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A-Level

Physics

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Chapter- wave

Electromagnetic Wave



- Visible light is just one part of a much bigger spectrum: The Electromagnetic Spectrum
- All electromagnetic waves have the following properties in common:
 - They are all **transverse** waves
 - They can all travel in a **vacuum**
 - They all travel at the **same speed** in a vacuum (free space) — the speed of light $3 \times 10^8 \text{ ms}^{-1}$
- The speed of light in air is approximately the same



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- These transverse waves consist of electric and magnetic fields oscillating at right angles to each other and to the direction in which the wave is travelling (in 3D space)
- Since they are transverse, all waves in this spectrum can be reflected, refracted, diffracted, polarised and produce interference patterns

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Uses of electromagnetic waves



WAVE	USE
RADIO	<ul style="list-style-type: none">• COMMUNICATION (RADIO AND TV)
MICROWAVE	<ul style="list-style-type: none">• HEATING FOOD• COMMUNICATION (WIFI, MOBILE PHONES, SATELLITES)
INFRARED	<ul style="list-style-type: none">• REMOTE CONTROLS• FIBRE OPTIC COMMUNICATION• THERMAL IMAGING (MEDICINE AND INDUSTRY)• NIGHT VISION• HEATING OR COOKING THINGS• MOTION SENSORS (FOR SECURITY ALARMS)
VISIBLE LIGHT	<ul style="list-style-type: none">• SEEING AND TAKING PHOTOGRAPHS/VIDEOS
ULTRAVIOLET	<ul style="list-style-type: none">• SECURITY MARKING (FLUORESCENCE)• FLUORESCENT BULBS• GETTING A SUNTAN.
X-RAYS	<ul style="list-style-type: none">• X-RAY IMAGES (MEDICINE, AIRPORT SECURITY AND INDUSTRY)
GAMMA RAYS	<ul style="list-style-type: none">• STERILISING MEDICAL INSTRUMENTS• TREATING CANCER

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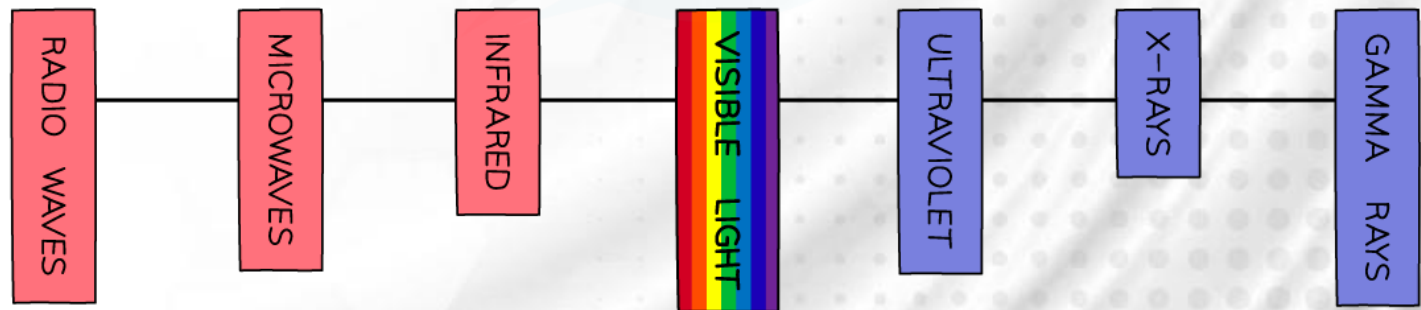
From Radio waves to Gamma rays



THE ELECTROMAGNETIC SPECTRUM

LOWER ENERGY
LONG WAVELENGTH
LOW FREQUENCY

HIGHER ENERGY
SHORT WAVELENGTH
HIGH FREQUENCY



- The electromagnetic spectrum is arranged in a specific order based on their wavelengths or frequencies
- This order is shown in the diagram below from longest wavelength (lowest frequency) to shortest wavelength (highest frequency)
- The higher the frequency, the higher the energy of the radiation.
- Radiation with higher energy is highly ionizing and is harmful to cells and tissues causing cancer.

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Radiation	Approximate wavelength range / m	Approximate frequency range / Hz
Radio	> 0.1	$< 3 \times 10^9$
Microwaves	$0.1 - 1 \times 10^{-3}$	$3 \times 10^9 - 3 \times 10^{11}$
Infra-red	$1 \times 10^{-3} - 7 \times 10^{-7}$	$3 \times 10^{11} - 4.3 \times 10^{14}$
Visible	$4 \times 10^{-7} - 7 \times 10^{-7}$	$7.5 \times 10^{14} - 4.3 \times 10^{14}$
Ultra-violet	$4 \times 10^{-7} - 1 \times 10^{-8}$	$7.5 \times 10^{14} - 3 \times 10^{16}$
X-rays	$1 \times 10^{-8} - 4 \times 10^{-13}$	$3 \times 10^{16} - 7.5 \times 10^{20}$
Gamma rays	$1 \times 10^{-10} - 1 \times 10^{-16}$	$3 \times 10^{18} - 3 \times 10^{24}$

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- To alternatively find the range of frequencies, convert the wavelengths using the wave equation: $c = f\lambda$ where c is the speed of light: $3.0 \times 10^8 \text{ m s}^{-1}$

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- Visible light is defined as the range of wavelengths (400 – 700 nm) which are visible to humans
- Visible light is the only part of the spectrum detectable by the human eye
 - However, this is only 0.0035% of the whole electromagnetic spectrum
- 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

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**Thank
you!**