

Use the following information to answer question 13.

Cosmic radiation has a higher frequency than gamma radiation.

Diagram of a Gamma Ray



13. Which of the following diagrams, drawn to the same time scale as the diagram above, best represents a cosmic ray?

A.



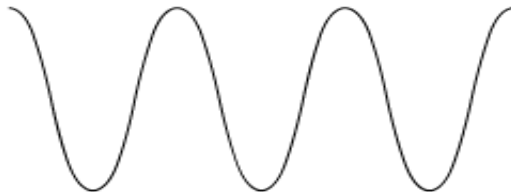
B.



C.



D.



Higher frequency means the number of waves increases

Sample Diploma Problem

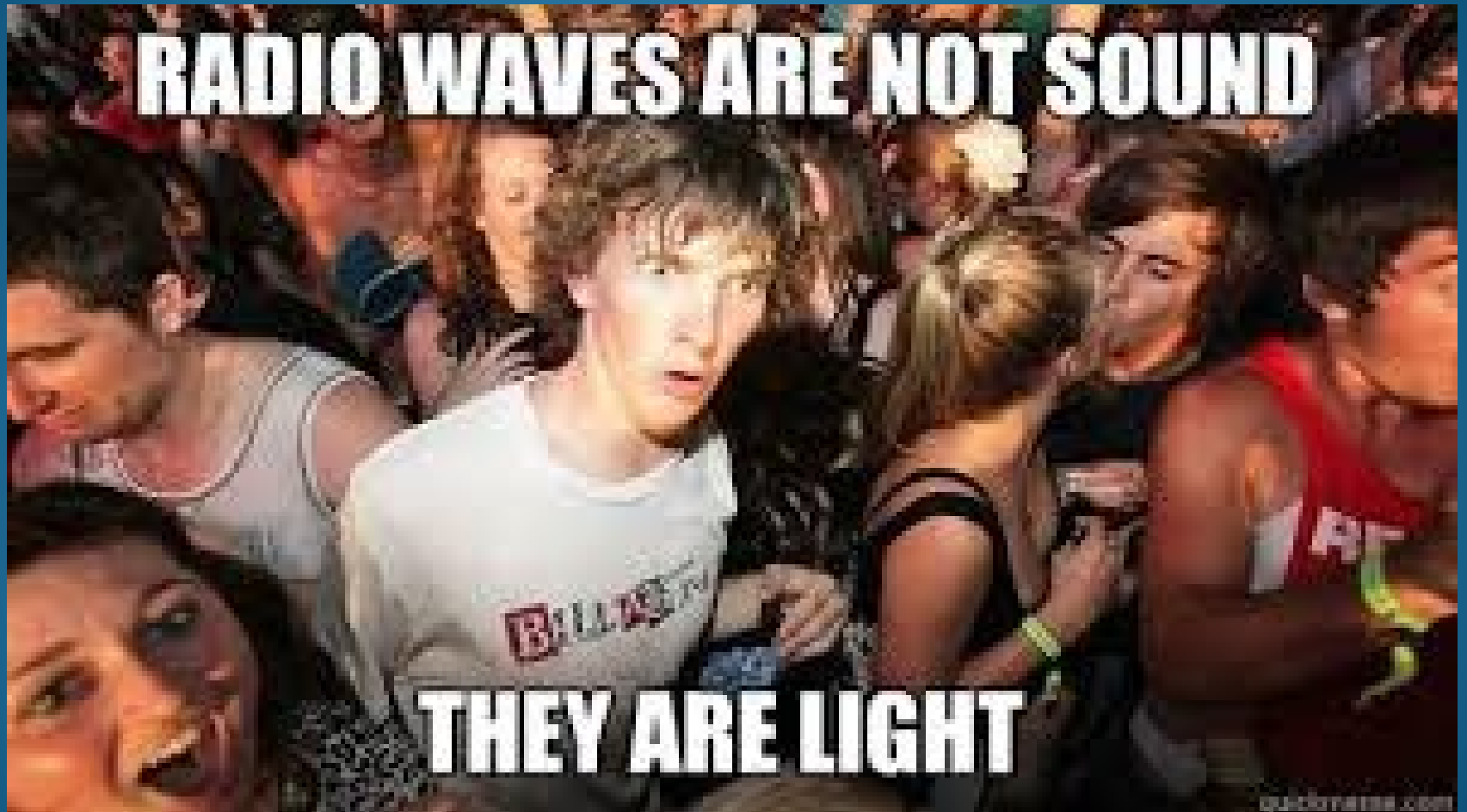
Numerical Response

10. Ultraviolet radiation with a frequency of 2.80×10^{17} Hz has a wavelength of $a.bc \times 10^{-d}$ m. The values of a , b , c , and d are $\frac{1}{a}$, $\frac{0}{b}$, $\frac{7}{c}$, and $\frac{9}{d}$.

(Record all four digits of your answer in the response boxes at the bottom of the screen.)

$$1.07 \times 10^{-9}$$

Types of Electromagnetic Radiation

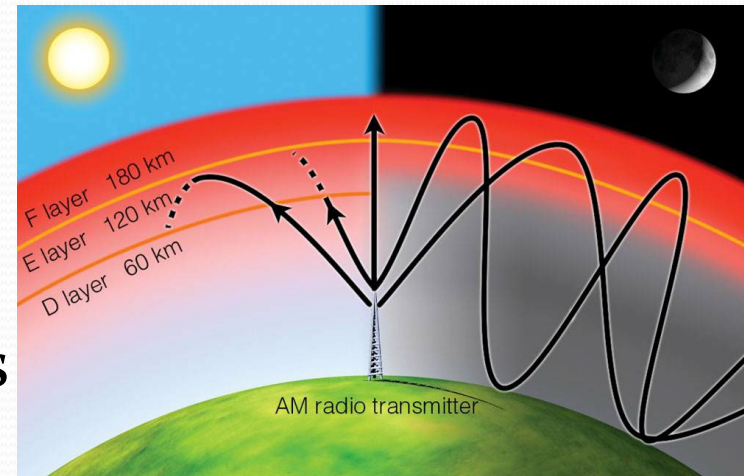


Curriculum

- describe the range of the electromagnetic spectrum from long, low-frequency radio waves through microwaves, infrared (IR) rays, visible light rays and ultraviolet (UV) radiation to very short, high-frequency waves, such as X-rays and gamma rays
- compare and contrast, to each other, the various constituents of the electromagnetic spectrum, on the basis of source, frequency, wavelength and energy, and their effect on living tissue
- recognize that Earth's atmosphere absorbs certain frequencies of EMR

Radio Waves

- Smallest frequency, biggest wavelength, lowest energy
- Because they are the lowest energy, they are unable to penetrate metal objects and an external antenna is required
- When the EMR enters the antenna, it causes its electrons to vibrate and the signal is decoded by the circuitry
- Used in communication
- This EMR has almost no effect on living tissue and is safe to be around in all situations



Microwaves

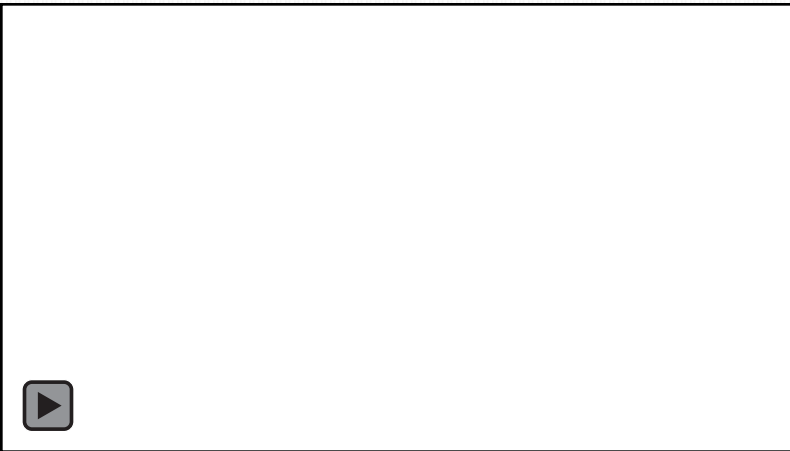
- Microwaves used in microwave ovens are set to 2450 MHz
- This is the frequency where water molecules start to vibrate, which warms your food
- Sending out microwaves at this frequency would be hazardous because living tissue has a large proportion of water
- Higher frequency microwaves can penetrate rain, snow, smoke and makes them great for radar or satellite

Example

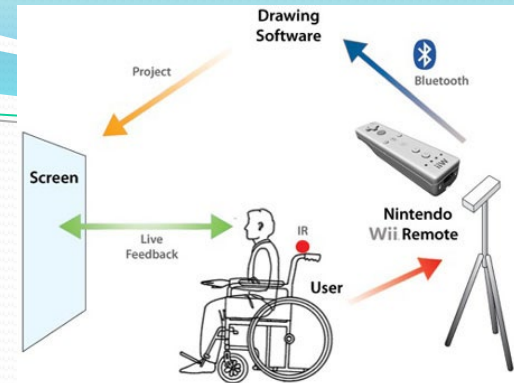
$$c = f\lambda$$

- Microwaves have a frequency of 2450 MHz, calculate their wavelength

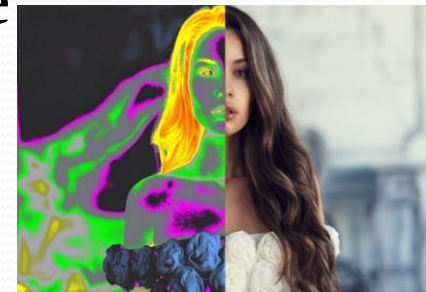
Infrared (IR)



Infrared (IR)



- Wavelengths are a little bigger than visible light and not detectable to the human eye
- **False color images** is what are produced when light is seen through an IR camera
- Nerves on our body are sensitive to these frequencies and that's why we can feel heat
- Remote controls for televisions are in the IR frequency
- It is advantageous for humans to be sensitive to these frequencies as hot things can burn us and can be a hazard



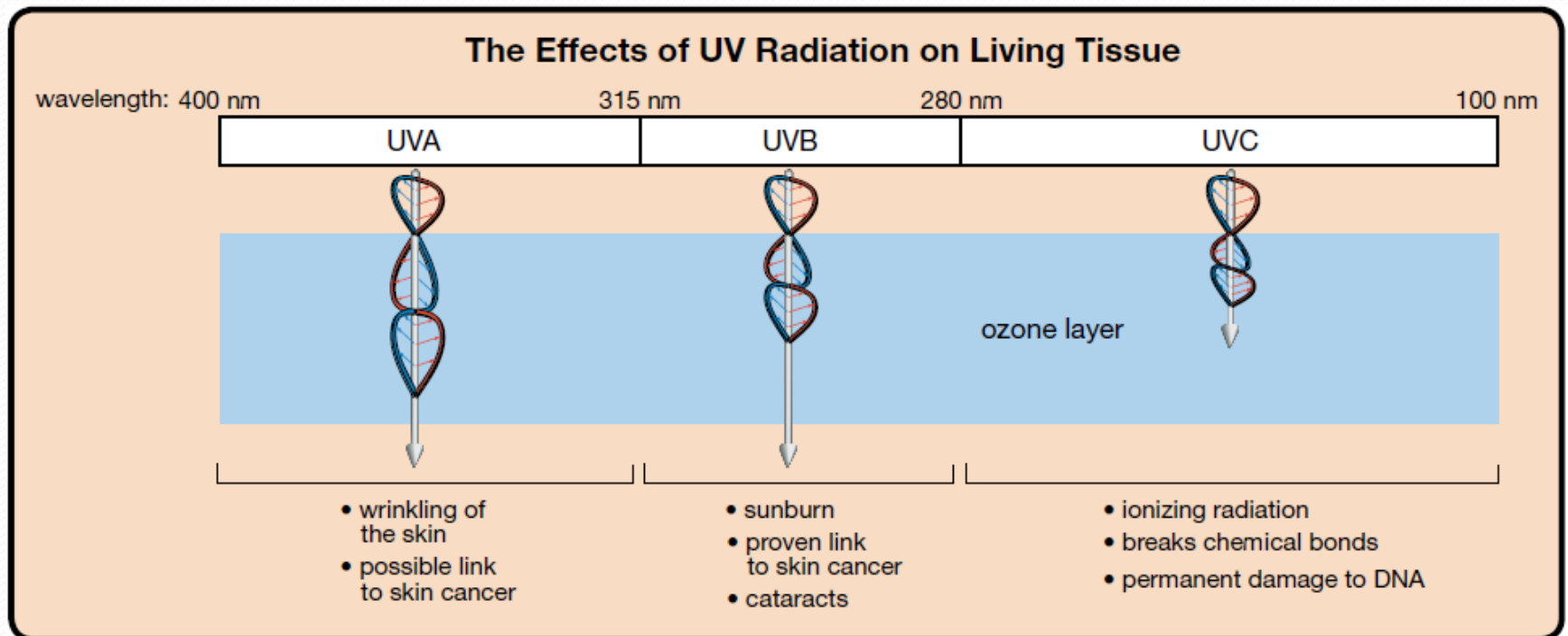
Visible Light

- We can only see light that is 400nm to 700nm
- Red is the biggest wavelength, lowest frequency, and lowest energy
- Einstein was the first person to classify light as photons, which are particles with their own frequencies



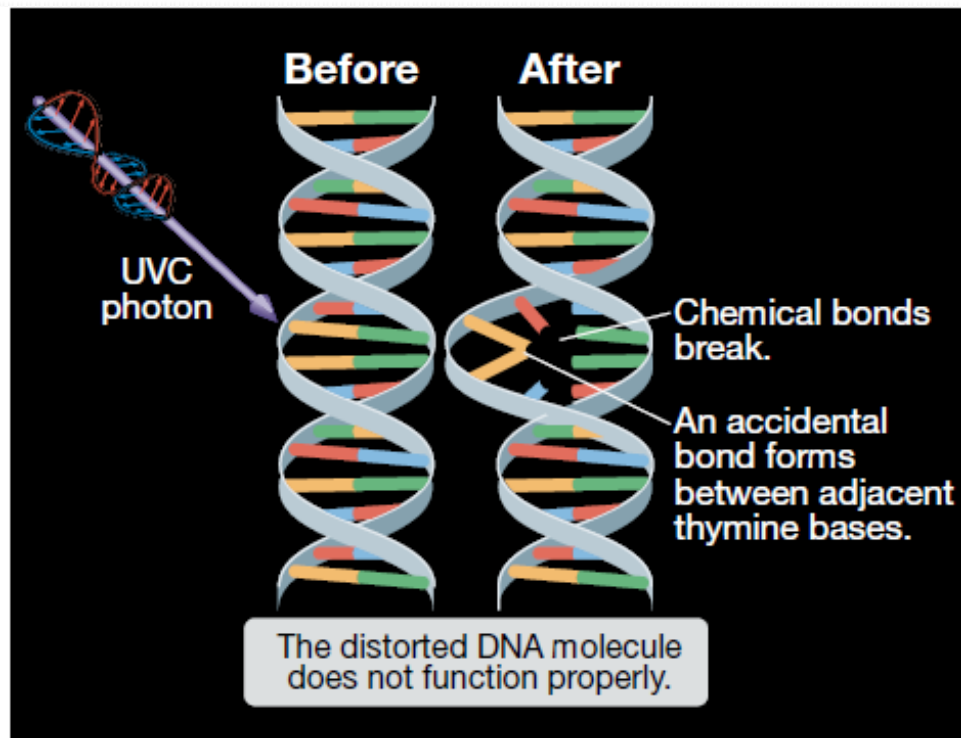
Ultraviolet Radiation (UV)

- These have a higher energy than visible light
- Can be broken up into different categories based on their wavelength



Ionizing Radiation

- **Ionizing radiation** is high energy radiation capable of ionizing material through which it passes, leading to the formation of free radicals, which can cause DNA to break



X Rays

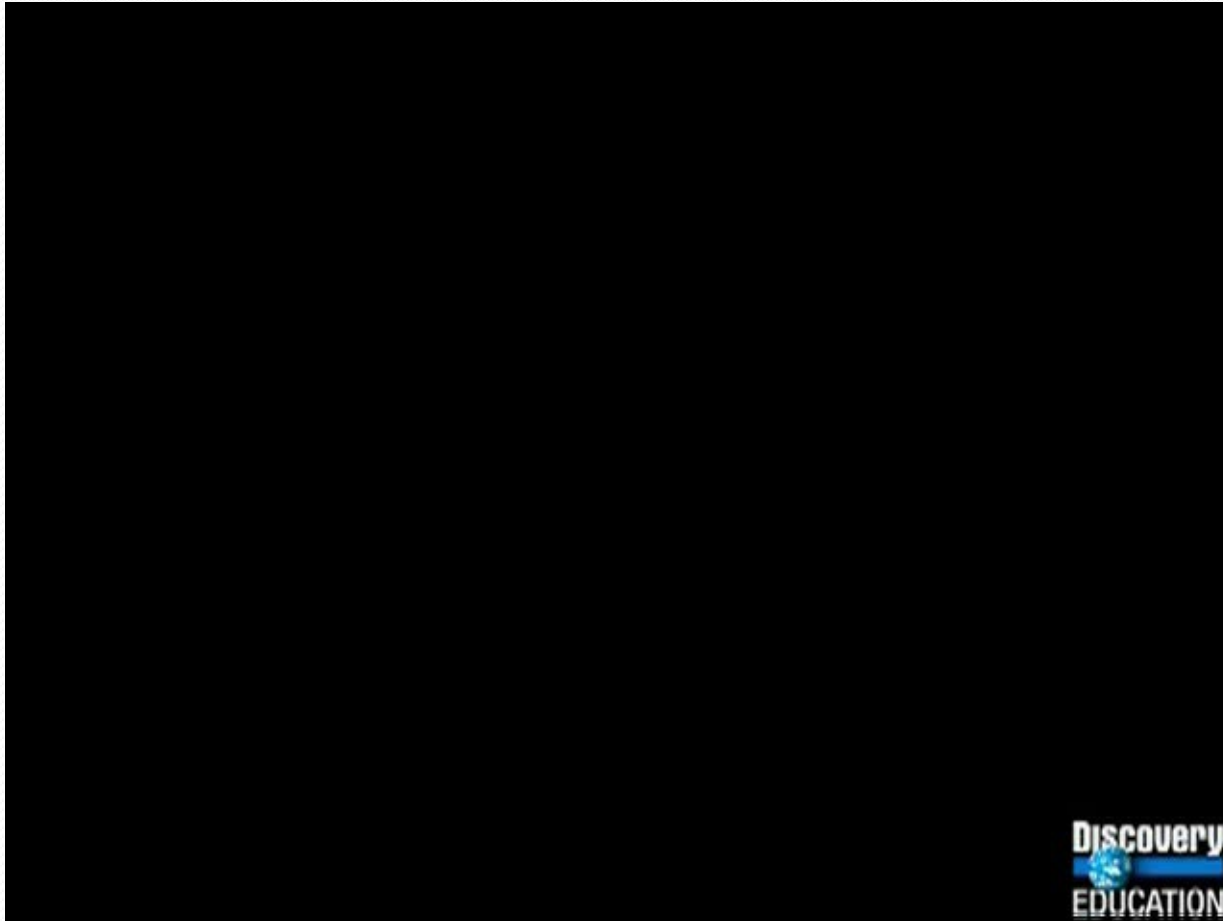
- X rays are produced by smashing fast moving electrons into metal plates
- X rays are able to penetrate tissue
- The denser the tissue, the more x rays are absorbed
- Skin and fat appears black because it doesn't absorb any and teeth and bones absorb a lot so they are white



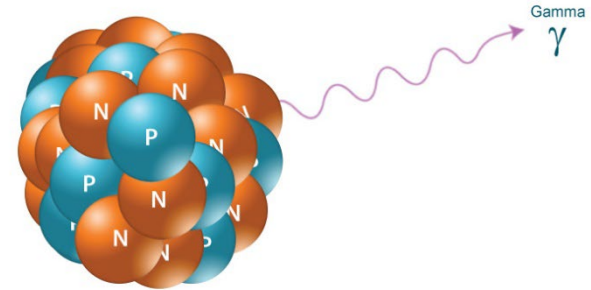
ALARA

- X ray radiation is ionizing and can damage your DNA
- Benefits for seeing inside of your body with negative effects of X rays must be balanced
- ALARA: As low as reasonably achievable
- Doctors will always try to limit your exposure to radiation as much as possible
- Rapidly dividing cells like in a fetus are especially susceptible to radiation
- **Radiation therapy** is when a beam of X rays is shot at cancer to kill them

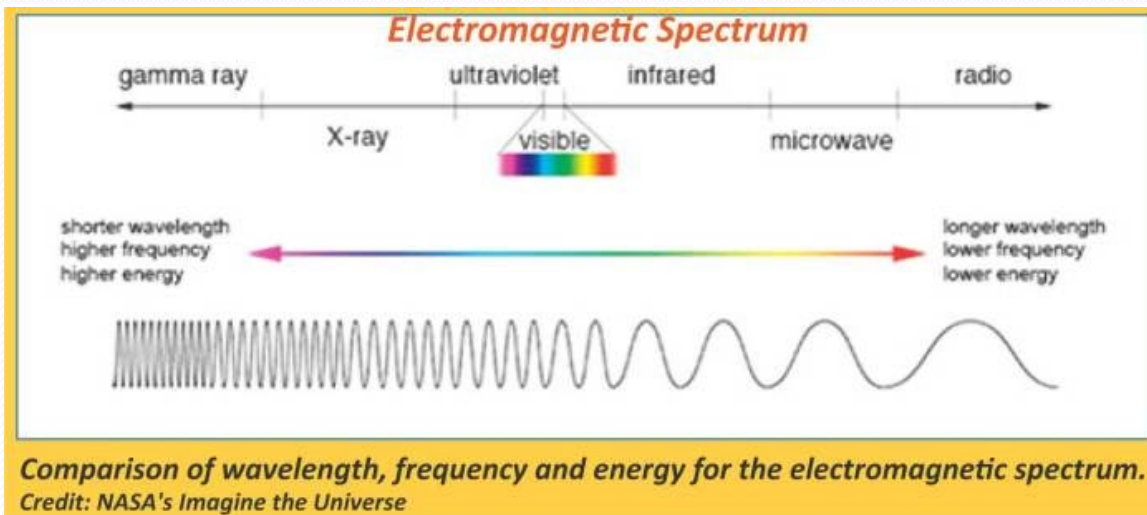
X rays 6 min



Gamma Radiation



- Only found emitted from radioactive materials
- These have the highest frequency, highest energy, smallest wavelength
- They are excellent at penetrating matter
- They come from the nuclei of atoms



Atmospheric Interactions

- The atmosphere absorbs and reflects different wavelengths at different rates

