

Keyword	Definition
<b>electromagnetic waves</b>	A group of waves that all travel at the same speed in a vacuum, and are all transverse.
<b>frequency</b>	The number of vibrations (or the number of waves) per second. One hertz (Hz) is one wave per second.
<b>infrared (IR)</b>	EM radiation that has a longer wavelength than visible. We can feel infrared radiation as warmth.
<b>interface</b>	The boundary between two materials.
<b>refraction</b>	The change in direction when a wave goes from one medium to another.
<b>transverse wave</b>	A wave in which the vibrations are at right angles to the direction the wave is travelling.
<b>ultraviolet (UV)</b>	EM radiation that has a shorter wavelength than visible light. Used to detect forged bank notes.
<b>vacuum</b>	A place where there is no matter at all.
<b>visible light</b>	Electromagnetic waves that can be detected by the human eye.
<b>gamma rays</b>	Electromagnetic radiation with the shortest wavelengths and highest frequencies.
<b>microwaves</b>	Electromagnetic radiation with a longer wavelength than infrared radiation but a shorter wavelength than radio waves.
<b>radio waves</b>	Electromagnetic radiation with the longest wavelengths and lowest frequencies.
<b>visible spectrum</b>	Electromagnetic waves that the human eye can detect. The colours that make up white light (red, orange, yellow, green, blue, indigo, violet).
<b>X-rays</b>	Electromagnetic radiation that has a shorter wavelength than ultraviolet radiation but a longer wavelength than gamma rays.
<b>oscillations</b>	Movements back and forth. In radio aerials, oscillations are repeated changes in voltage and current.
<b>Mutation</b>	A change in the DNA instructions in a cell.

Key facts to remember:

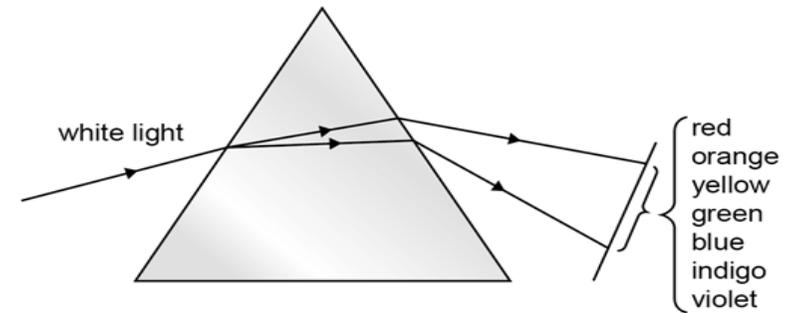
All EM (electromagnetic) waves are transverse waves.

All EM waves travel at the same speed (velocity) through a vacuum (space) at 300 million m/s.

EM waves are grouped based on their wavelengths and frequency. There are 7 basic EM waves. Radio waves, microwaves, infrared, visible light, UV, Xrays , gamma waves.

Our eyes can only detect a small part of this spectrum –visible light.

Different colours of light have different wavelengths from **longest to shortest: red, orange, yellow, green, blue, indigo, violet.** (ROYGBIV) or pneumatic; Richard Of York Gave Battle In Vain)



## Wave Speed Equation

wave speed (m/s) = frequency (Hz) × wavelength (

$$v = f \times \lambda$$



Short wavelength,  
 high frequency



Long wavelength,  
 low frequency

Part of EM spectrum	Uses of EM waves	Dangers of EM Waves
<b>Gamma rays</b>	Sterilising food and medical equipment. Detection of cancer and treatment of cancer	mutation or damage to cells in the body
<b>X-rays</b>	Observing the internal structure of objects, airport security scanners, medical x-rays	
<b>UV</b>	Security marking, fluorescent lamps, detecting forged bank notes, disinfecting water	damage to surface cells & eyes, leading to skin cancer and eye conditions. Sunburn.
<b>Visible light</b>	Vision, photography, illumination	
<b>Infrared</b>	cooking, thermal imaging, short range communications, optical fibres, television remote controls, security systems	skin burns
<b>microwaves</b>	cooking, communications and satellite transmissions	internal heating of body cells
<b>Radio waves</b>	broadcasting, communications, satellite transmissions	

To Remember

Potential danger increases with increasing frequency

Radio waves have the **LOWEST** frequencies and **LONGEST** wavelengths.  
 Gamma waves have the **HIGHEST** frequencies and **SHORTEST** wavelengths.

**Practise questions:**  
 All the long waves in the electromagnetic spectrum are used in communication. Which part (or parts) of the electromagnetic spectrum is used:  
 a) to transmit mobile phone signals  
 b) to transmit radio and TV broadcasts  
 c) to send information along optical fibres  
 d) by lighthouses to warn ships of danger  
 e) to send remote control signals to TVs?

**GCSE 6 mark question:**  
 Infrared and ultraviolet waves have different frequencies. Both types of wave can have harmful effects on humans.  
 Compare and contrast the harmful effects of infrared and ultraviolet waves.

## HIGHER ONLY- Long Wavelengths

### EM waves for Communication

Radio waves are transmitted easily through air. They do not cause damage if absorbed by the body. They can also be reflected to change their direction.

#### How radio waves are produced:

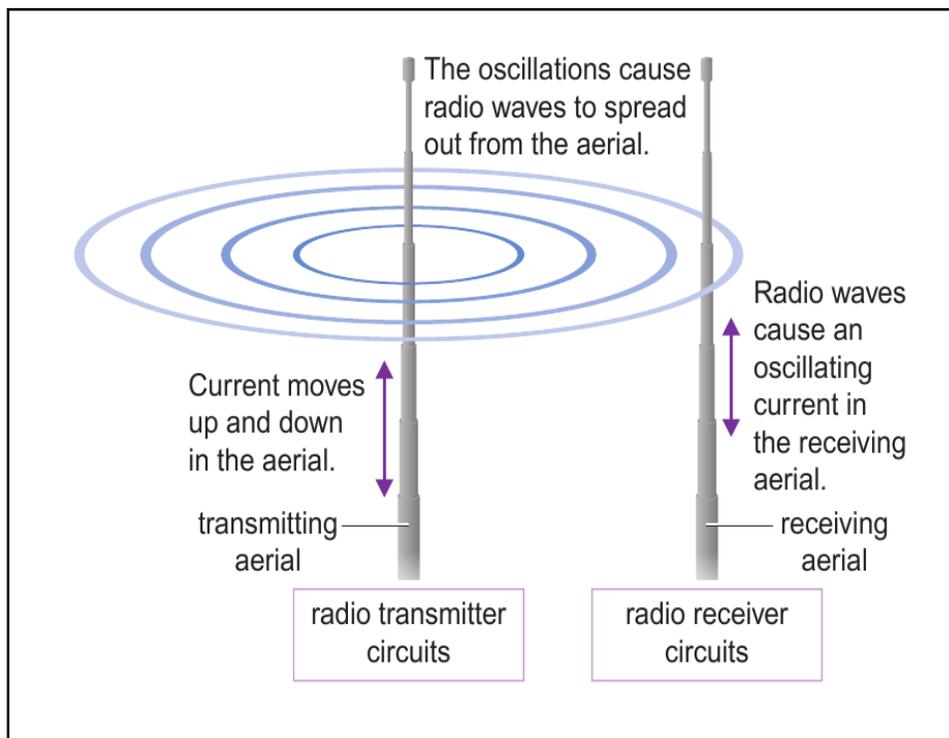
Radio waves are produced by oscillations in electrical circuits. AC are made up of oscillating charges. As the charges oscillate, they produce oscillating electric and magnetic fields. A metal rod can be used as an aerial to receive radio waves. The radio waves are absorbed by the metal and cause oscillations in electric circuits connected to the aerial.

#### Discovering infrared:

Herschel (1738-1822) put dark, coloured filters on his telescope to help observe the sun safely. He noticed different coloured filters heated up the telescope to different extents. He used a prism to split sunlight into a spectrum and put a thermometer in each of the colours in turn.

#### Practise GCSE question questions:

Describe how are radio waves are produced and detected?



#### Useful websites:

schoolgy

<https://members.gcsepod.com/shared/podcasts/title/11121>