# Knowledge Organiser Y8 Waves

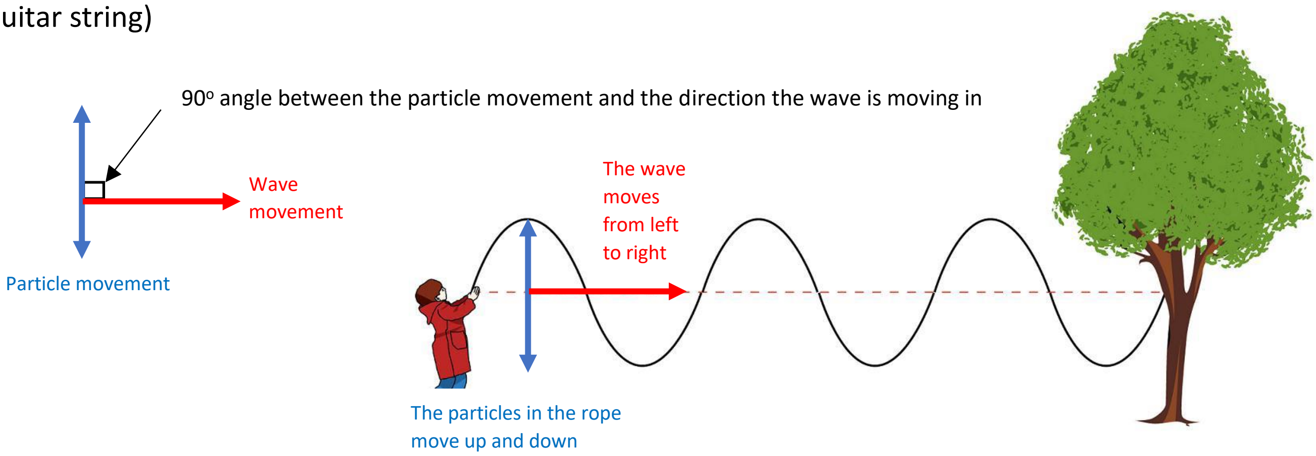
**Year 8 Waves Knowledge Organiser**

**Waves transfer energy from one place to another, without transferring material.** For example, in the picture lower down the page, the wave on the rope transfers energy from the boy to the tree, but the rope itself does not move from the boy to the tree.

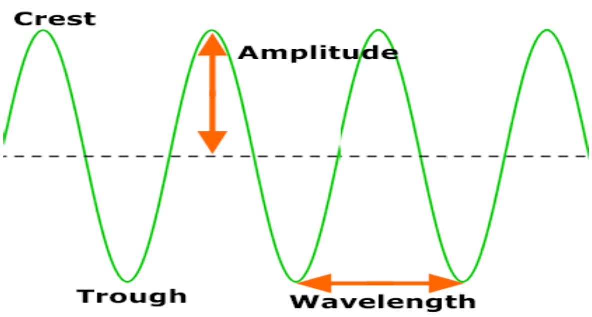
There are 2 types of wave – transverse and longitudinal

## Transverse waves

In 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)



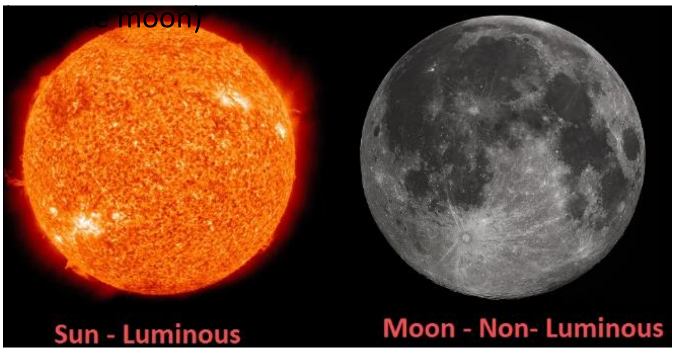

Waves can be compared by their **characteristics**, including **wavelength**, **frequency** and **amplitude**.

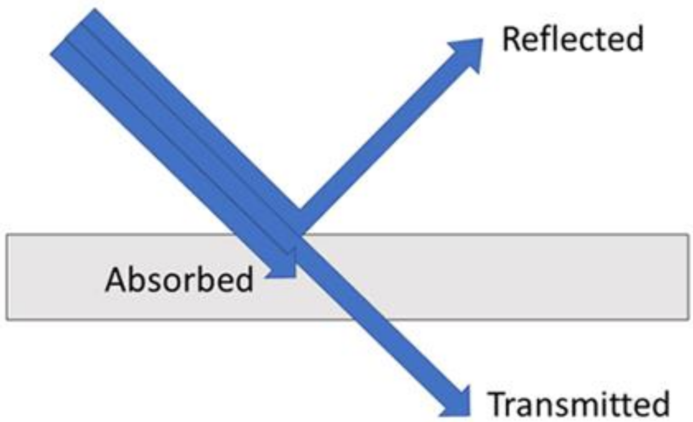



| Characteristic | Definition |
|---|---|
| Amplitude | The maximum distance a point on a wave moves from its rest position (measured in metres) |
| Wavelength | The distance from a point on one wave to a point on the next wave (measured in m) |
| Frequency | The number of waves passing a point each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



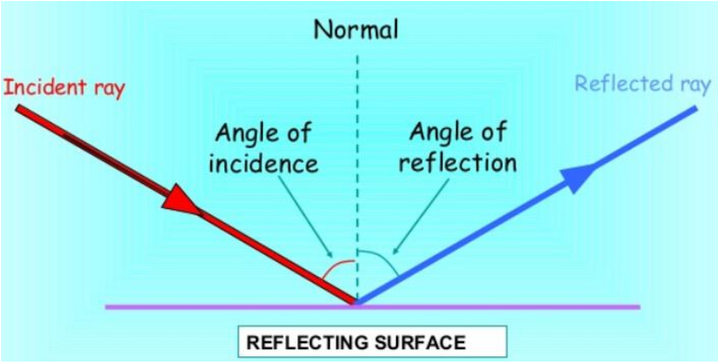




When waves hit an object, they may be **reflected**, **transmitted**, or **absorbed**.

# Knowledge Organiser Y8 Waves

**Reflection**

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




Ray diagram top tips:

- Always remember to use a **ruler** to draw straight lines
- Always use an **arrow** to show the direction of each ray
- Always draw a **normal** line on the diagram where a ray hits a surface

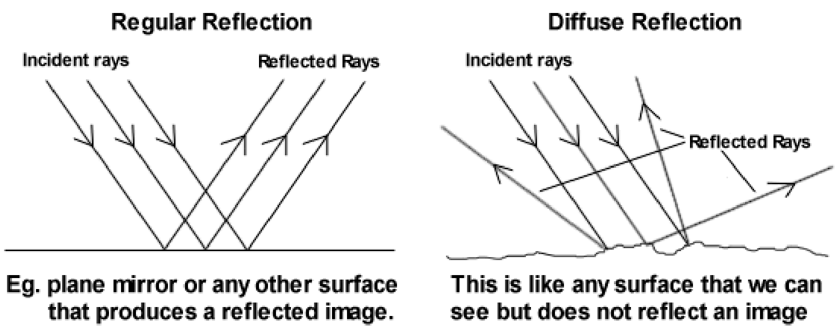
| | |
|---|---|
| **Incident ray** | The incoming light |
| **Reflected ray** | The light that is reflected at the surface |
| **Normal line** | An imaginary line that is drawn at the point a wave meets the surface at 90° to the surface |
| **Angle of incidence** | The angle that the incident ray makes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

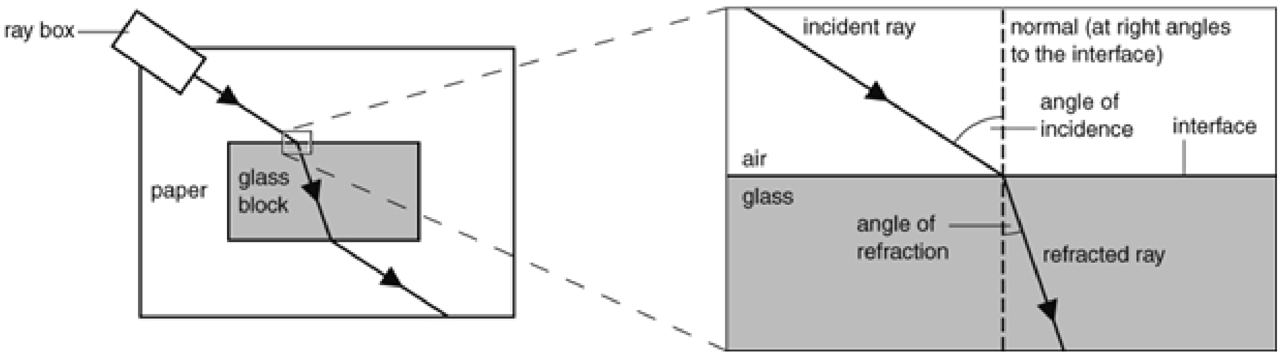
When light reflects off a smooth surface in a single direction it is called **specular reflection**. This is why you can see your reflection in shiny surfaces.

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.




**Refraction**

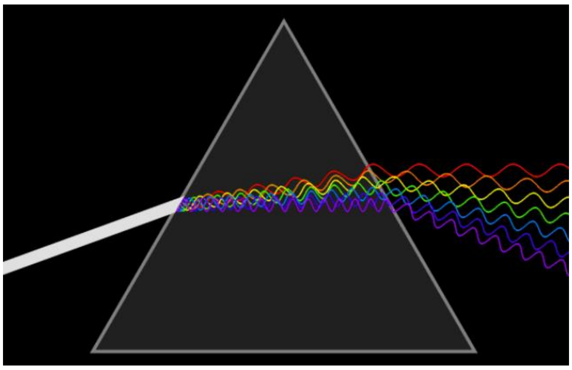
When light is transmitted from one material to another, it changes speed and direction. This is called **refraction**. When entering a denser material, light slows down and bends towards the normal line. When entering a less dense material, light speeds up and bends away from the normal line. The bigger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



# Knowledge Organiser Y8 Waves

This can be seen in the diagram above - when light enters the block it is going into a more dense material than the air, and so the light bends towards the normal line. When the light leaves the block it is going into the air which is less dense than the block and so the light bends away from the normal line.

When white light is directed at a **prism**, it is split into a **spectrum** of colours (**R**ed, **O**range**, Y**ellow, **G**reen, **B**lue, **I**ndigo, **V**iolet = **ROYGBIV**) . This process is called **dispersion**.



This occurs because different colours of light have different wavelengths and refract (bend) by different amounts.

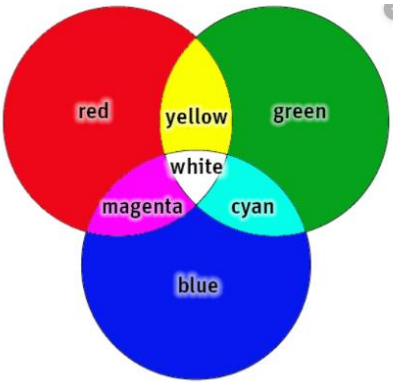
Red light has the longest wavelength and refracts the least.

Violet light has the longest wavelength and refracts the most.

Rainbows are formed because little water droplets in the air act like tiny prisms and white light is dispersed into the spectrum of colours.

**Colour and filters**

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



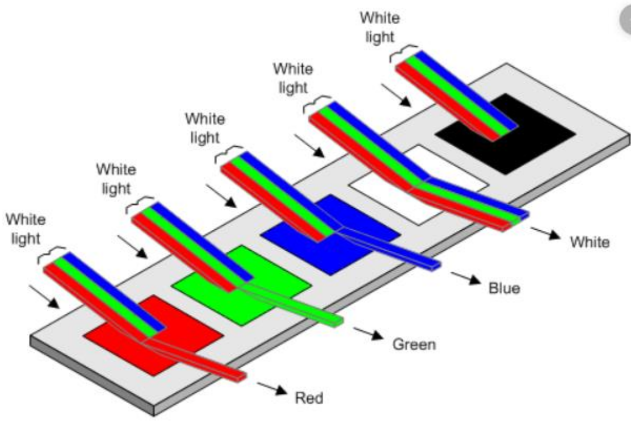

White light is made up of equal amounts of red, green and blue light.

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. Opaque objects absorb most colours and reflect certain colours. The colour that is reflected is the colour that the object appears to be. For example, a leaf will absorb blue and red light and will reflect green, so leaves appear to be green.

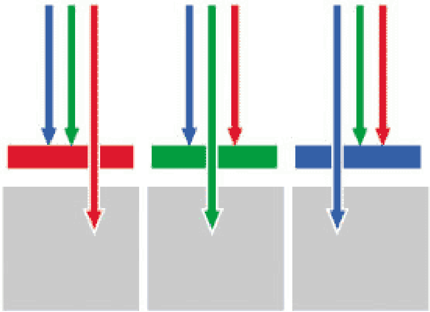
Black light does not exist – objects appear to be black if no light is transmitted or reflected.




Shining white light on different colored paints

# Knowledge Organiser Y8 Waves

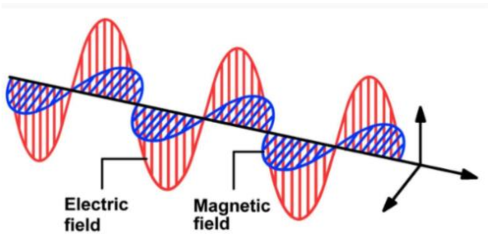
**Transparent** materials are "see through" and transmit almost all of the light through e.g. glass.
**Translucent** materials transmit most light. Things may seem blurry through a translucent object e.g. frosted window in a bathroom, tracing paper.



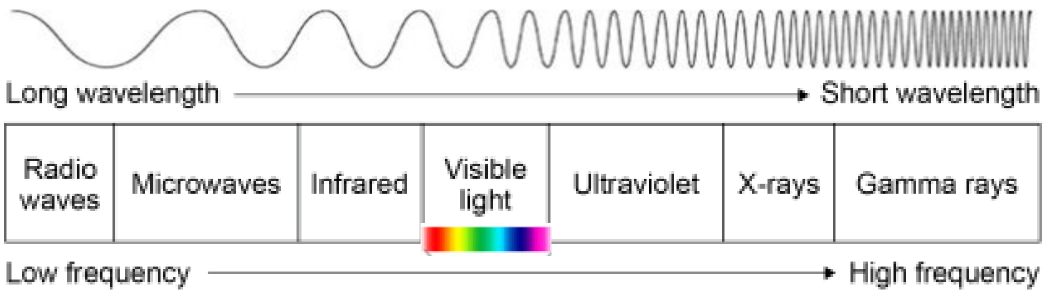
**Filters** are transparent and can be used to create rays of coloured light from white light. Filters will only transmit certain colours and will absorb the rest.

**<u>The electromagnetic spectrum</u>**

Light is an example of an electromagnetic wave. It is a **transverse** wave because electric and magnetic fields vibrate at right angles to the direction the wave is travelling. We know that electromagnetic waves don't use the vibration of particles because light travels through the **vacuum** of space from the sun to the earth.




Light forms just a small part of the **continuous electromagnetic spectrum**.



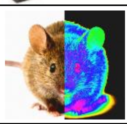
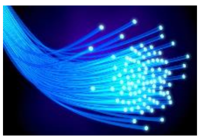

Come up with your own way to memorise the order!

E.g. **G**ate **X** **U**sually **L**ets **I**n **M**ost **R**adiation

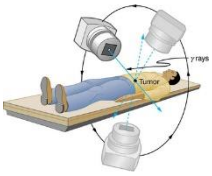
or **R**abid **M**onkeys **I**n **V**elvet **U**nderpants e**x**crete **g**ummy bears

Our eyes only detect visible light and so only detect a very limited range of electromagnetic waves.

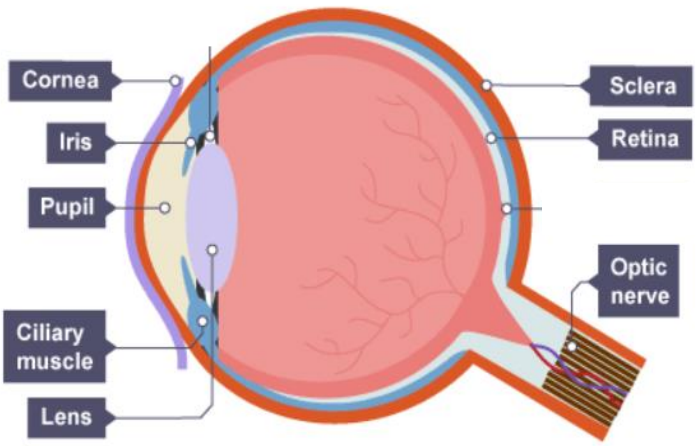
All electromagnetic waves travel at 300,000,000 m/s (or 300,000 km/s).

| **Type of electromagnetic wave** | **Use** |
|---|---|
| Radio  | TV and radio communication |
| Microwaves   | Heating food – microwaves are absorbed by *water* molecules in food, causing them to vibrate more and pass energy to the rest of the food<br>Mobile phone and satellite communication |
| Infrared   | Heating (in electric heaters, toasters, ovens)<br>Detected by thermal imaging cameras<br>Remote controls |
| Visible light  | Fibre optic cables for communication |

# Knowledge Organiser Y8 Waves

| | |
|---|---|
| Ultraviolet  | Ultraviolet light in sunlight can cause skin to tan or burn. Suncream is designed to absorb harmful UV rays |
| X-rays  | Medical imaging. X-rays are absorbed by dense materials like bone, so they appear as a shadow on an x-ray |
| Gamma  | Used for medical imaging and cancer treatment |

## 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) |
| 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 which further refracts light to focus it onto the retina. Rod cells and cone cells in the retina change light to electrical nerve impulses. The optic nerve carries the nerve impulses to the brain

**Rod cells** in our retinas detect light but cannot distinguish colour.

There are 3 different type of **cone cells** in the retina to detect each of the 3 primary colours (red, green, blue). They function best in relatively bright light.

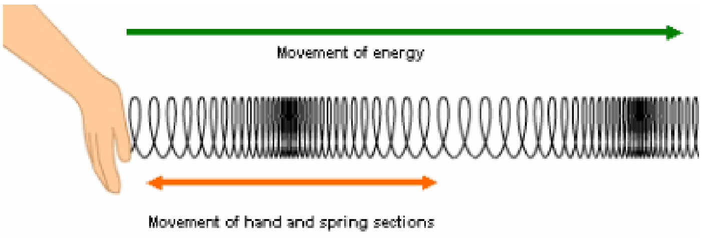
Rod cells can detect much lower levels of light than cone cells – this explains why when light levels are very low, it appears that things are in black and white.

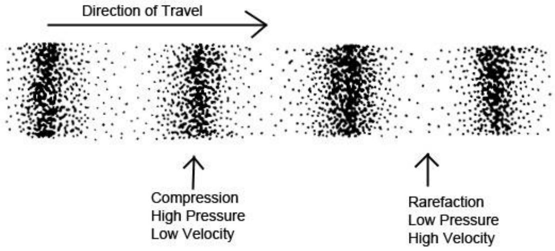
## Sound waves

# Knowledge Organiser Y8 Waves

Sound waves are 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**.

## Longitudinal waves



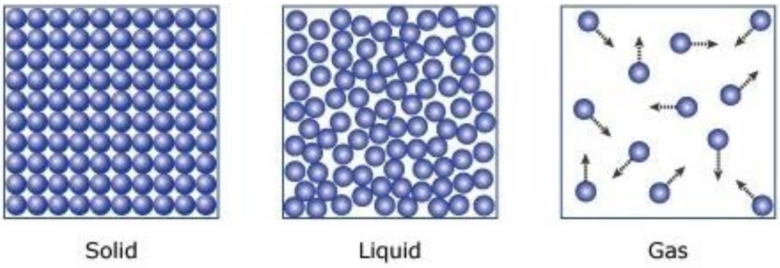




In longitudinal waves, the particles vibrate in the **same direction** as the wave is travelling. Examples include sound waves, seismic P waves, waves on a slinky (seen in picture on left above)

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

## The speed of sound waves

Year 7 Particle Model Recap!



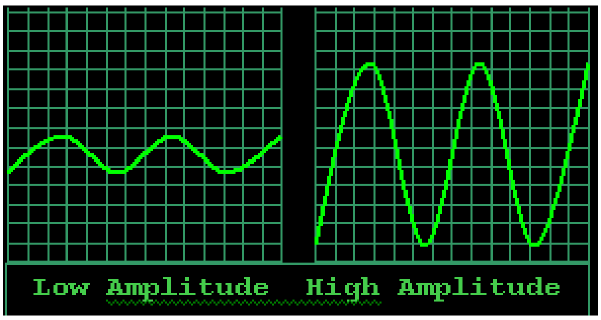

Sound waves travel fastest in solids because the particles are close together. Sound waves travel slowest in gases because the particles are so far apart.

The speed of sound in air is around 340 m/s.

This is nearly 1 million times slower than the speed of light. This is why you see a firework explode before you hear the explosion!

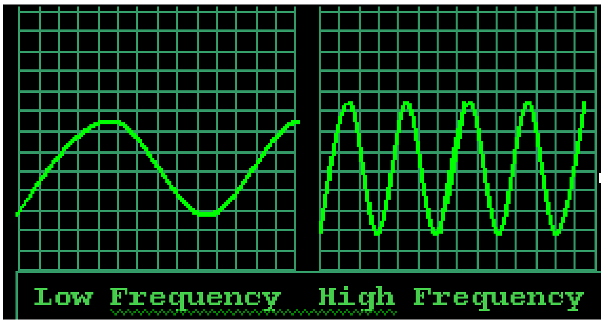
## Properties of sound waves

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.

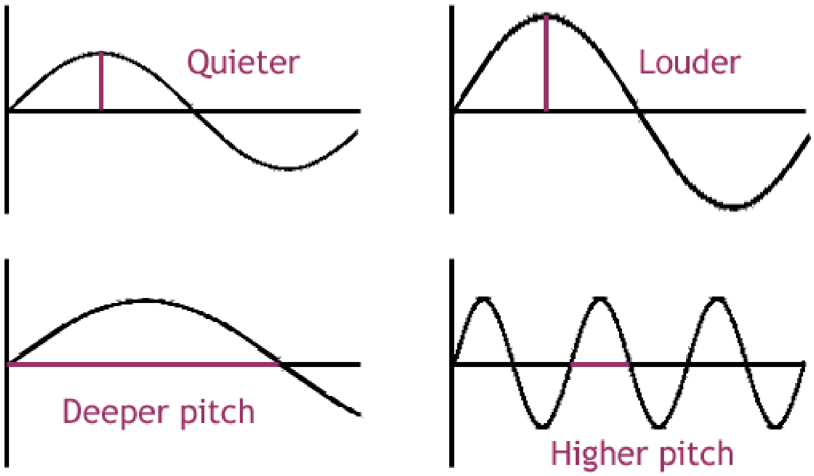



The loudness of a sound is described as the **volume** or **intensity** of the sound and is measured in **decibels (dB).** The volume is determined by the **amplitude** of the wave. The larger the **amplitude** of the wave, the louder the sound.

# Knowledge Organiser Y8 Waves

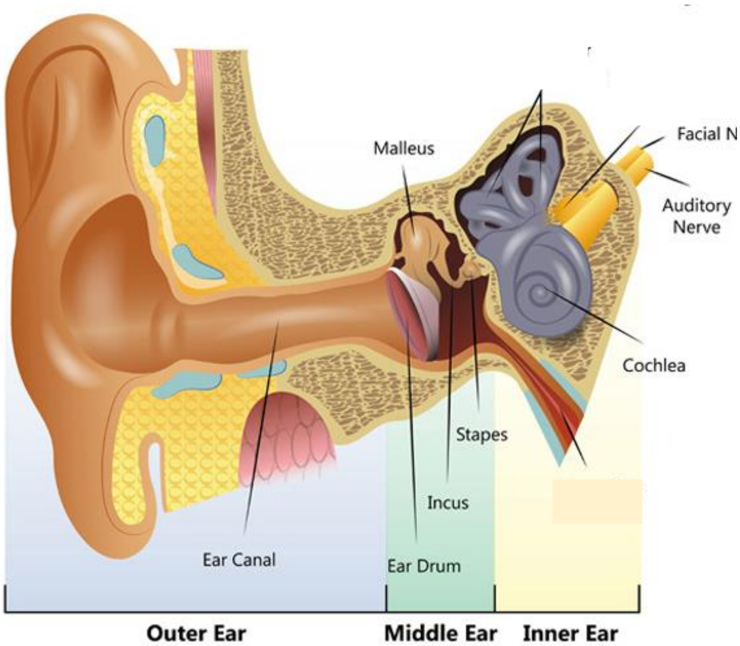



The **pitch** describes how high or low a sound is and is determined by the **frequency** of the wave. The higher the frequency  the higher the pitch of the wave.




**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 |

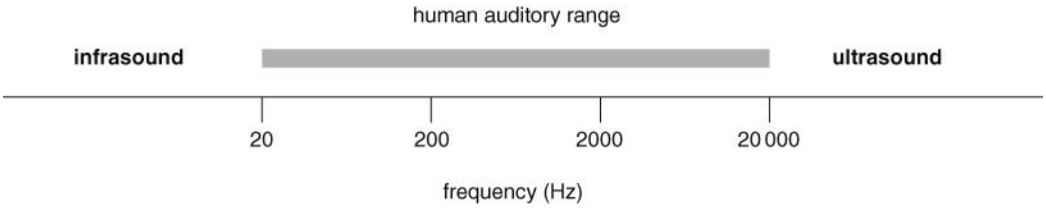



Exposure to high volumes of sound can cause permanent hearing loss or a ringing in the ears called tinnitus. Hearing loss may be caused by damaging the ear drum itself, or by flattening the tiny hairs in the cochlea.

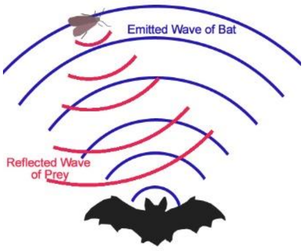
**Ultrasound**

# Knowledge Organiser Y8 Waves

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 (20kHz).

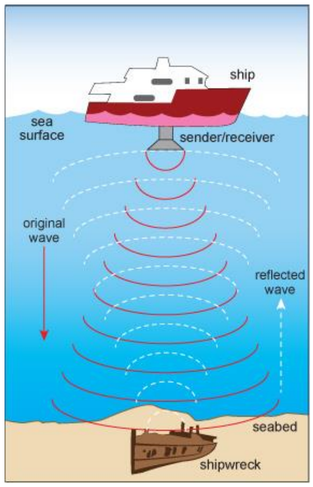



Any sound with a frequency lower than the human auditory range is called **infrasound**. Any sound with a frequency higher than the human auditory range is called **ultrasound.**




The reflection of a sound wave is called an **echo**. Some animals, such as bats and some dolphins, use the echoes of ultrasound to locate prey and avoid obstacles. This is called **echolocation**.

Humans use the echoes of ultrasound in **sonar** technology to find the depth of the sea or locate fish or submarines. The reflection of ultrasound is also used to detect small cracks in machinery and in ultrasound scanning (e.g. foetal scanning)




We can also use the energy transferred by ultrasound to clean delicate objects such as jewellery, in physiotherapy (to relieve pain or aid healing) or breaking up kidney stones.