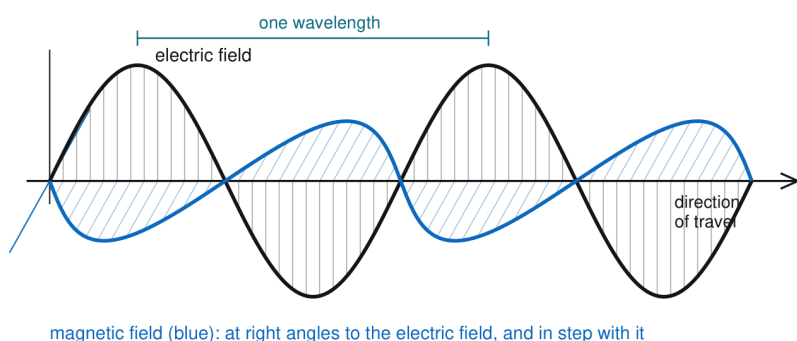


Electromagnetic spectrum

Typed version of the handwritten class notes (20 October 2020). The original handwritten pages are on the same page of megalecture.com.

What an electromagnetic wave is

An electromagnetic wave is a wave which consists of oscillating electric and magnetic fields.



Properties

- Electromagnetic waves are **transverse** waves.
- Electromagnetic waves are **progressive** waves: they physically move from one place to another.
- They transfer energy from one place to another.
- They can travel through any medium, including a vacuum.
- All electromagnetic waves travel at the speed of light, 3×10^8 m/s, in a vacuum (and very nearly that in air).
- All electromagnetic waves follow the wave equation $v = f\lambda$.
- When an electromagnetic wave travels from one medium to another, its speed and wavelength change but its frequency remains unchanged.
- The frequency of a wave is set by its source.
- They obey the laws of reflection and the laws of refraction.
- They do not carry any charge or have mass (mass and charge are properties of particles).



The spectrum

From the shortest wavelength (highest frequency) to the longest wavelength (lowest frequency):

Wave	Typical frequency
Gamma rays	10^{21} Hz
X-rays	10^{18} Hz
Ultraviolet rays	10^{15} Hz
Visible light	10^{14} Hz
Infra-red radiation	10^{13} Hz
Microwaves	10^{10} Hz
Radio waves	10^4 Hz

Memory aid (from radio waves to gamma rays): **R**aw **M**eal **I**s **V**ery **U**nsanitary, **E**xcept **G**iraffe.
Radio, Microwaves, Infra-red, Visible, Ultraviolet, X-rays, Gamma.

- Learn the frequencies.
- You can calculate the wavelength using the formula $v = f\lambda$, so $\lambda = (3 \times 10^8) \div f$.

Uses of electromagnetic waves

1. Radio waves

- Used to broadcast radio and television signals.
- Transferred from transmitters to receivers over several kilometres.

2. Microwaves

- Used to transmit satellite television signals and mobile phone signals over very long distances, because they have a very high range.

3. Infra-red waves

- Infra-red radiation is used in the remote control of devices.
- Grills and toasters also use infra-red radiation.

4. Visible light

- Optical fibres use visible light to transfer digital signals from one place to another over long distances.
- Telephones.

5. Ultraviolet radiation

- Used to sterilise medical equipment, as it destroys micro-organisms.
- Sunbeds.

6. X-rays

- Used in security scanners and for detecting cracks in metal.
- Also used in medicine to produce a two-dimensional image of the inside of the body.

7. Gamma rays

- Used in medicine to kill tumours and cancer cells.
- Engineering applications, such as detecting cracks in metal.

Checked by Mega Lecture

This typed version was checked against the Cambridge O Level Physics (5054) syllabus. Changes from the handwritten notes: the infra-red frequency (written as 10^9 Hz) and the microwave frequency (written as 10^6 Hz) are replaced by typical values, 10^{13} Hz and 10^{10} Hz; "in a vacuum" is added to the speed of light; "They have fixed frequencies" is reworded. Everything else follows the handwritten notes. Spotted a mistake? Tell us on WhatsApp: +92 336 780 1123.