

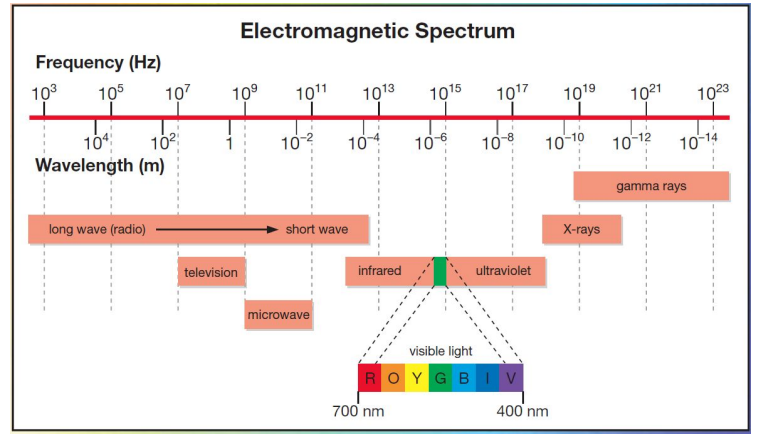
Science 30	Unit C: Physics
Lesson 10 - Electromagnetic Spectrum	84 mins

## Electromagnetic Spectrum

the wide band of different types of electromagnetic radiation ranging from radio waves to gamma rays

*Note that some of the individual bands of electromagnetic radiation overlap one another. This is because the same type of electromagnetic radiation can be used to accomplish a number of very different tasks. As an example, waves with a frequency between  $10^9$  and  $10^{11}$  Hz can be used for both communication (classified as radio waves) and for radar (classified as microwaves).*

- the nature of the source for each band
- the energy transmitted by each band
- the effects of each band on living tissue



## Radio Waves

- a type of electromagnetic radiation with a frequency less than 3000 GHz
- Doesn't penetrate well, so an external antenna is needed

Uses :

- Communication (FM (short wave) and AM (long wave))
- MRI (magnetic resonance imaging): internal images of organisms, using radio and magnetic fields. ( $\lambda = 4m$ )
- ELF (extremely low frequency): power lines 60Hz

## Microwaves

- a type of electromagnetic radiation with a frequency between 1 GHz and 100 GHz;
- Transmit more energy than radio

Uses :

- Radar
- Satellite (GPS)
- communications
- cooking food

## Infrared Radiation

- a type of electromagnetic radiation, with a frequency between  $3.0 \times 10^{11}$  Hz and  $4.3 \times 10^{14}$  Hz
- Transmit more energy than radio

Uses :

- increases the vibrations between molecules, resulting in heating effects
- Remotes for TVs

## WIFI

- a type of electromagnetic radiation, with a frequency between 2.5 GHz and 5GHz

Uses :

- Telecommunications and data transfer

## Visible Light

- The complete range of all colours of light that can

Uses :

be seen by the human eye: red, orange, yellow, green, blue, indigo, and violet; frequencies range from  $4.3 \times 10^{14}$  Hz to  $7.5 \times 10^{14}$  Hz

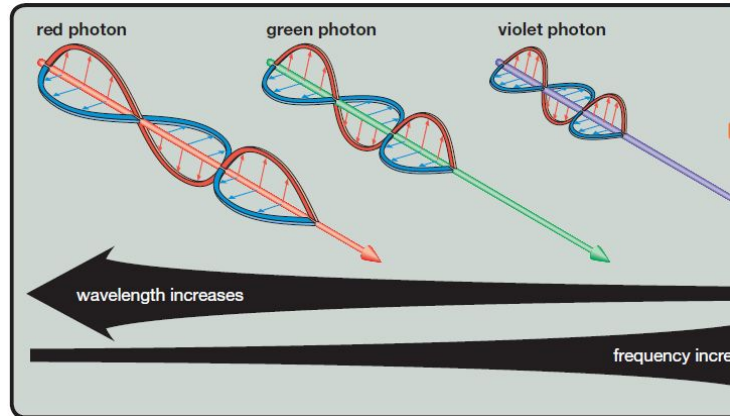
- (long) ROY-G-BIV (short)
- Generally comes from “hot” things (red “cool” blue “hot”)

Photon - a small bundle of electromagnetic energy

*A photon can behave like a particle in that it can collide and interact with an individual atom, but it has no mass because it is a tiny packet of electromagnetic energy. The energy of an individual photon depends upon the frequency of the radiation—the higher the frequency, the greater the energy of the photon.*

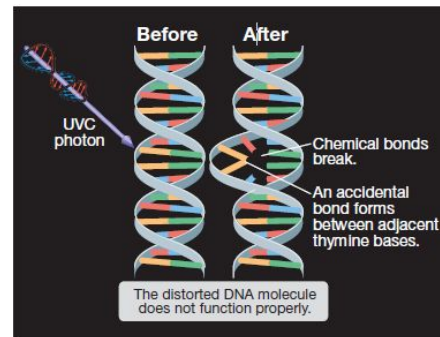
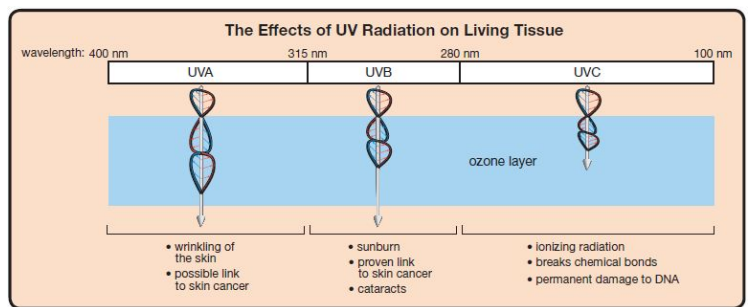
Red low energy, Blue high energy (think flames blue flame hot, red flame cooler)

- What you see
- Photosynthesis (uses the energy from blue and red photons) - why leaves are green (reflected)



### Ultraviolet Radiation (UV)

- a type of electromagnetic radiation, frequencies range from  $7.5 \times 10^{14}$  Hz to  $1 \times 10^{18}$  Hz
- emitted by very hot objects
- Some people refer to an ultraviolet light source as a “black light,” but the word black means the absence of light, so this is not really an accurate description. The best way to think of ultraviolet light is in terms of photons.
- ionizing radiation: high-energy radiation capable of ionizing the material through which it passes, leading to the formation of free radicals



### X-Ray

- high-energy electromagnetic radiation with a frequency between  $10^{18}$  and  $10^{21}$  Hz; can be produced when fast-moving electrons strike a metal target

Uses :

- Penetrates Tissue easily but not bone, can make pictures.

### Gamma Radiation

- the highest energy form of electromagnetic radiation with frequencies above  $10^{19}$  Hz; emitted from the nuclei of radioactive materials

Uses :

- radiation therapy: the medical use of ionizing radiation to treat disease, especially forms of cancer



# Science 30 - Lesson 34 - Unit C - Electromagnetic Spectrum

Name: \_\_\_\_\_

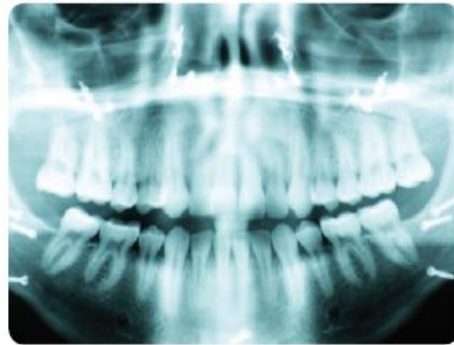
## Practice

- 1) Identify which part of a radio wave causes electrons in a car's antenna to vibrate.
  
- 2) In Chapter 1 you learned that metal objects can shield both electric and magnetic fields.
  - a) Explain why a car's antenna must be located outside the car or built into the windshield.
  
  - b) Explain why a car's radio is momentarily unable to receive a signal when the car travels under a highway overpass or in a mountain valley.
  
- 3) Many people enjoy speculating about the possibility of intelligent life inhabiting planets that orbit stars other than the Sun. It has been estimated that the first television shows broadcast in the mid-1900s would take about 50 years to reach all of the planets orbiting the nearest 400 stars to Earth. Estimate how far a radio wave containing a TV signal could travel in 50 years.
  
- 4) If WIFI and Microwave ovens use electromagnetic radiation with a frequency of 2500 MHz, calculate the wavelength. Why is WIFI safe and Microwaves not?
  
- 5) Explain the following statement.

When reheating a plate of food in a microwave oven, it is important not to leave a metal fork on the plate. The metal fork will act as an antenna for the microwaves in the oven, resulting in dangerous sparking.
  
- 6) Identify the characteristic of UV photons that makes them more hazardous to living tissue than photons of visible light.

- 7) Explain why the specialized light bulbs used for growing plants indoors tend to have a reddish-purple colour.
- 8) Explain why people who use tanning beds should wear protective goggles.

Use the picture below to answer the next 2 questions



- 9) Explain why the tiny screws appear white in the image.
- 10) Closely examine the teeth on the lower left of the picture. Describe the evidence that supports the idea that these teeth have soft tissue, like nerves and blood vessels, inside them.
- 11) An X-ray technician may deal with dozens of patients requiring X-rays every day. Explain why it is important for the technician to operate the X-ray machine from behind a shielded wall.
- 12) Ultrasound is the preferred imaging technology for checking the development of an unborn child. This technology produces images that can be displayed on a computer monitor. How do you know ultrasound is not ionizing radiation?
- 13) Explain why X-rays are not used to monitor the development of unborn children.