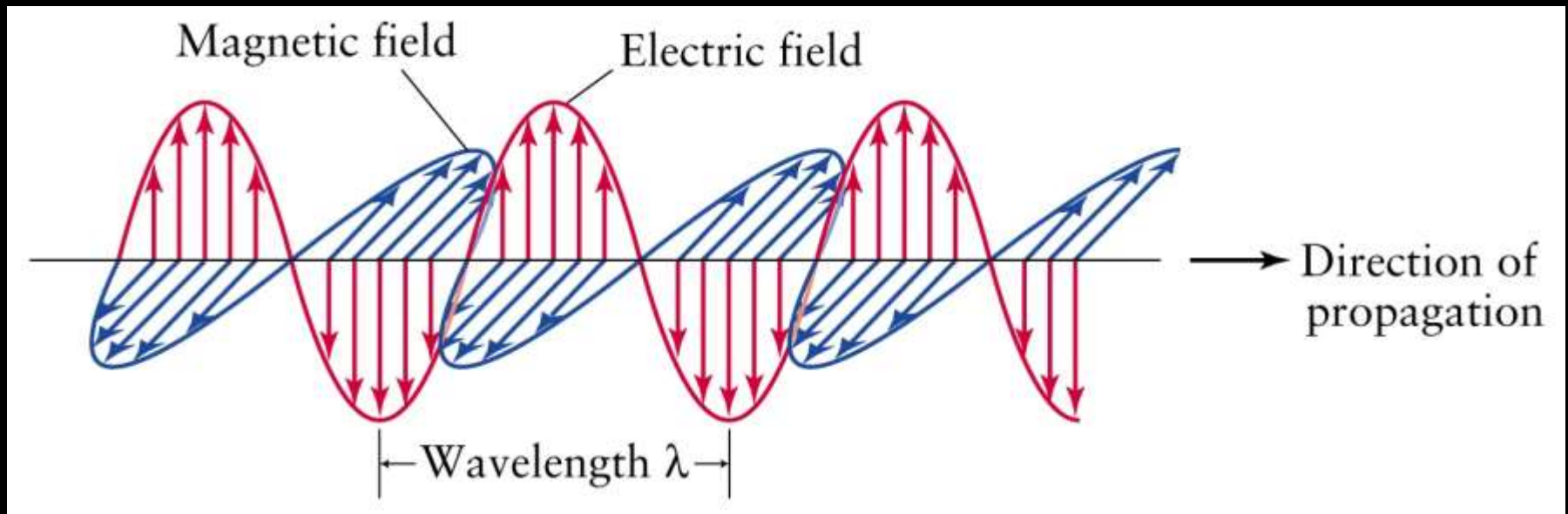
Electromagnetic Waves & the Electromagnetic Spectrum

Electromagnetic Waves

- Transverse waves without a medium!
- (They can travel through empty space)

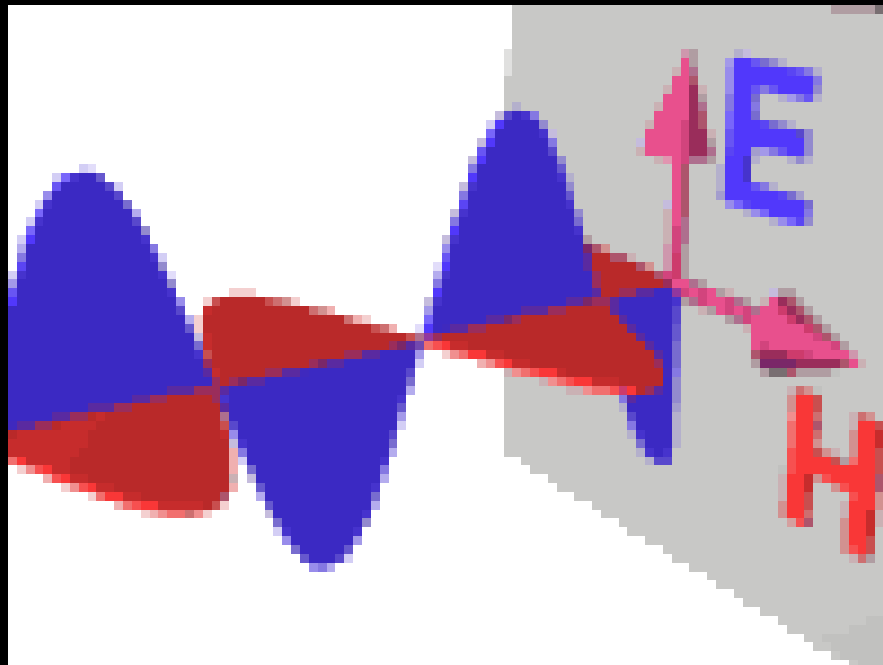


- They travel as vibrations in electrical and magnetic fields.
- Have some magnetic and some electrical properties to them.



When an electric field changes, so does the magnetic field. The changing magnetic field causes the electric field to change. When one field vibrates—so does the other.

RESULT-An electromagnetic wave.



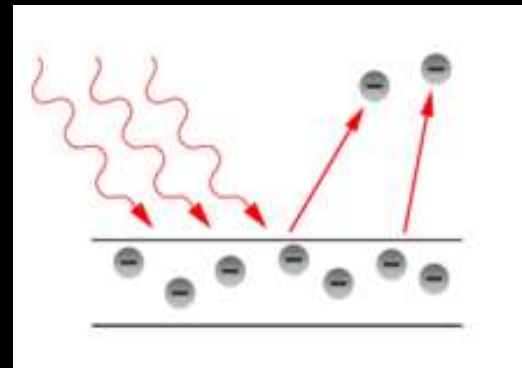
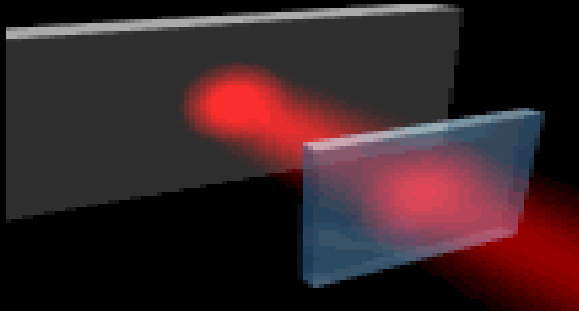
Electromagnetic waves travel **VERY FAST** - around 300,000 kilometres per second (the speed of light).

At this speed they can go around the world 8 times in one second.



Waves or Particles?

- Electromagnetic radiation has properties of waves but also can be thought of as a **stream of particles**.
- Example: Light
 - Light as a wave: Light behaves as a transverse wave which we can filter using polarized lenses.
 - Light as particles (photons): When directed at a substance light can knock electrons off of a substance (Photoelectric effect)



Electromagnetic Spectrum—name for the range of electromagnetic waves when placed in order of increasing frequency

RADIO WAVES

INFRARED RAYS

ULTRAVIOLET RAYS

GAMMA RAYS

MICROWAVES

VISIBLE LIGHT

X-RAYS



Radio waves

Microwaves

Infrared rays

Visible light

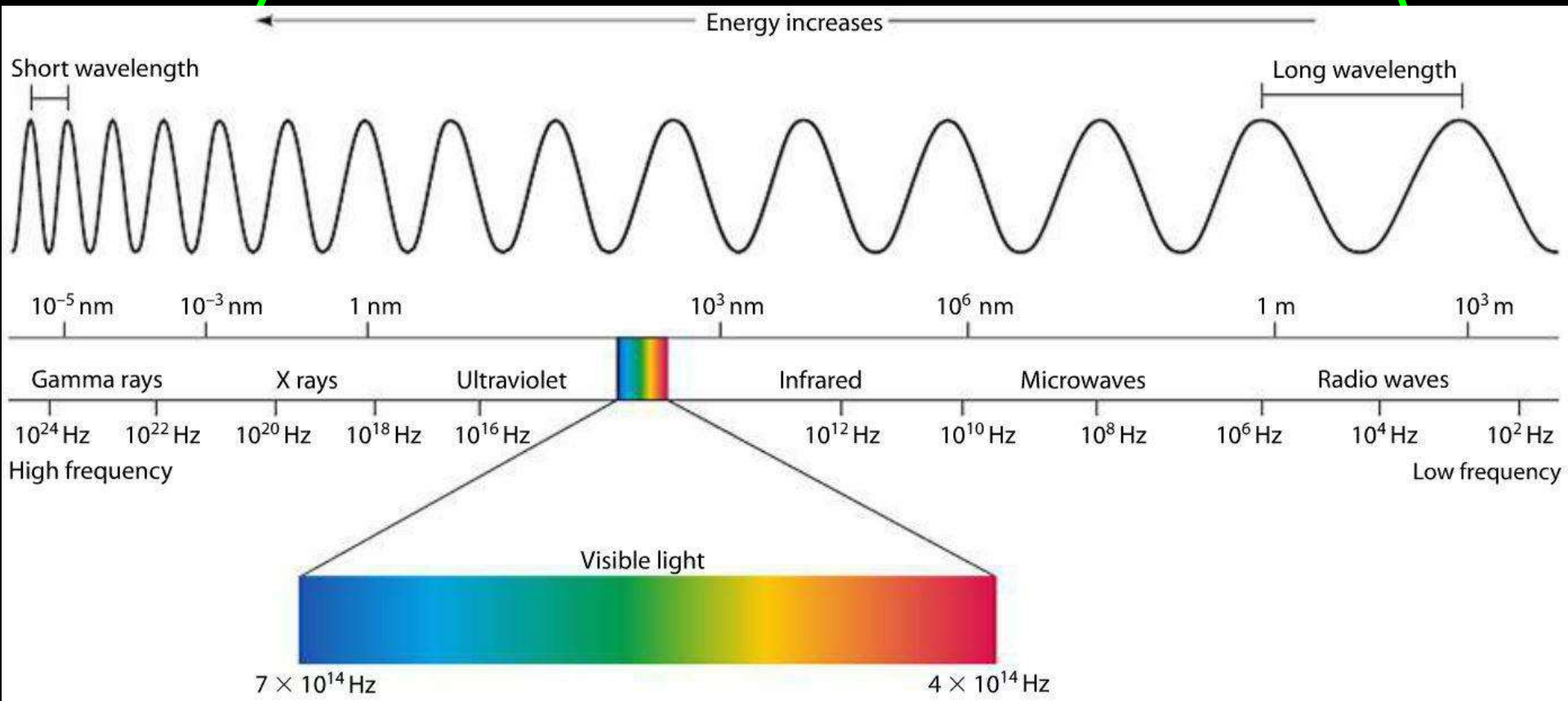
Ultraviolet rays

X-rays

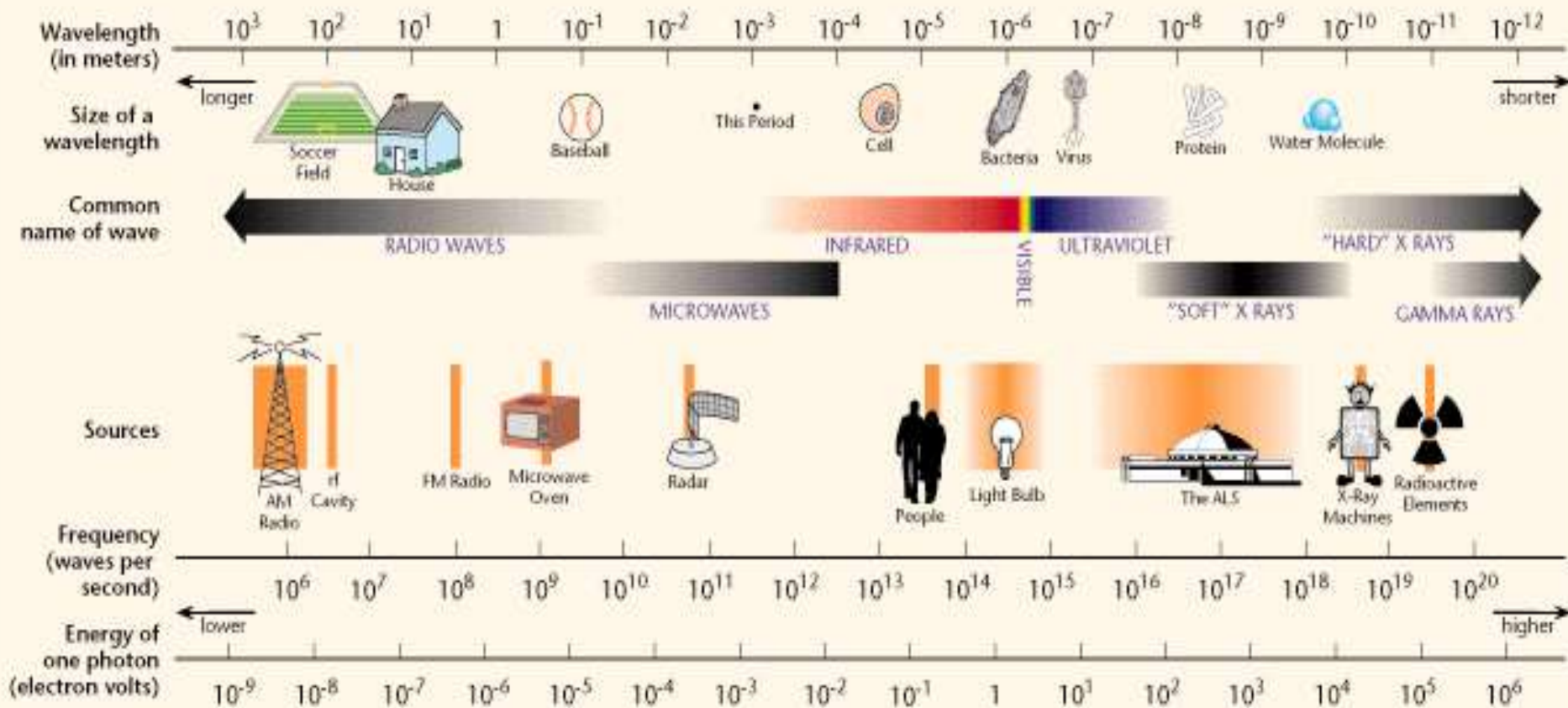
Gamma



Notice the wavelength is shorter (Gamma Rays) and long (Radio waves)

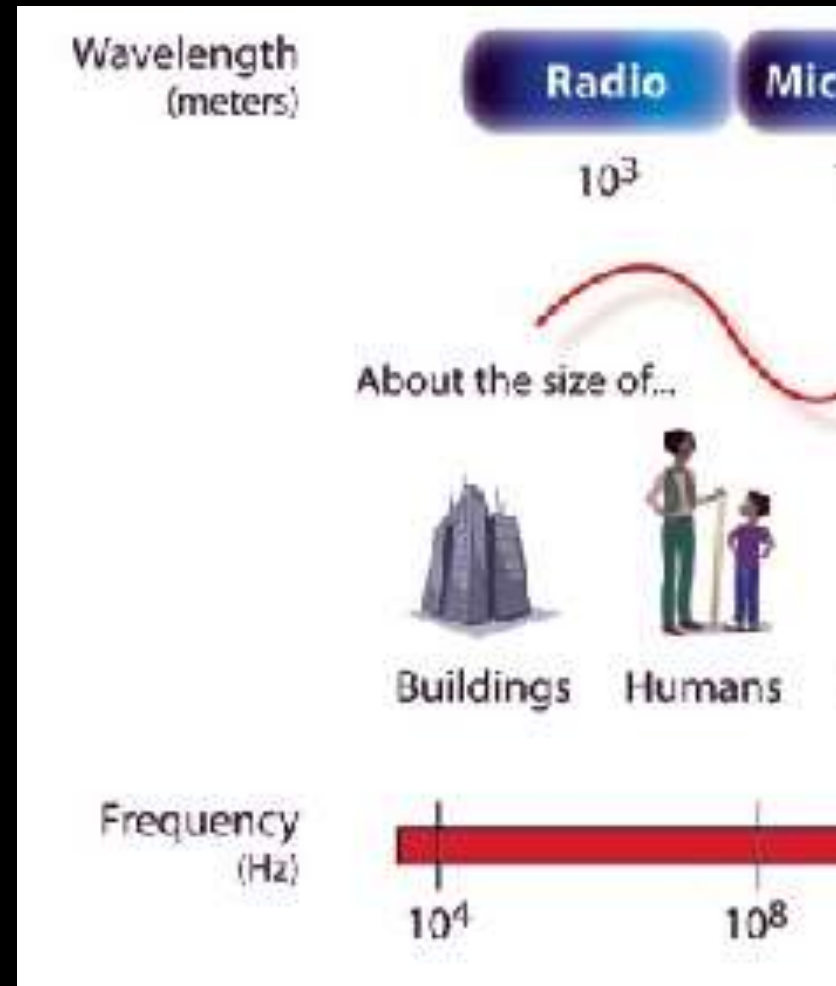


THE ELECTROMAGNETIC SPECTRUM



RADIO WAVES

Have the longest wavelengths and lowest frequencies of all the electromagnetic waves.

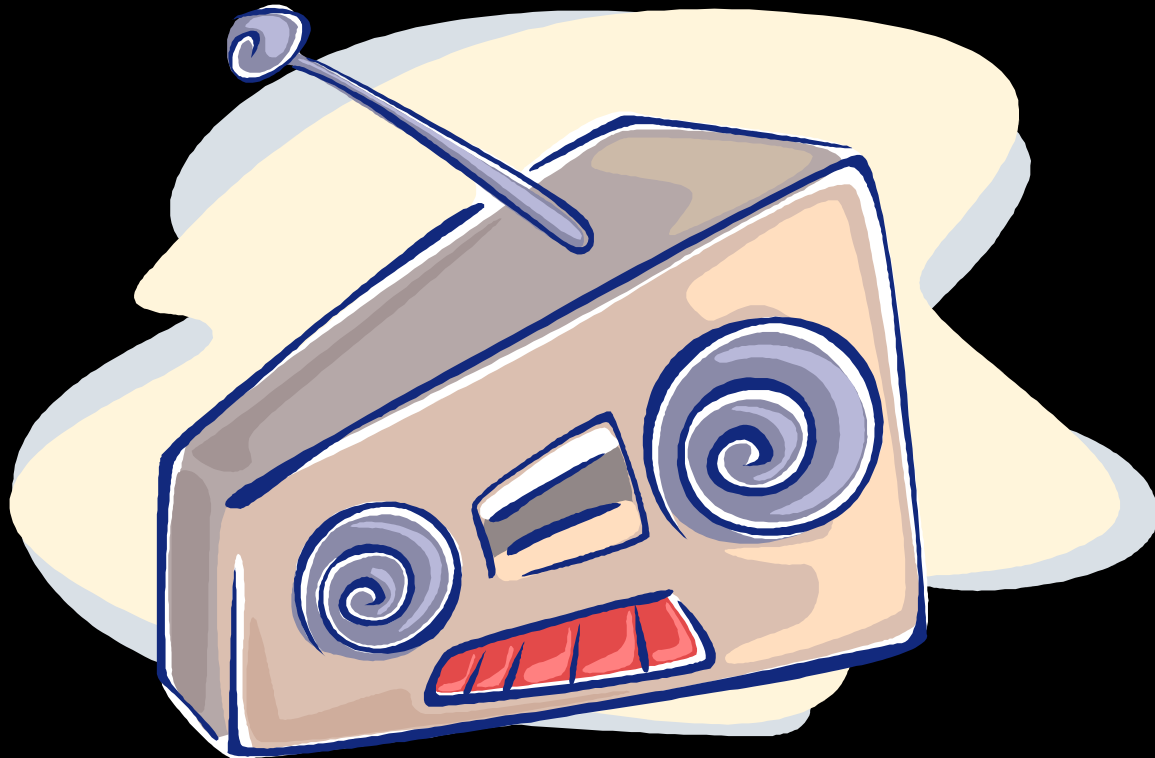


Global Positioning Systems (GPS) measure the time it takes a radio wave to travel from several satellites to the receiver, determining the distance to each satellite.



A radio picks up radio waves through an antenna and converts it to sound waves.

- Each radio station in an area broadcasts at a different frequency.
 - # on radio dial tells frequency.

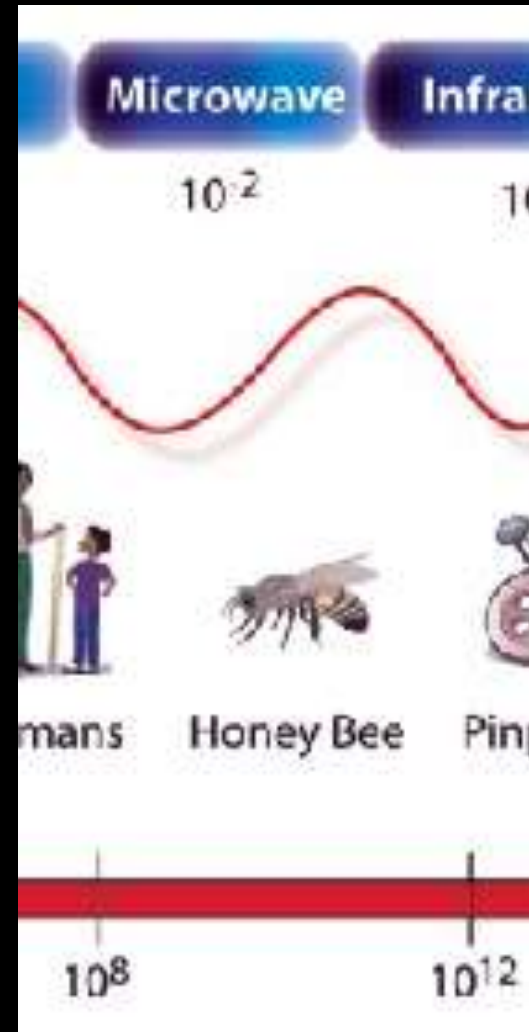


MRI
(MAGNETIC RESONANCE IMAGING)
Uses Short wave radio waves with a magnet to create an image.

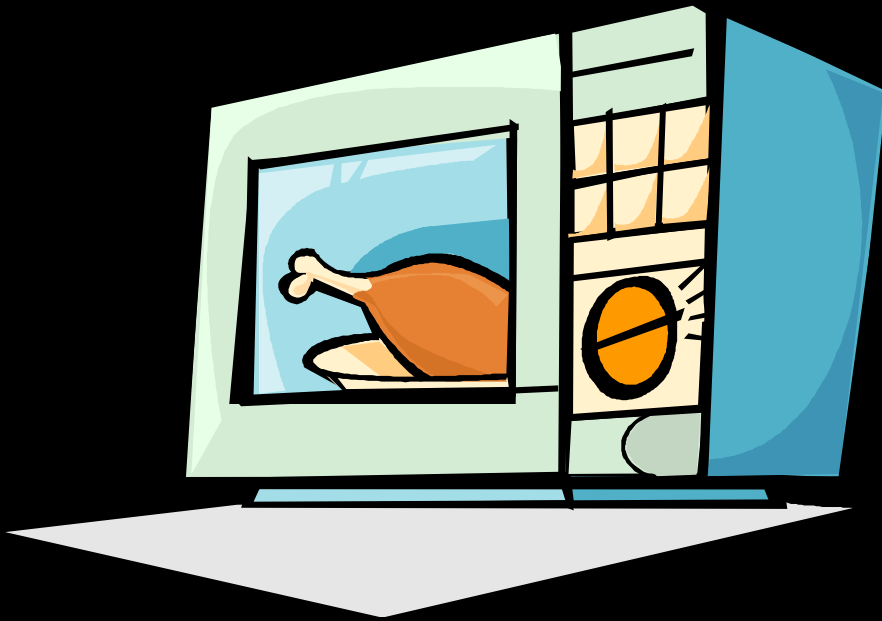


MICROWAVES

Have the shortest wavelengths and the highest frequency of the radio waves.



Used in microwave ovens.



- Waves transfer energy to the water in the food causing them to vibrate which in turn transfers energy in the form of heat to the food.

RADAR

(Radio Detection and Ranging)

Used to find the speed of an object by sending out radio waves and measuring the time it takes them to return.



INFRARED RAYS

Infrared = below
red

Shorter
wavelength and
higher
frequency than
microwaves.



You can feel the
longest ones as
warmth on your
skin

Warm objects
give off more
heat energy than
cool objects.

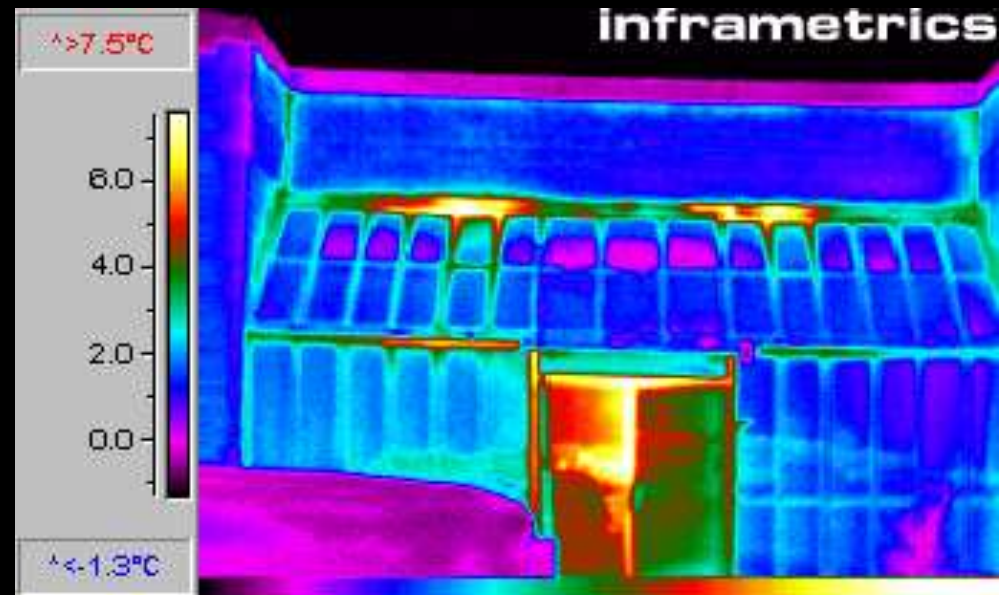


Thermogram—a picture that shows regions of different temperatures in the body. Temperatures are calculated by the amount of infrared radiation given off.

Therefore people give off infrared rays.



Heat lamps give off infrared waves.



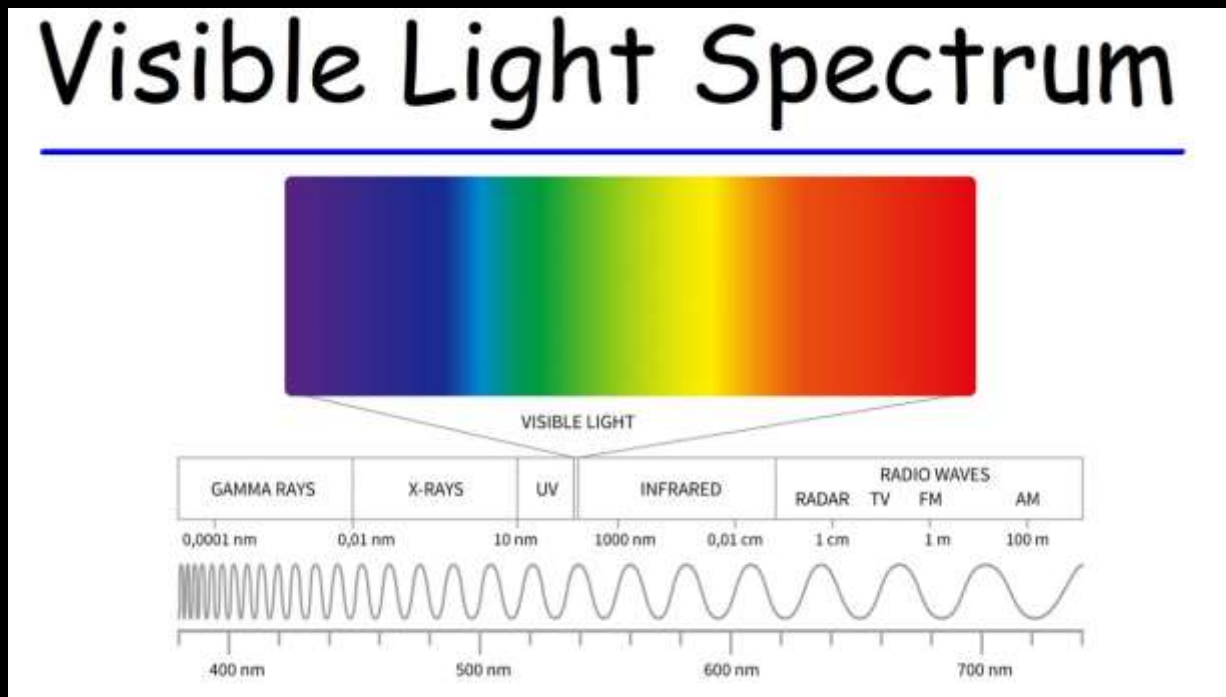
VISIBLE LIGHT

Shorter wavelength and higher frequency than infrared rays.

Electromagnetic waves we can see.

Longest wavelength= red light

Shortest wavelength= violet (purple) light



When light enters a new medium it bends (refracts). Each wavelength bends a different amount allowing white light to separate into its various colors
VIBGYOR

Typically, the human eye can detect wavelengths from 380 to 700 nanometers.

Visible portion of spectrum

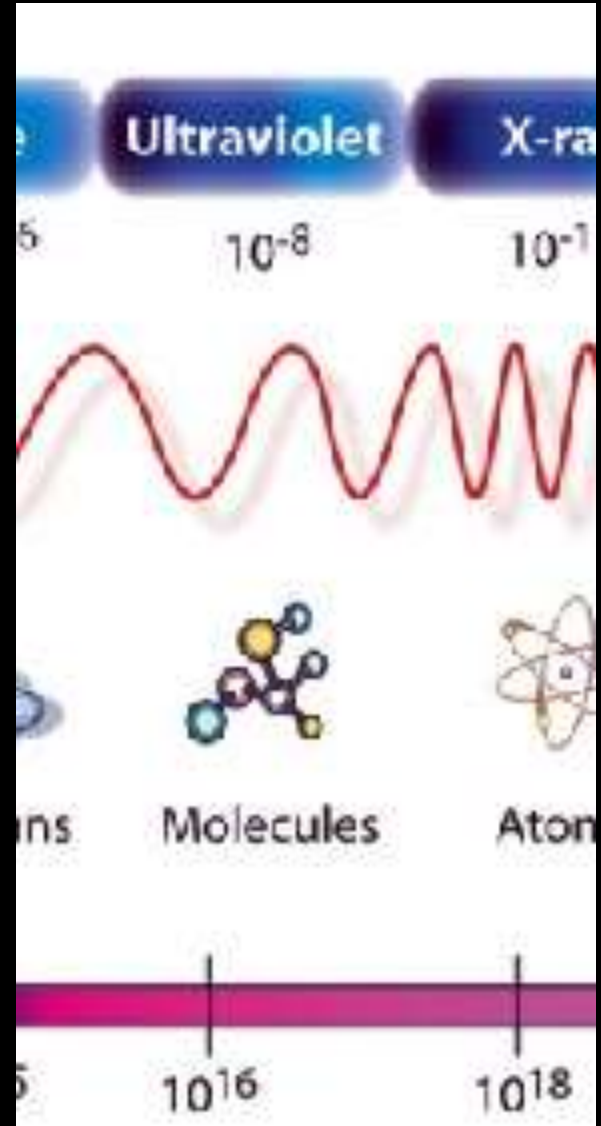
- Violet: 0.4 μm to 0.446 μm
- Blue: 0.446 μm to 0.500 μm
- Green: 0.500 μm to 0.578 μm
- Yellow: 0.578 μm to 0.592 μm
- Orange: 0.592 μm to 0.620 μm
- Red: 0.620 μm to 0.7 μm

Among these blue, green and red are the primary colors

ULTRAVIOLET RAYS

Shorter wavelength and higher frequency than visible light

Carry more energy than visible light



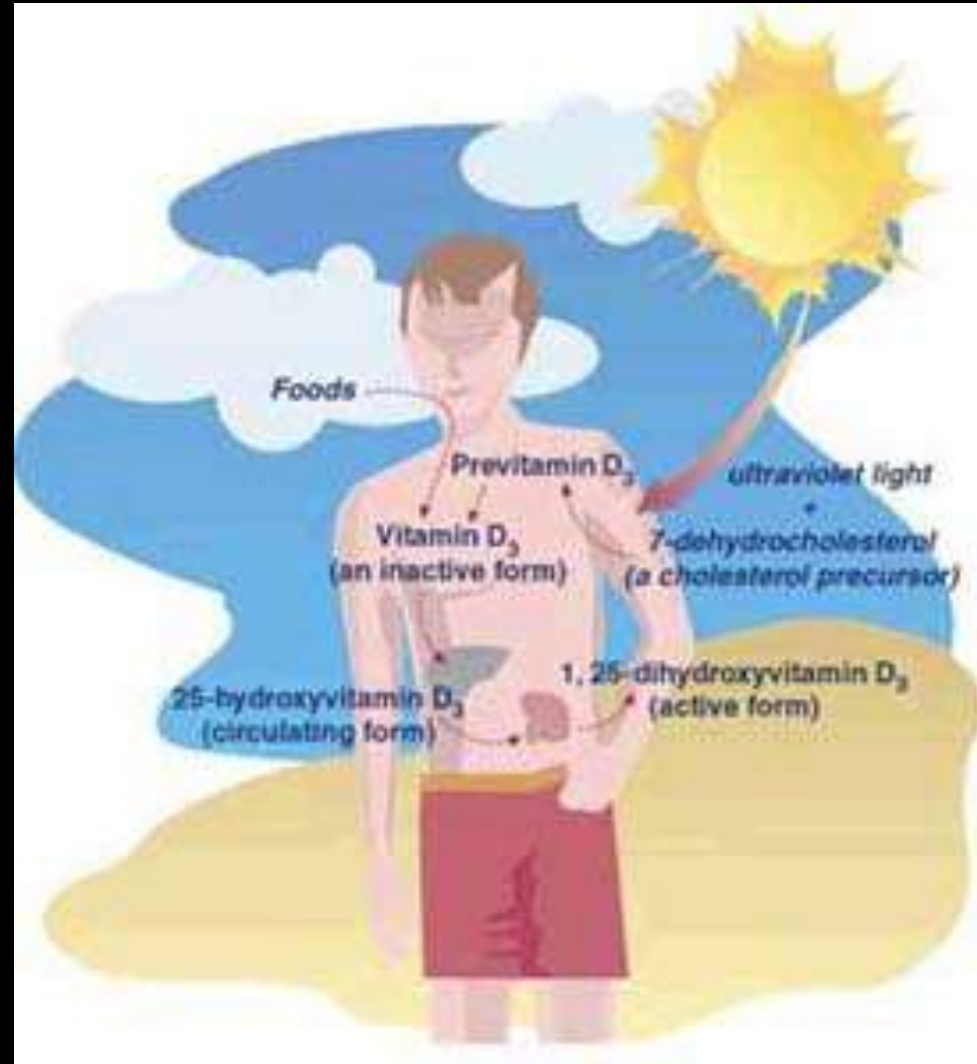
Used to kill
bacteria.
(Sterilization
of equipment)



Too much can cause skin cancer.
Use sun block to protect against
(UV rays)



Causes your skin to produce vitamin D (good for teeth and bones)

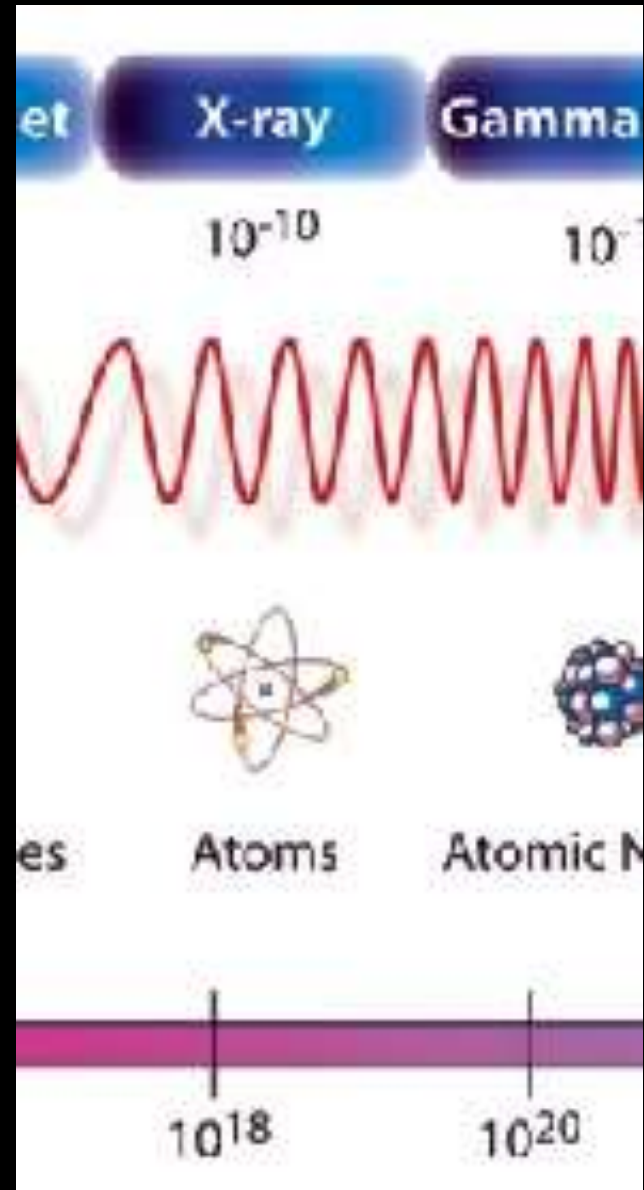


X- RAYS

Shorter
wavelength and
higher
frequency than
UV-rays

Carry a great
amount of
energy

Can penetrate
most matter.



Bones and teeth absorb x-rays. (The light part of an x-ray image indicates a place where the x-ray was absorbed)



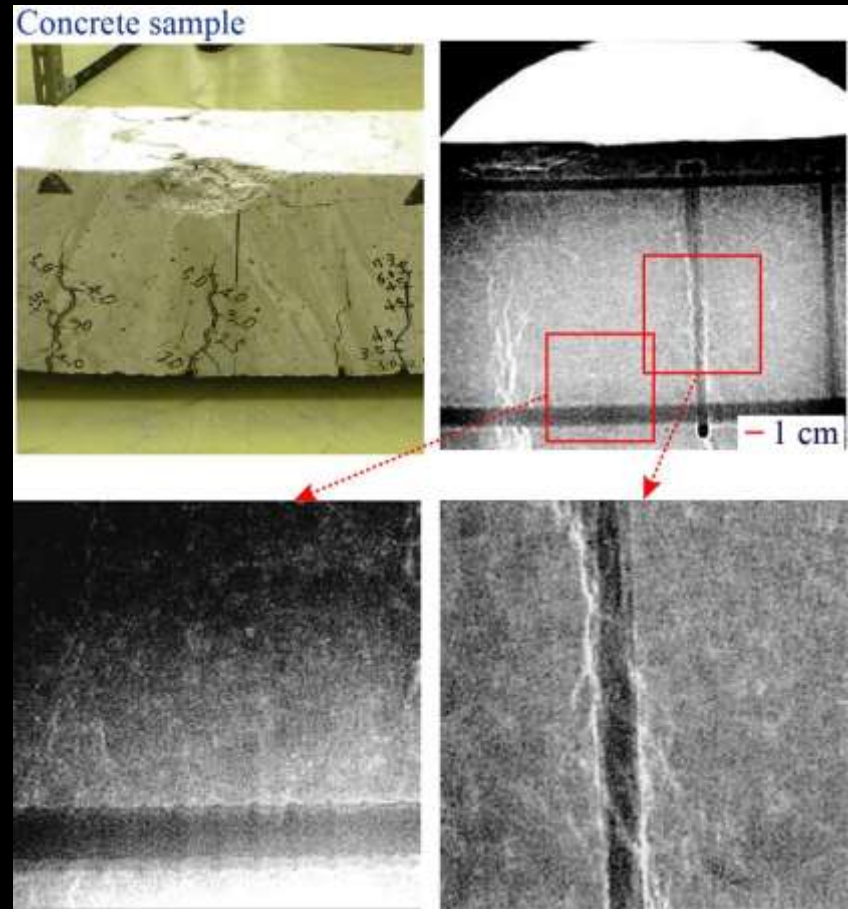
Too much exposure
can cause cancer

(lead vest at
dentist protects
organs from
unnecessary
exposure),
Airport security
uses to see
through your bags



Used by engineers to check for tiny cracks in structures.

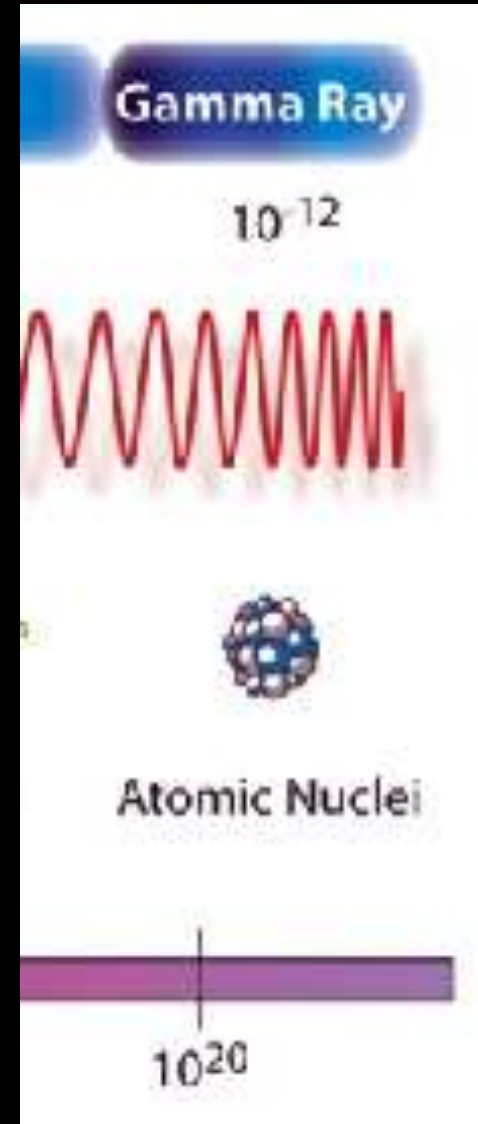
- The rays pass through the cracks and the cracks appear dark on film.



GAMMA RAYS

Shorter wavelength
and higher frequency
than X-rays

Carry the greatest
amount of energy
and penetrate the
most.



Used in radiation treatment to kill cancer cells.

Can be very harmful if not used correctly.



The Incredible
Hulk was the
victim of
gamma
radiation.



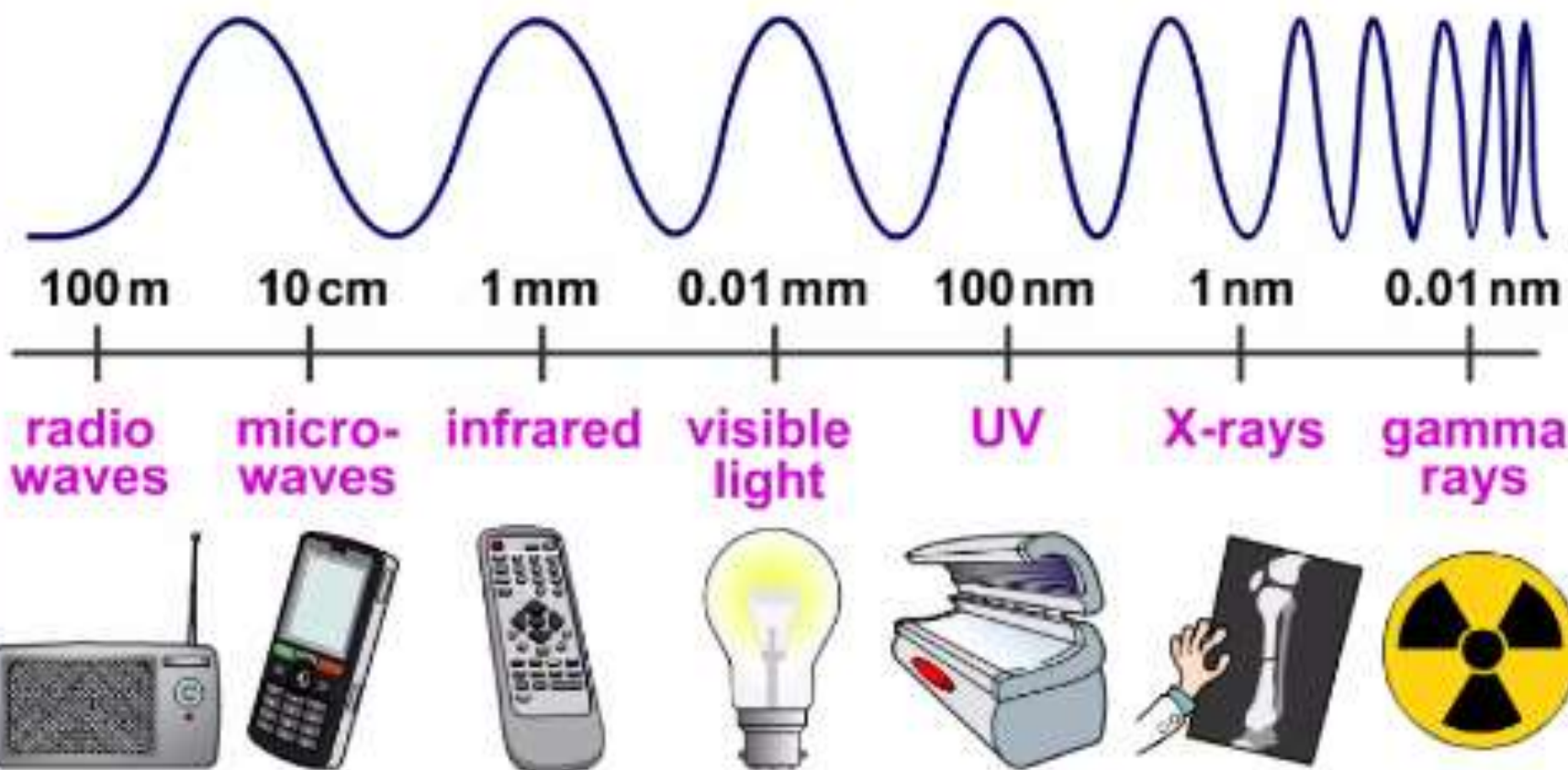
Exploding
nuclear
weapons emit
gamma rays.



Brief SUMMARY

- A. All electromagnetic waves travel at the same speed. (300,000,000 meters/second) in a vacuum.
- B. They all have different wavelengths and different frequencies.
- Long wavelength → lowest frequency
 - Short wavelength → highest frequency
 - The higher the frequency the higher the energy.

What are the properties of the electromagnetic spectrum?



?

