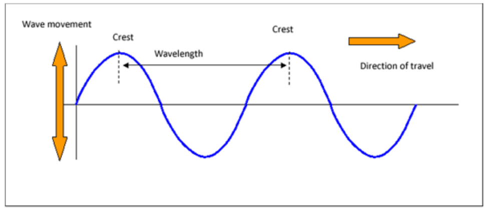
P6 Knowledge Organiser – 4.6.1 - Waves

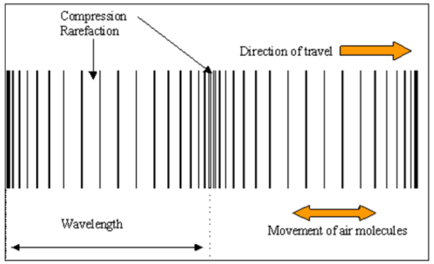
Transverse and Longitudinal Waves

Waves can be either Transverse or Longitudinal. Transverse Waves. All waves transfer energy.



In a transverse waves the particles oscillate perpendicular to the direction of energy transfer. Examples of transverse waves include water waves and electromagnetic waves.

In a longitudinal wave the particles oscillate parallel to the direction of energy transfer. Examples of longitudinal waves include sound waves.



Wave Properties

The frequency of a wave is the number of waves passing through a fixed point each second.

The amplitude of a wave is the maximum displacement of a point on a wave from its undisturbed position.

The wavelength of a wave is the distance from a point on one wave to the equivalent point on the adjacent wave.

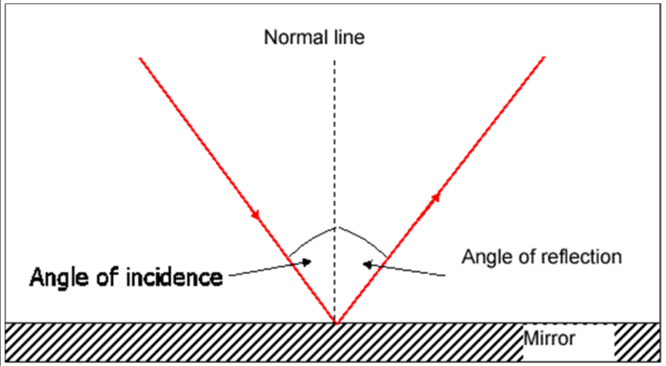
The wave speed is the speed at which the wave moves through the medium. This is also the speed at which the energy is transferred through the medium.

Reflection of waves

Waves can be reflected at a boundary between two different materials. They could also be transmitted or absorbed at a boundary between two different materials.

A ray diagram illustrates the reflection of a wave at a boundary. All ray diagrams should be drawn with a pencil and arrows clearly indicate the direction the light is travelling. These arrows must be included in all ray diagrams.

The angle of incidence = the angle of reflection



Wave Equation

Period = 1/frequency (you do not need to recall)

Wave speed = frequency x wavelength

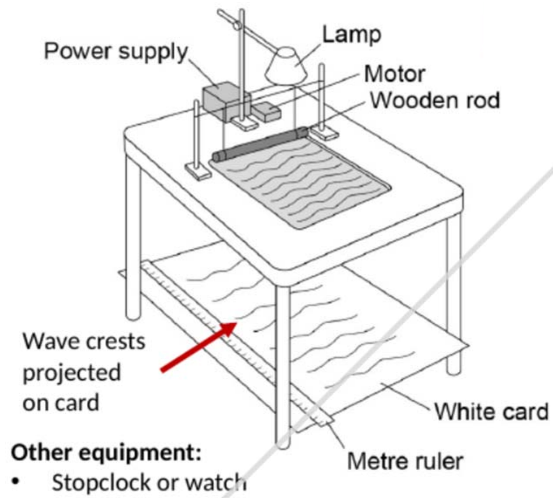
Quantity	Symbol	Unit
Frequency	f	Hz
Wave Speed	v	m/s
Wavelength	λ	m
period	T	s

Sound Waves

Sound waves can travel through solids causing vibrations in the solid.

In the human ear, sound waves cause the ear drum to vibrate which allows us to detect sound. The conversion of sound waves to vibrations of solids only works over a limited frequency range. This restricts the range of human hearing. The range of human hearing is from 20Hz to 20kHz.

Ripple tank required practical



Method A: ripple tank

1. Place a metre ruler at right angles to the waves shown in the pattern on the card.
2. Measure across as many waves as possible. Then divide that length by the number of waves. This gives the **wavelength** of the waves.
3. Count the number of waves passing a point in the pattern over a given time (say 10 seconds).
4. Then divide the number of waves counted by 10. This gives the **frequency** of the waves.
5. Record your measurements.

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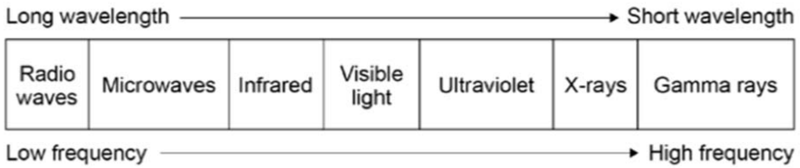
Types of Electromagnetic Waves

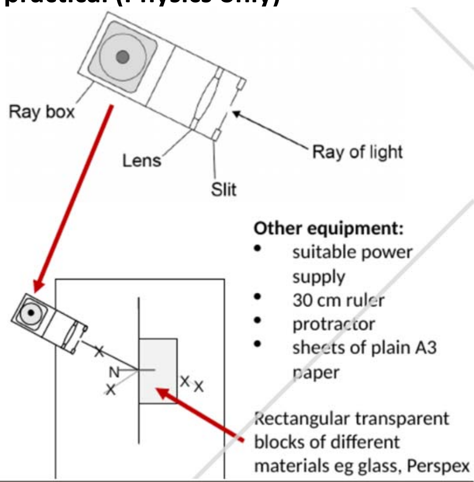
Electromagnetic waves are transverse waves that transfer energy from the source to an absorber. All electromagnetic waves travel at the same speed, $3x10^8$m/s. Electromagnetic waves form a continuous spectrum . The spectrum is grouped by order of their wavelength and frequency. Humans can only detect the visible light part of the spectrum with their eyes.



Component	Use
Radio Waves	Television and radio signal
Microwaves	Satellite communication, cooking food
Infrared	Electrical heaters, cooking food, infrared cameras
Visible Light	Fibre optic communication
Ultraviolet	Sun tanning, detecting forged notes
X-Rays	Medical imaging and treatment
Gamma Rays	Kill cancer cells, sterilization.

Reflection of waves – Required practical (Physics only)

Waves can be reflected at the boundary between two different materials. Waves can be absorbed or transmitted at the boundary between two different materials.



Method

1. Draw around the transparent block, and draw a normal line from the middle of the block . Be careful **not** to move it.
2. Switch on the ray box. Move the ray box or paper to change the angle of incidence. Do this until you see:
   - a clear ray reflected from the surface of the block
   - another clear ray leaving the opposite face of the block.
3. Mark the path of the incident ray, the reflected ray and the transmitted ray (see diagram)
4. Use the protractor to measure:
   - the angle between the incident ray and normal - this is the angle of incidence
   - the angle between the reflected ray and normal - this is the angle of reflection
   - the angle between the ray inside the block and the normal - this is the angle of refraction.
5. Record these measurements.
6. Move the ray box to a range of different angles of incidence and make the same measurements.
7. Repeat for a block of different material, using the same paths for the incident rays as with the first block.

Properties of Electromagnetic Waves

Radio waves can be produced by oscillations in electric circuits. When radio waves are absorbed they can create an alternating current with the same frequency as the radio wave itself, so radio waves can themselves induce oscillations in an electrical circuit.

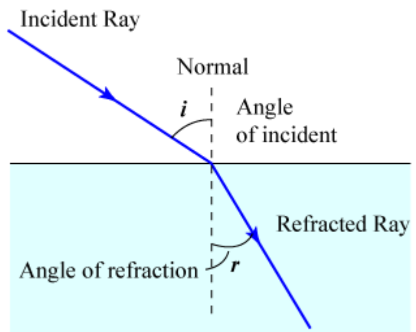
Changes in atoms and the nuclei of atoms can result in electromagnetic waves being generated or absorbed over a wide frequency range. Gamma rays originate from changes in the nucleus of an atom.

Ultraviolet 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 is a measure of the risk of harm resulting from an exposure of the body to the radiation.

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 the mutation of genes and cancer.

Properties of Electromagnetic Waves

Electromagnetic Waves can be absorbed, transmit, refract or reflect. Refraction is due to the difference in velocity that the waves travel in the different substances. A ray diagram can be used to illustrate refraction.



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Light

Each colour of light on in the visible spectrum has its own narrow band of wavelength and frequency. Colour filters can be used by absorbing certain wavelengths (and colour) and transmitting other wavelength's (and colours).

The colour of an opaque object is determined by which wavelengths of light are more strongly reflected. Wavelengths that are not reflected are absorbed.

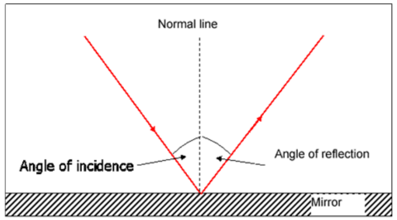
An object appears white because all of the wavelengths of light are reflected equally off the object. If all of the wavelengths are absorbed the object appears black.

Objects that transmit light are transparent if the transmit all light through or translucent if they tranmit some light through.

Reflection of Light

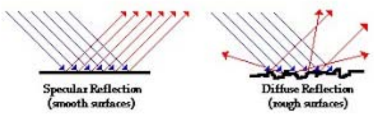
Waves can be reflected at a boundary between two different materials.

A ray diagram can be used to show the law of reflection.

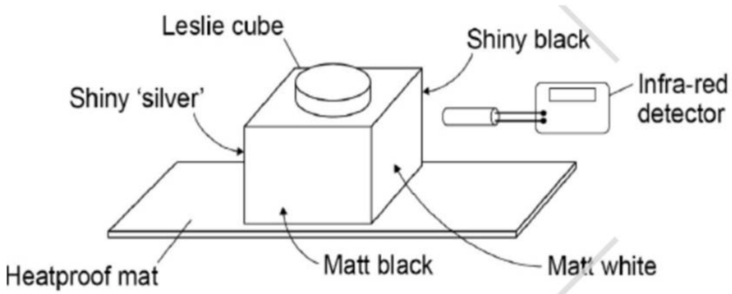


The normal line is a perpendicular line from the surface. All angles are measured to the normal. The angle of incidence is equal to the angle of reflection when light is reflected by a plane mirror.

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.



Infra red radiation Required Practical



Method:

1. Place the Leslie cube on to a heat proof mat.
2. Fill the cube with very hot water and replace the lid of the cube.
3. Use the detector to measure the amount of infrared radiated from each surface.
4. Make sure that before a reading is taken the detector is the same distance from each surface.
5. Record your data in a suitable results table.

All bodies (objects), no matter what temperature, emit and absorb infrared radiation. The hotter the body, the more infrared radiation it radiates in a given time. A perfect black body is an object that absorbs all of the radiation incident on it. A black body 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.

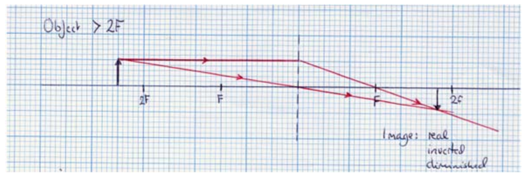
Lenses

A lens will form an image by refracting light. In a convex lens parallel light rays are brought to focus at a point by the principal focus. The distance to the principal focus is called the focal length. Images produced by convex lenses can be either real or virtual. Concave lenses always produce virtual images.

In ray diagrams a convex lens will be represented by:

A concave lens will be represented by:

An image is 'real' if the image if formed on a ray diagram on the right hand side of the lens on a ray diagram. i.e. the rays actually meet. This is an example of a ray diagram of a convex lens



A virtual image is formed by rays diverging after passing through the lens and being traced back to a principal focus on the left hand side of a ray diagram.

The image height of an object can be measured using a ray diagram, as well as the object height. This can be used to calculate the magnification of an object.

$$magnification = \frac{image\ height}{object\ height}$$

Magnification does not have any units. You do not need to remember this equation.