6 waves

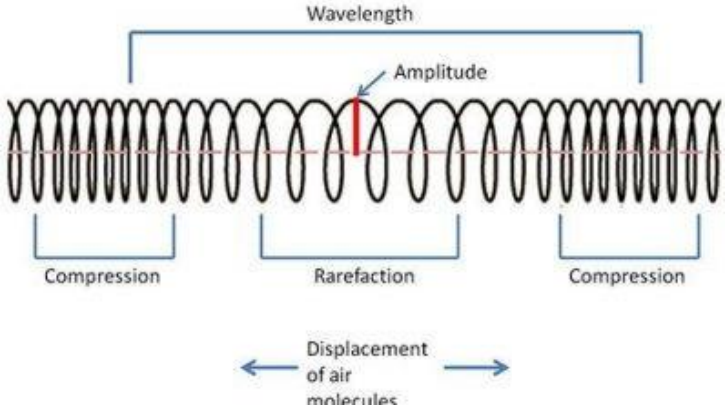
Definitions

Amplitude - the maximum displacement of a point on a wave away from its undisturbed position.
Wavelength - the distance from a point on one wave to the equivalent point on the adjacent wave.
Frequency - the number of waves passing a point each second.
Period - how long it takes for one wave to pass a point.
Wave speed - the speed at which the energy is transferred (or the wave moves) through the medium.
Electromagnetic waves - transverse waves that transfer energy from the source of the waves to an absorber.
Refraction – The change in direction of a wave when they pass from one medium to another.
Normal – An imaginary line at 90^{O} to the boundary.

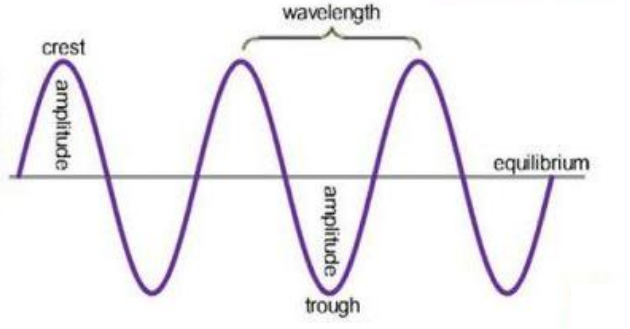
Waves

- Waves may be either transverse or longitudinal.
- In a **transverse** wave the oscillations are perpendicular to the direction of energy transfer. The ripples on a water surface are an example of a transverse wave.
- In a **longitudinal** wave the oscillations are parallel to the direction of energy transfer. Longitudinal waves show areas of compression and rarefaction. Sound waves travelling through air are longitudinal.

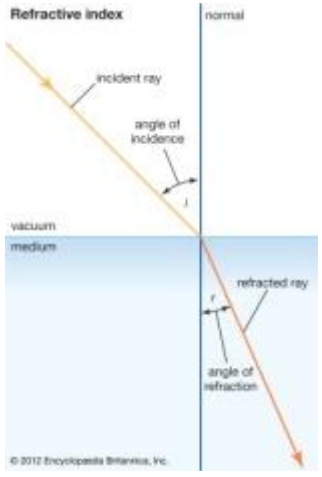
Longitudinal Wave

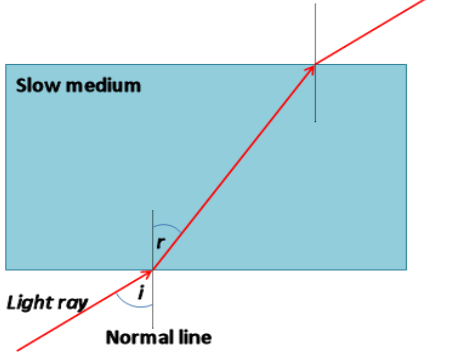


Transverse Wave



Refraction





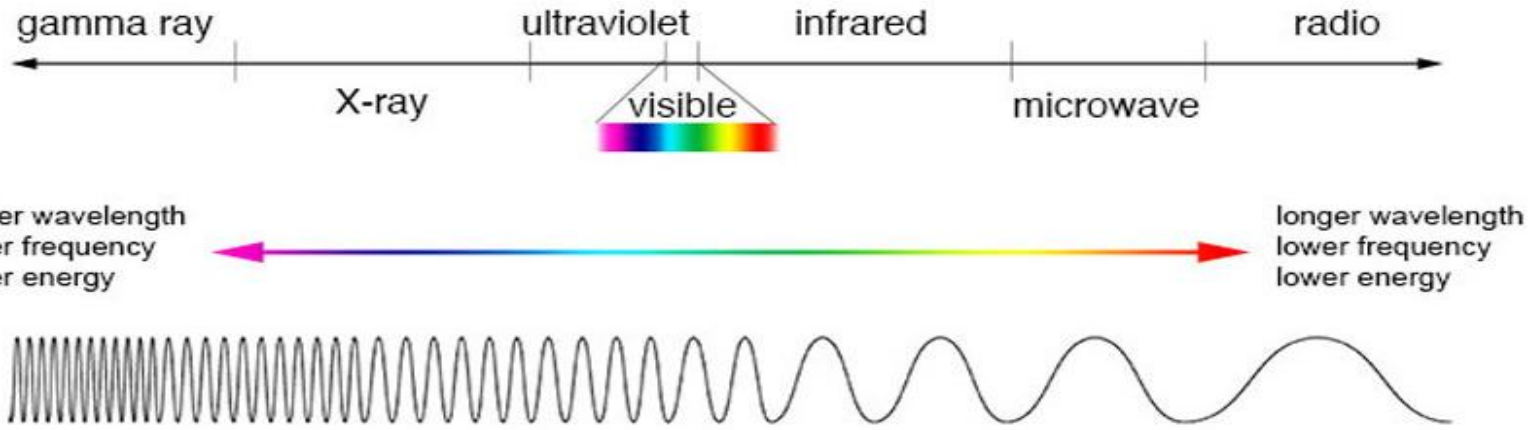
Refraction doesn't occur when a wave hits at 90^{O} to the surface. (HT)

Equations

Wavespeed (m/s) = frequency (Hz) x wavelength (m)

Electromagnetic spectrum

Electromagnetic waves form a continuous spectrum and all types of electromagnetic wave travel at the same velocity through a vacuum (space) or air.

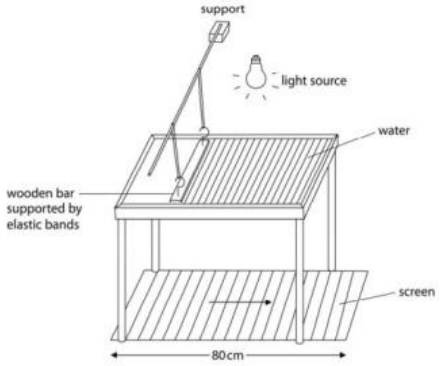


Electromagnetic waves have many practical applications. For example:

- **radiowaves** – television and radio
- **microwaves** – satellite communications, cooking food
- **infrared** – electrical heaters, cooking food, infra-red cameras
- **visible light** – fibre optic communications
- **ultraviolet** – energy efficient lamps, sun tanning
- **X-rays** – medical imaging and treatments.
- **gamma** – medical treatments, including radiotherapy

Changes in atoms and the nuclei of atoms can result in electromagnetic waves being generated or absorbed over a wide frequency range.

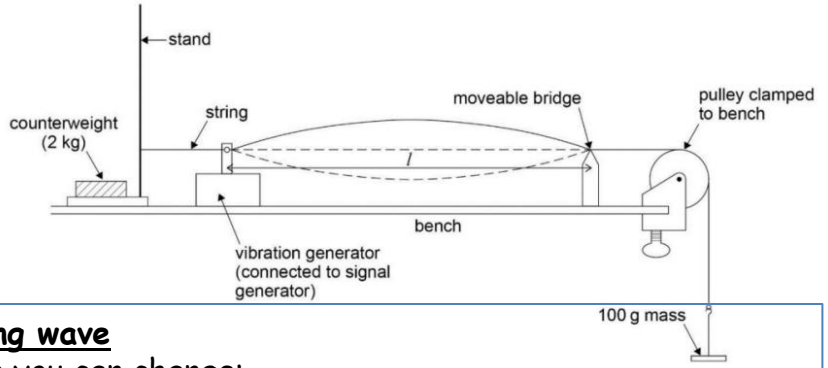
- **Gamma** rays originate from changes in the nucleus of an atom.
- **Radio** waves can be produced by oscillations in electrical circuits. **HT** only.
- When radio waves are absorbed they may create an alternating current with the same frequency as the radio wave itself, so radio waves can also produce oscillations in an electrical circuit. **HT** only.
- **Ultra-violet waves, X-rays and gamma rays** can have hazardous effects on human body tissue. The effects depend on the type of radiation and the size of the dose. Radiation dose (in Sieverts) is a measure of the damage caused by the radiation in the body.
- **Ultra-violet 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 mutation of genes and cancer.



RP Waves: Ripple tank

Wave speed = frequency x wavelength.

1. Measure the **frequency** by counting the number of waves passing a point in 10 seconds.
2. Divide by 10 to get the number per second.
3. Measure the **wavelength** by measuring the length of 10 waves (peak to peak) and dividing by 10.
4. Multiply to get the **wave speed**.



RP Waves: Standing wave

To change the wave you can change:

• the **frequency** at which the generator vibrates (adjust the frequency of the signal generator)

• the **length** of string allowed to vibrate (move the wooden bridge) • the **tension** in the string (add or remove masses).

To measure:

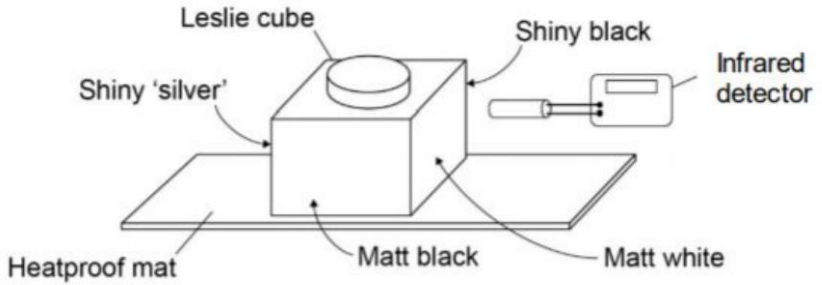
Wavelength – Use a metre ruler to measure across as many half wavelengths as possible. Divide the total length by the number of half waves. Multiply by two to give the wavelength.

Frequency – the frequency of the power supply.

Speed – this will be calculated using the equation: wave speed = frequency x wavelength

Measuring the speed of sound

- Find the speed of sound by measuring the time taken for an echo to get back to you after clapping your hands or banging two large lumps of wood together, near a wall.
- The distance to the wall will need to be measured (and doubled to find the distance the sound wave travels).



RP Radiation & Absorption

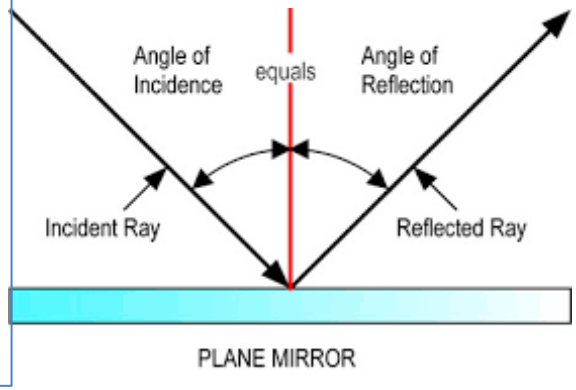
- Measure the temperature of each side of the Leslie cube using an infrared thermometer
- Greater temperature means greater emission/absorption of radiation

Triple only

Reflection

How we hear sound

Sound waves can travel through solids causing vibrations in the solid. Within the ear, sound waves cause the ear drum and other parts to vibrate which causes the sensation of sound. The conversion of sound waves to vibrations of solids works over a limited frequency range.



Definitions

Reflection – the change in direction of a wave at the boundary between different media so it goes back into the original media.

Principal axis – An imaginary line going through the centre of the lens.

Principal focus – The point at which the rays of light converge.

Focal length – The distance between the lens and the image.

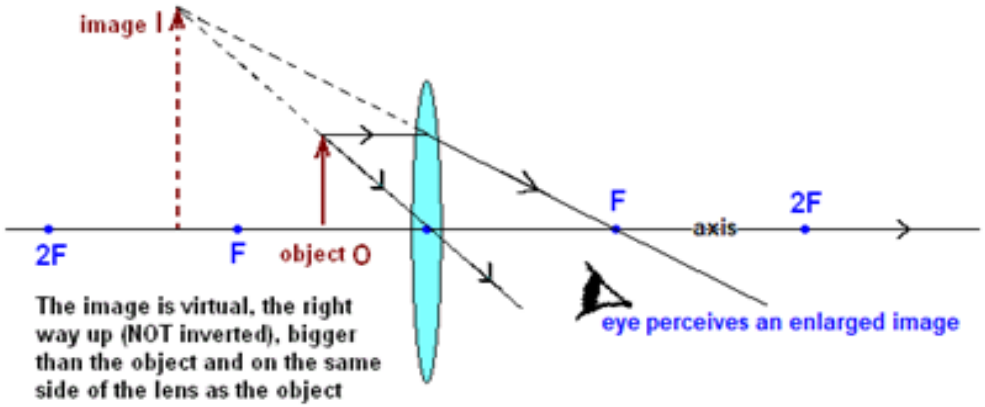
Colour

- Reflection from a smooth surface in a single direction is called **specular reflection**
- Reflection from a rough surface causes scattering this is called **diffuse reflection**.
- The colour of an opaque object is determined by which wavelengths of light are more strongly reflected.
- Wavelengths not reflected are absorbed.
- If all wavelengths are reflected equally the object appears white.
- If all wavelengths are absorbed the objects appears black.
- Objects that transmit light are either transparent or translucent.

Sound Waves & Seismic Waves

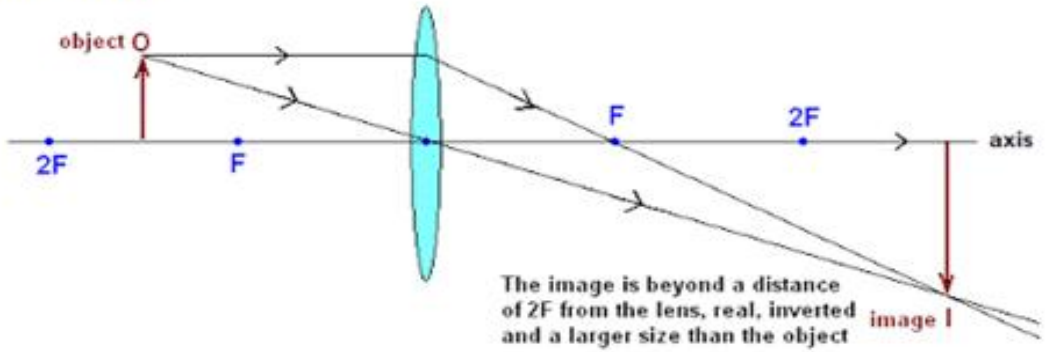
- Ultrasound waves have a frequency higher than the upper limit of hearing for humans.
- Ultrasound waves are partially reflected when they meet a boundary between two different media.
- The time taken for the reflections to reach a detector can be used to determine how far away such a boundary is.
- Seismic waves are produced by earthquakes. **P-waves are longitudinal**, seismic waves. P-waves travel at different speeds through solids and liquids.
- **S-waves are transverse**, seismic waves. S-waves cannot travel through a liquid.
- P-waves and S-waves provide evidence for the structure and size of the earth's core.
- Echo sounding, using high frequency sound waves is used to detect objects in deep water and measure water depth.

Concave lens

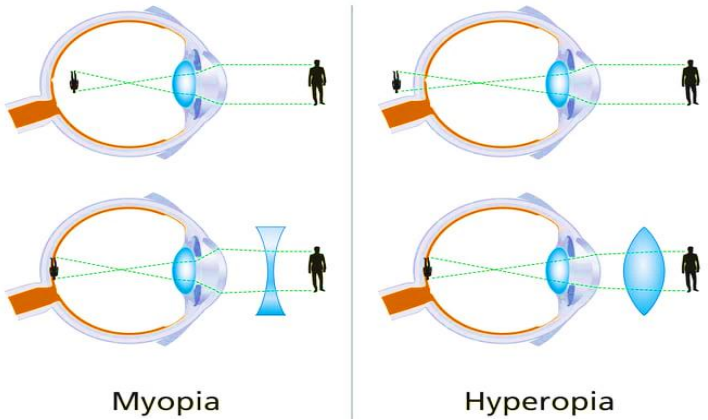


The image is virtual, the right way up (NOT inverted), bigger than the object and on the same side of the lens as the object

Convex lens



The image is beyond a distance of 2F from the lens, real, inverted and a larger size than the object



Black body radiation

All objects emit and absorb infra-red radiation. The hotter an object is the more infra-red radiation it radiates in a given time.

A **perfect black body** is an object that absorbs all of the radiation incident on it. The object does not reflect or transmit any radiation. Since a good absorber is also a good emitter a perfect black body would be the best possible emitter.

All objects emit radiation. The intensity and wavelength distribution of any emission depends on the temperature of the object. When the temperature is increased the intensity of every wavelength of radiation emitted increases but the intensity of the shorter wavelengths increases *more rapidly* making the object appear **more white**.

An object at constant temperature is absorbing radiation at the **same rate** as it is emitting radiation. The temperature of an object increases when the object absorbs radiation faster than it emits radiation. **HT only**.

The temperature of the Earth depends on many factors including; the rates of absorption and emission of radiation, reflection of radiation into space. **HT only**.