Waves

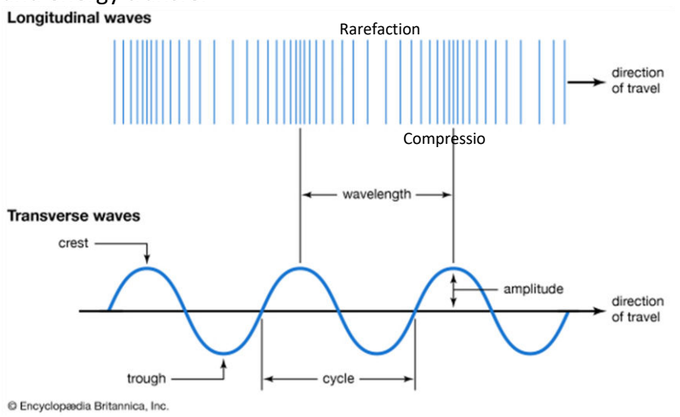
Key term	Definition
Amplitude	Displacement of wave motion from undisturbed position
Wavelength	Length of one complete wave to same point on adjacent wave in metres
Frequency	Number of oscillations per second or waves passing a point per second measured in Hertz
Oscillation	A regular periodic motion or change
Period	The time taken for one complete oscillation
Absorb	Energy taken in from a wave by a material, heating it
Transmit	Energy passing through a material as a wave
Reflect	Wave bounces off a material
Refract	Wave changing direction due to changing speed
Emit	Energy being released by an object as a wave

Wv 01

Transverse & Longitudinal Features

A

Transverse wave motion is **perpendicular** to the direction of travel and energy transfer.
Longitudinal wave motion is **parallel** to the direction of travel and energy transfer



Transverse wave examples – Light, water surface, plucked string, slinky, seismic S-waves
Longitudinal wave examples – Sound, slinky, seismic P-waves

Required Practicals

1) Wave speed - measuring wave speed, frequency, wavelength in liquid (ripple tank) and solid (string)
2) (P Only) Reflection & refraction – investigate law of reflection off different surfaces and refraction through different substances
3) Investigate amount of IR absorbed or radiated from different surfaces.

Wv 02

Equations

$$v = f\lambda$$

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

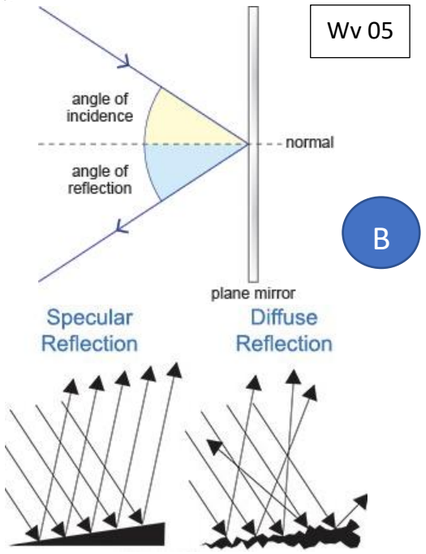
$$f = \frac{1}{T}$$

frequency = 1 / time period
(Hz) (s)

Reflection (P)

All waves can reflect. In reflection the incident angle is equal to the reflected angle when measured from the normal. Flat surfaces give specular reflections which can form images and diffuse reflections which don't.

Wv 05

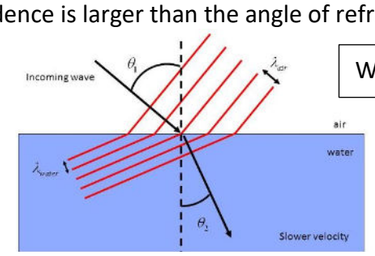


B

Refraction

All waves can refract. In refraction the wave changes direction as it changes velocity between materials, which affects the wavelength too as the frequency remains constant. If the wave slows the angle of incidence is larger than the angle of refraction

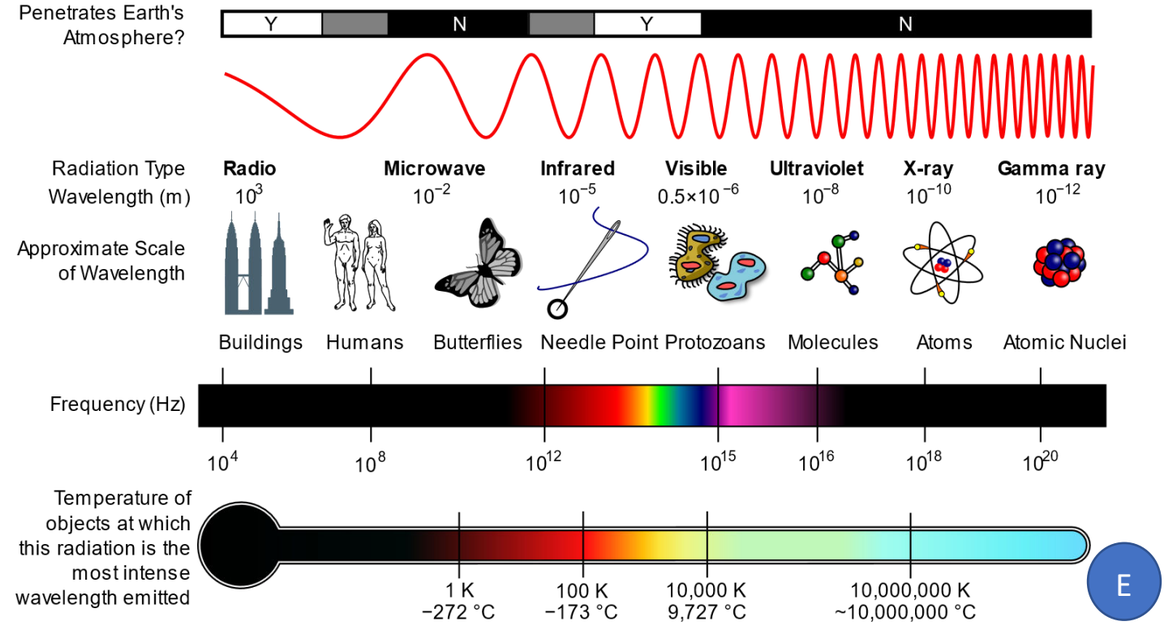
Wv 07



Electromagnetic Spectrum

Wv 10

EM waves are all transverse and travel in straight lines at the speed of light ($3x10^8$ m/s)



E

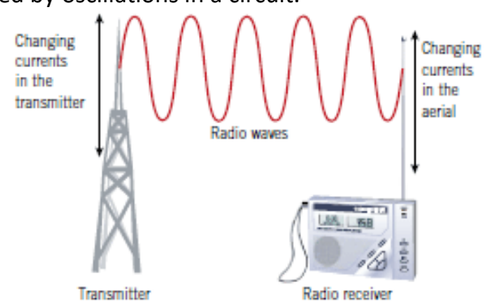
Uses and risks of EM Spectrum

Wv 11 & 12

Radio	TV and Radio
Microwaves	Satellite comms, cooking food, mobile phones, wi-fi
Infrared	Electrical heaters, cooking food, infrared cameras
Visible	Fibre optic communications, cameras
Ultraviolet	Energy efficient lamps, sun tanning, security markings
X-rays	Medical imaging, security in airports
Gamma	Medical treatment, sterilisation of equipment

F

(HT) Radio waves can be produced by oscillations in a circuit.



Radio waves absorbed by an antenna can create and alternating current with the same frequency as the wave.

The higher energy waves (Ultraviolet, X rays and gamma rays) have an associated risk as they can cause changes in atoms or the nucleus.

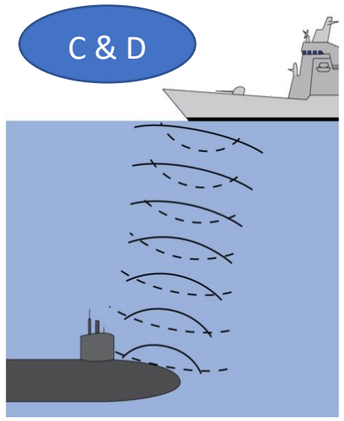
Ultraviolet waves can cause skin to age prematurely and increase the risk of skin cancer. X-rays and gamma rays are ionising radiation that can cause mutations of genes which lead to cancer.

Ultrasound & distance measurement (P)

Wv 04 & 08

C & D

Human hearing has a range of 20 – 20,000 Hz. Sound above 20,000Hz is ultrasound – it along with other sounds can be used to detect distances. A wave is emitted, reflected and detected. The time for travel is measured and using s = vt the distance is found. This is twice the distance to the object as it is the time for the wave to go there and back.



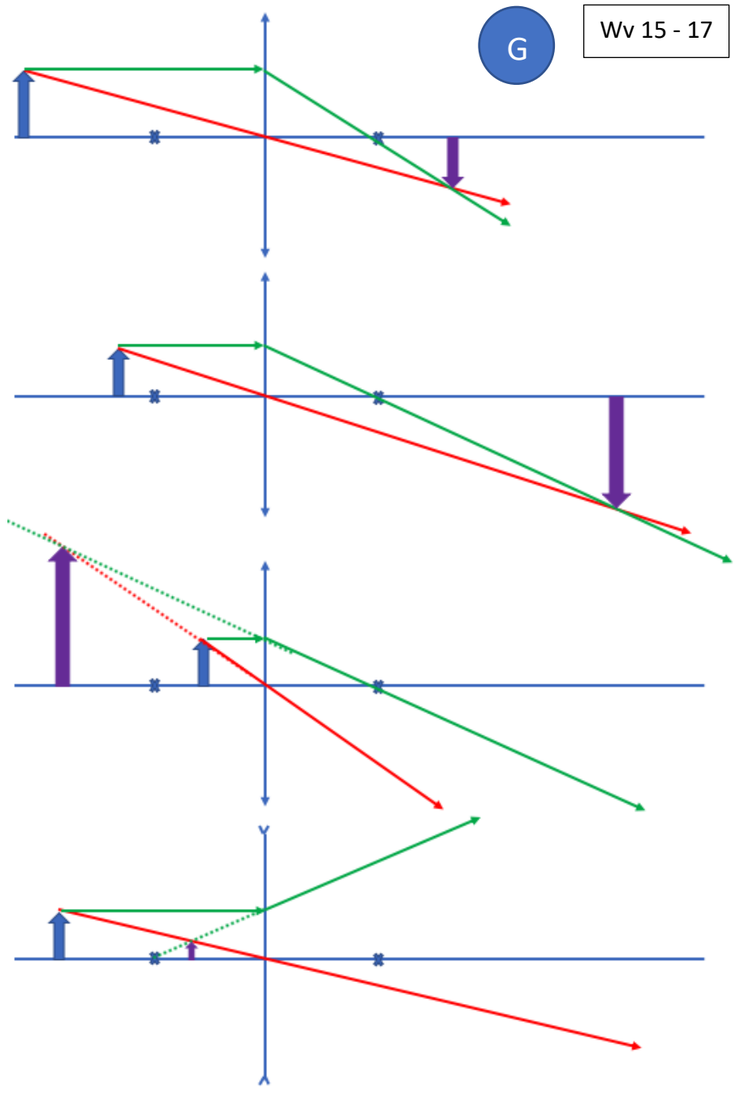
Medical ultrasound is made using a transducer and has a very high frequency – over 20MHz – as this means it has a short wavelength which provides sharp images. The crystal producing the ultrasound is small so that it vibrates more easily at a higher frequency. Ultrasound is much safer for imaging foetuses than x-rays as it is completely non ionising

Ray Diagrams (P)

G

Wv 15 - 17

One from top of object through optical centre
One parallel to principal axis then through/from focal point.
An image is described a real or virtual, upright or inverted, magnified or diminished
A real image can be projected and occurs if the rays actually cross, a virtual image is formed when the rays don't cross.
Upright or inverted is used when compared to the orientation of object.
Magnified or diminished is used to describe if the image is larger or smaller than the object.
Convex lenses can act in three ways depending on object location (more than 2F as in camera, between 2F and F as in projector, closer than F as in magnifying glass)
Concave lenses always give the same image type.



Seismic waves (P)

D

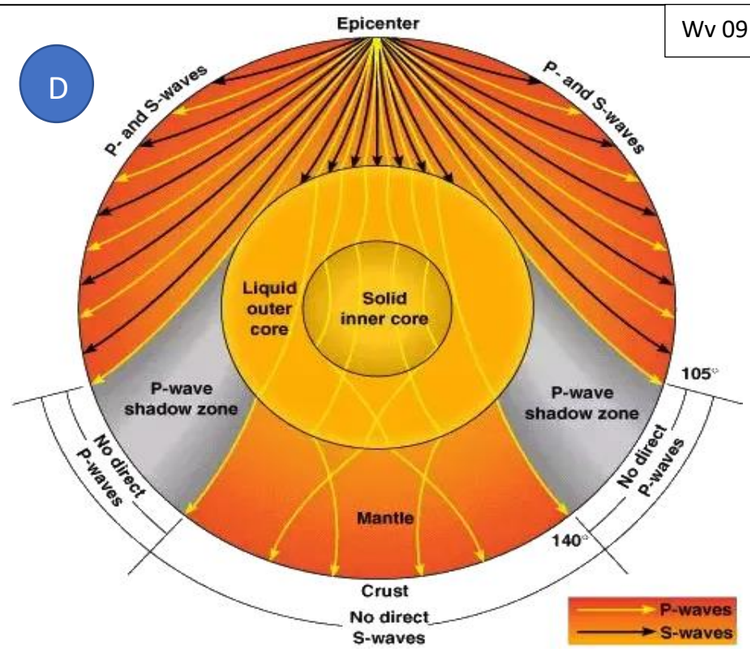
Wv 09

P waves – primary – pressure – longitudinal
S waves – secondary – shear – transverse

S waves cannot travel through liquids so cannot pass through outer core. This tells us about the internal structure of the Earth

Wave paths curve as they refract. This is because the density of the mantle changes with depth, which changes the speed of the waves.

The difference in arrival times between P and S waves can help determine how far away the earthquake epicentre was.

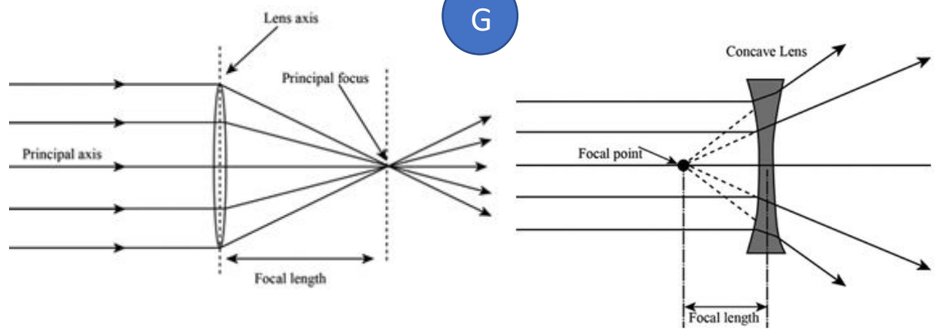


Wv 14

Lenses (P)

G

Lenses change the direction of a light ray due to refraction. Converging lenses bring parallel rays in to a point. Diverging lenses spread parallel rays out from a point. The point is the focal point and its distance from the lens centre is the focal length

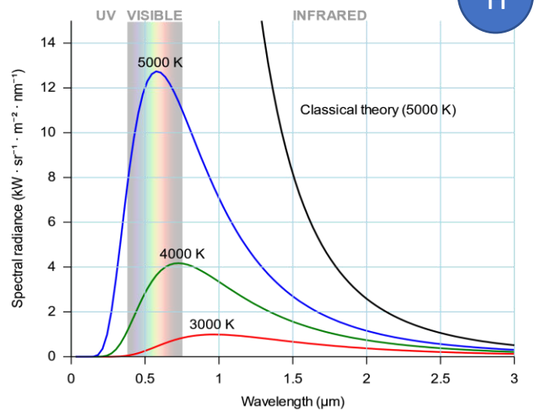


Wv 19

Black Body Radiation (P)

H

Matt black is a good absorber and emitter. A perfect black body will absorb 100% of EM radiation falling on it. If at a constant temperature it will then re-emit the radiation – usually in the infra-red range. The hotter the object, the more into the visible spectrum the light produced is.



The Earth's atmosphere can be modelled as a black body, absorbing radiation from the Sun and re-emitting some into space. If absorption is greater than emission, the global atmospheric temperature increases.

Colour Mixing (P)

Visible light is made of a combination of Red, Green and Blue light. Opaque objects reflect the colour of light they appear and absorb the others. Transparent or translucent objects transmit the colour of light they appear and absorb the others.

Wv 18

G