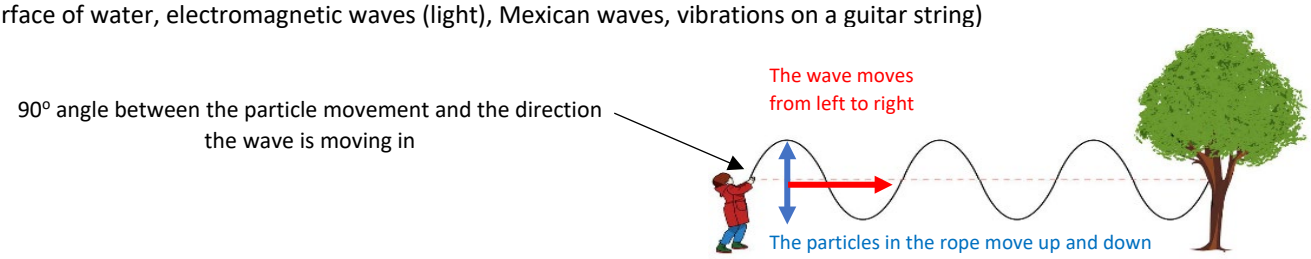
Year 8 Waves Knowledge Organiser – LIGHT

Waves transfer energy from one place to another, without transferring material.

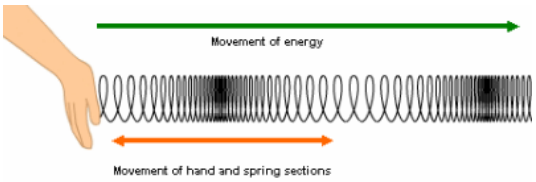
There are 2 types of wave – transverse and longitudinal

Transverse waves - The particles or fields vibrate at **right angles to the direction** the wave is travelling. Examples include: waves on the surface of water, electromagnetic waves (light), Mexican waves, vibrations on a guitar string)

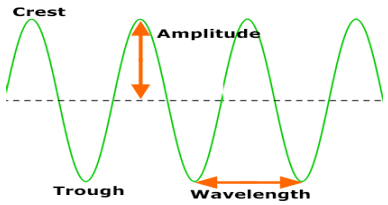


Longitudinal waves - The particles vibrate in the **same direction** as the wave is travelling. Examples include sound waves and waves on a slinky.

The movement of particles produces areas of low pressure (rarefaction) and high pressure (compression)



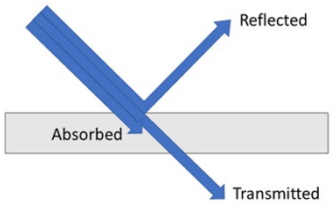
Properties of waves



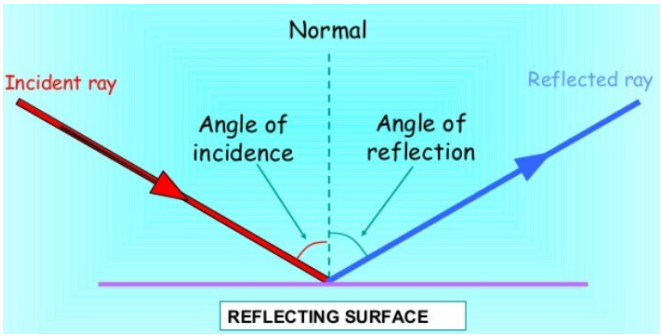
Characteristic	Definition
Amplitude	The maximum distance a point on a wave moves from its rest position (measured in metres)
Wavelength	The distance from a point on one wave to a point on the next wave (measured in m)
Frequency	The number of waves passing a point each second (measured in hertz (Hz))

Objects that **emit** (give off) light are called **luminous** objects (e.g. the sun). Most objects are **non-luminous** as they do not give off their own light. We are able to see non-luminous objects because light reflects off them into our eyes. (e.g. the moon).

When waves hit an object, they may be **reflected**, **transmitted**, or **absorbed**.



Reflection - Waves travel in straight lines. We can show the path that light takes by drawing a **ray diagram**.



Incident ray	The incoming light
Reflected ray	The light that is reflected at the surface
Normal line	An imaginary line that is drawn at the point a wave meets the surface at 90° to the surface
Angle of incidence	The angle that the incident ray makes with the normal line
Angle of reflection	The angle that the reflected ray makes with the normal line

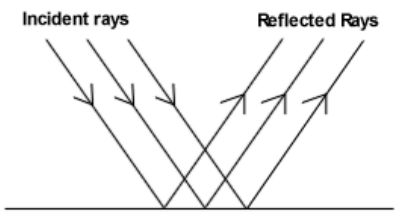
The law of reflection: The angle of reflection is always **equal** to the angle of incidence

There are 2 types of reflection – **specular reflection** and **diffuse reflection**

When light reflects off a **smooth** surface in a **single direction** it is called **specular reflection**. This is why you can see your reflection in shiny surfaces.

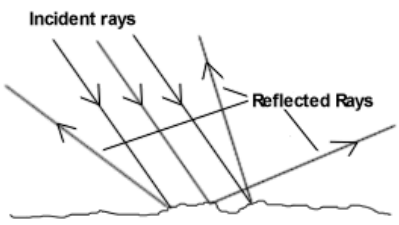
When light reflects off a **rough surface**, light is **scattered** in all directions. This is called **diffuse reflection** and is the reason you can see your exercise book, but you can't see your reflection in it.

Specular Reflection



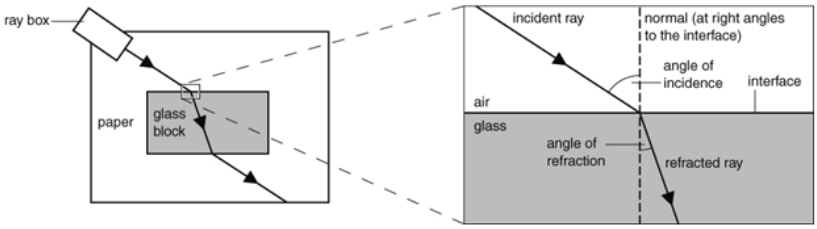
Eg. plane mirror or any other surface that produces a reflected image.

Diffuse Reflection

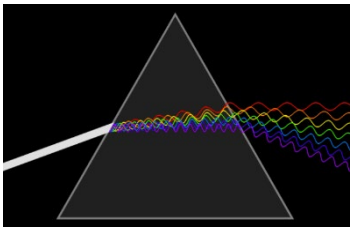


This is like any surface that we can see but does not reflect an image

Refraction –

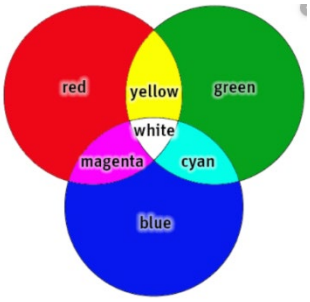


- When light is transmitted from one material to another, it **changes speed and direction**.
- When entering a **denser material**, light **slows down** and **bends towards** the normal line.
- When entering a **less dense** material, light **speeds up** and **bends away** from the normal line.
- The bigger the change in density, the more the light will be refracted.



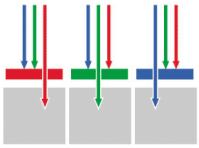
When white light is directed at a **prism**, it is split into a **spectrum** of colours (**Red**, **Orange**, **Yellow**, **Green**, **Blue**, **Indigo**, **Violet** = **ROYGBIV**) . This process is called **dispersion**.

This occurs because different colours of light have different **wavelengths** and refract (bend) by different amounts. **Red light** has the **longest wavelength** and **refracts the least**. **Violet light** has the **shortest wavelength** and **refracts the most**.



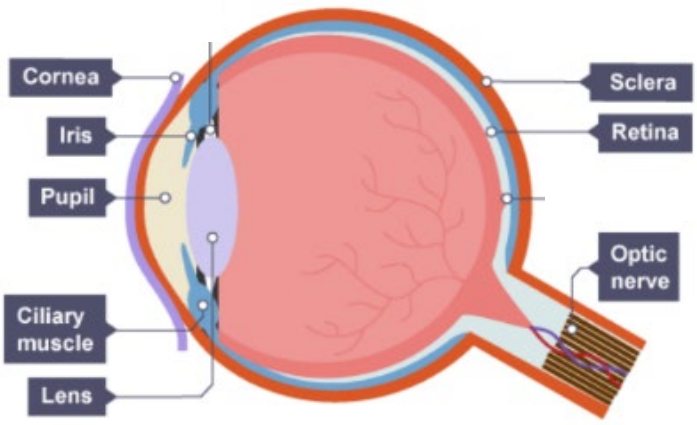
Colour and filters - The spectrum can be simplified into the 3 **primary colours** of light – red, green and blue.

- White light is made up of equal amounts of red, green and blue light.
- Combinations of primary colours can be seen as **secondary colours-** magenta (red and blue), yellow (red and green), cyan (blue and green).
- **Opaque** materials **do not transmit light** but **only absorb and reflect**. The colour that an opaque object reflects is the colour that the object appears to be.
- Black light does not exist – objects appear to be black if no light is transmitted or reflected.
- **Transparent** materials are "see through" and **transmit almost all of the light** through e.g. glass.
- **Translucent** materials **transmit most light**. Things may seem blurry through a translucent object e.g. frosted window
- **Filters** are transparent and can be used to create rays of coloured light from white light. Filters will only transmit certain colours and will absorb the rest.



The eye

Part of the eye	Function
Cornea	The transparent front part of the eye that covers the iris and the pupil and refracts light as it enters the eye
Iris	The coloured part of the eye (blue, brown, green etc.) that controls how much light enters the pupil
Pupil	The circular opening of the iris where light enters the eye
Lens	Further refracts light to focus it onto the retina at the back of the eye.
Ciliary muscle	Changes the shape of the lens to change the focus
Retina	The back of the eye which contains the light receptor cells (rod cells and cone cells). Rod cells – detect low levels of light but cannot distinguish colour. Cone cells – 3 different types, one for each primary colour of light. Work best in bright light!
Optic nerve	Carries nerve impulses from the eye to the brain
Sclera	The tough white outer layer of the eye which helps to protect the eye from injury



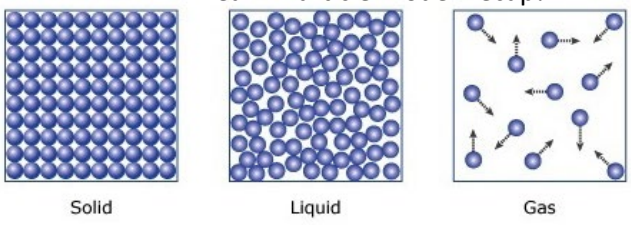
- Light passes through the **transparent cornea** which **refracts** the light.
- Light enters through the eye through the circular opening in the iris: the **pupil**. When the light is **bright**, the **muscles** in the iris **contract** causing the pupil to be **constricted** (become small) so **less light** can enter. When light levels are low, the muscles in the iris **relax** causing the pupil to **dilate** (become large) and so **more light** can enter.
- The **lens** further **refracts** light to **focus it** onto the **retina**. Rod cells and cone cells in the retina **change light to electrical nerve impulse**s. The **optic nerve** carries the nerve impulses to the brain

Sound waves – Caused by the **vibration of particles**. This means that sound waves cannot be transferred through a vacuum, as **vacuums do not contain particles**. Sound waves are **longitudinal waves**.

The speed of sound waves - Sound waves **travel fastest in solids** because the particles are close together. Sound waves **travel slowest in gases** because the particles are so far apart.

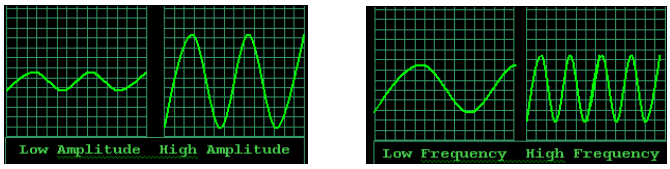
The speed of sound in air is around **330 m/s**. This is nearly 1 million times **slower than the speed of light**.

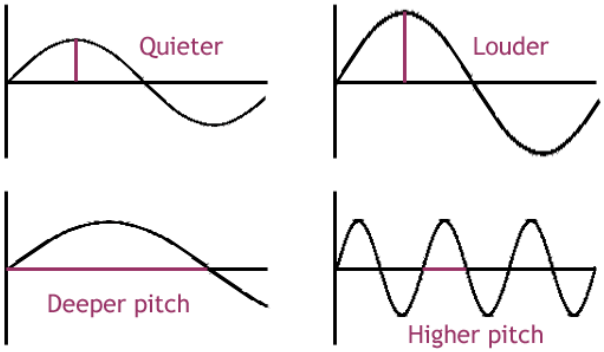
Year 7 Particle Model Recap!



Properties of sound waves

Although sound waves are longitudinal, we can view them on an **oscilloscope** to measure the wave's **amplitude, wavelength** and to calculate the **frequency** of the wave.



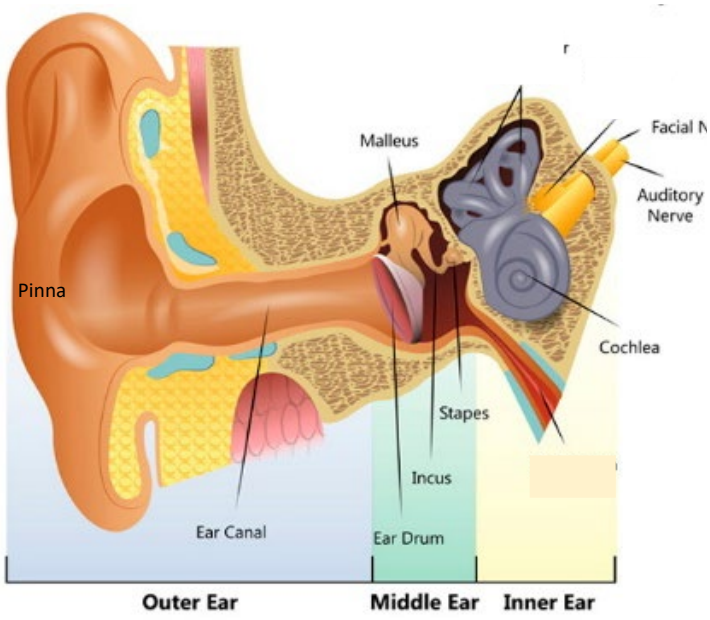


The loudness of a sound is described as the **volume** or **intensity** of the sound and is measured in **decibels (dB).** The volume is determined by the **amplitude** of the wave. The larger the **amplitude** of the wave, the louder the sound.

The **pitch** describes how high or low a sound is and is determined by the **frequency** of the wave. The higher the frequency the higher the pitch of the wave.

The ear

Part of the ear	Function
Pinna	The only visible part of the ear with a special helical shape. It helps to funnel sound into the ear
Ear canal	The pathway running from the outer ear to the ear drum in the middle ear
Ear drum	A thin, cone shaped membrane which senses vibrating sound waves in the ear canal and vibrates with the same frequency
Ear bones	The 3 smallest bones in the human body – the *malleus, incus* and *stapes*. These amplify (make bigger) the vibrations from the ear drum
Cochlea	Vibrations pass through fluid inside the cochlea where tiny hairs detect them and convert the vibrations to electrical nerve impulses
Auditory nerve	Transmits nerve impulses from the cochlea to the brain



Exposure to high volumes of sound can cause permanent hearing loss or a ringing in the ears called tinnitus. Hearing loss may be caused by damaging the ear drum itself, or by flattening the tiny hairs in the cochlea.

The **auditory range** of an animal is the **range of frequencies of sound** it can hear.

Different animals have different auditory ranges. The auditory range of humans is **20Hz to 20,000Hz.**