Electromagnetic waves and uses of EM waves

Properties of EM Waves

- Electromagnetic waves are defined as:

"Transverse waves that transfer energy from the source of the waves to an absorber"

- All electromagnetic waves share the following properties:

1. They are all **transverse**
2. They can all travel through a **vacuum**
3. They all travel at the **same speed** in a vacuum

- There are 7 types of electromagnetic waves, which all together form a **continuous spectrum**

The EM Spectrum

- The electromagnetic spectrum is arranged in a specific order based on the wavelengths or frequencies

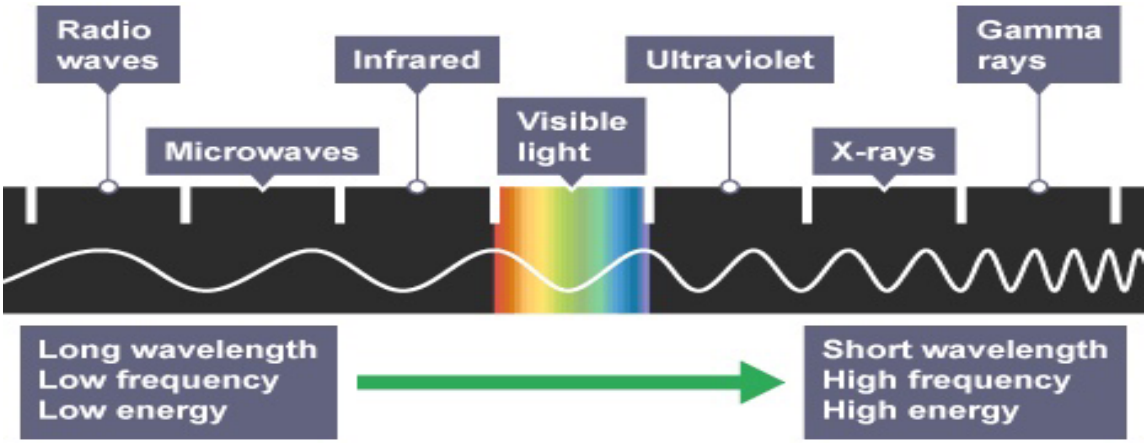
- The **higher** the **frequency**, the higher the **energy** of the radiation

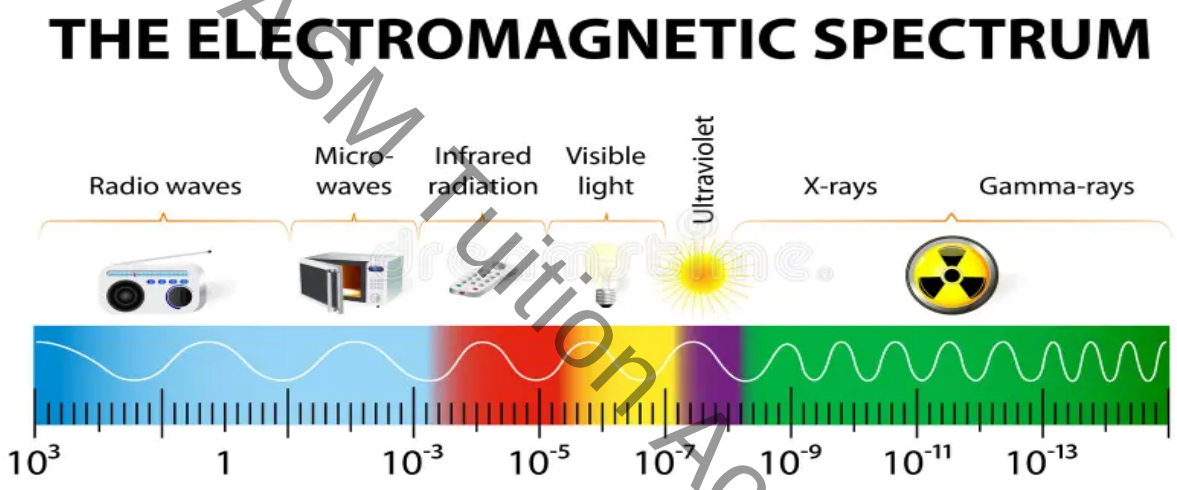
- Radiation with higher energy is:

1. Highly ionising
2. Harmful to cells and tissues causing cancer (e.g. UV, X-rays, Gamma rays)

- Radiation with lower energy is:

1. Useful for communications
2. Less harmful to humans





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Visible Light

- Visible light is defined as

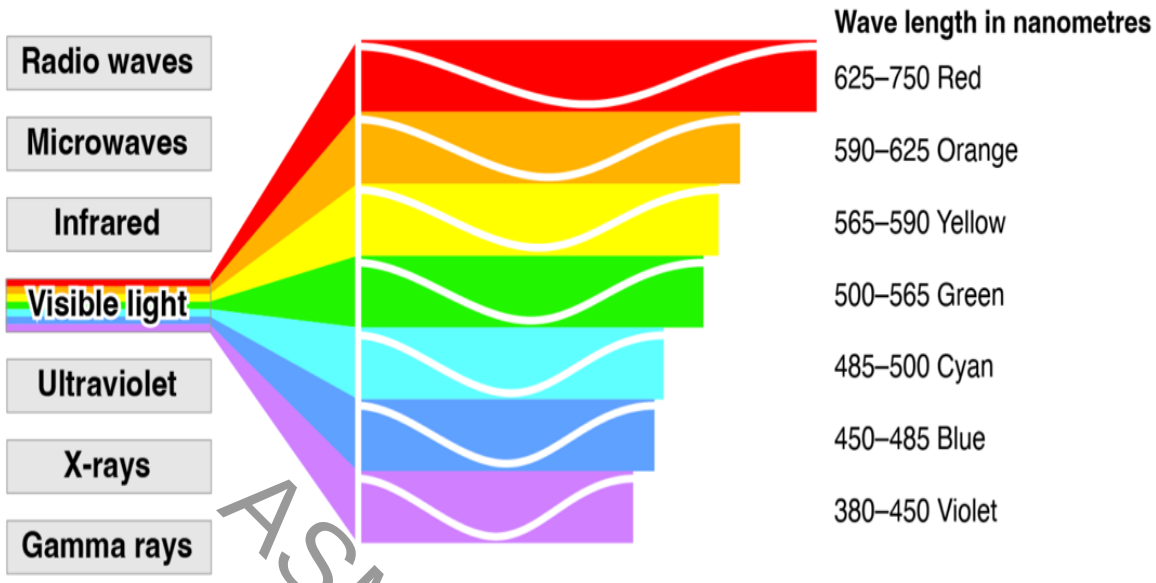
  "**the range of wavelengths which are visible to humans**"

- Visible light is the **only** part of the spectrum detectable by the human eye
- In the natural world, many animals, such as birds, bees and certain fish, are able to perceive beyond visible light and can see infra-red and UV wavelengths of light

Different colours have Different wavelengths

The different colours of waves correspond to different wavelengths:

- **Red** has the **longest** wavelength (and the lowest frequency and energy)
- **Violet** has the **shortest** wavelength (and the highest frequency and energy)

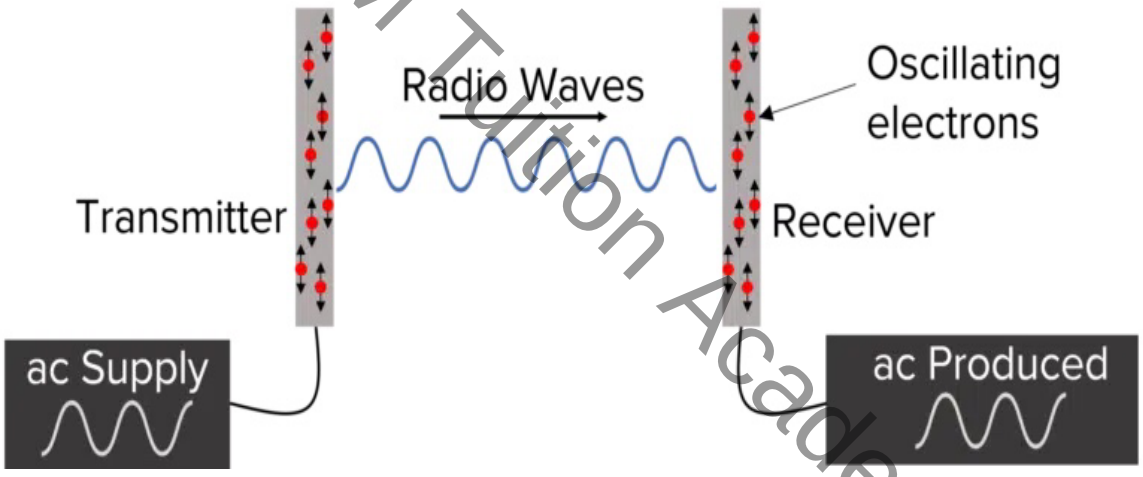


Radio Waves:

Radio waves are electromagnetic waves with wavelength longer than 10cm. They used to transmit the signals to radios, television and Bluetooth communications devices.

Transmitting Radio Waves

- **Radio waves** can be produced by **oscillating charges**. These oscillating charges produce **oscillating electric and magnetic fields i.e. electromagnetic waves.**
- We can make oscillating charges using an **alternating current (ac)**.
- The **frequency of the radio waves** produced depends on the **frequency of the alternating current**.
- The ac supply causes electrons in the transmitter to oscillate. These electrons produce radio waves which are transmitted over as distance. At the receiver, the radio waves cause electrons to oscillate. The electrons produce an ac current in the receiver.



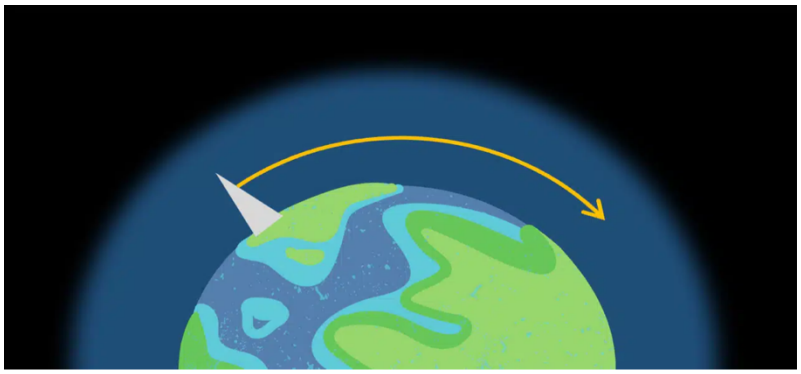
Uses of Radio Waves

In general, radio waves are electromagnetic waves with wavelength longer than 10 cm, however they can also be split into different types of radio waves according to their **wavelengths**. Each type of radio wave has different uses.

1. Long-wave Radio Waves

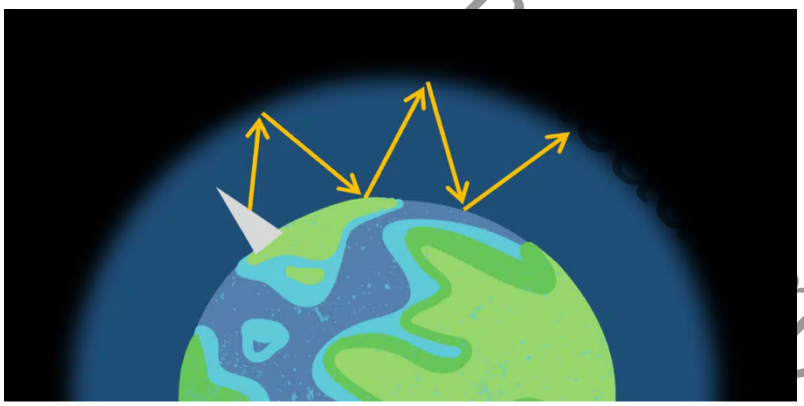
- Long-wave radio waves have wavelengths between **1 -10 km**.
- These radio waves diffract around large objects such as hills, tunnels and the curved surface on the Earth.

- Long-wave radio waves can transmit signals to a receiver that is not in the line **of sight** of the transmitter and therefore they can be used for **long-range communications**.



2. Short-wave Radio Waves

- Short-wave radio waves have wavelengths between **10 -100 m**.
- These waves do not diffract around large objects however they **reflect** off the **ionosphere** (an electrically charged layer of gas in the upper atmosphere).
- This also allows communication with transmitters or receivers that are not in the **line of sight**.
- Bluetooth communication devices also use short-wave signals to transfer radio waves over short distances.



3. TV and FM Radio Signals

- Radio waves used to transmit signals for TV and radio use **very short wavelengths**.
- These waves do not diffract around large objects or reflect off the ionosphere and so the transmitter and receiver need to be in the **line of sight** of one another.
- the signals does not bend or travel far through buildings