Light & Sound Key Notes

Shadows & The Eye

Light carries energy and travels as a wave

Light travels extremely quickly - 300,000 km/s (much faster than sound - think about fireworks / thunderstorms)

Light waves travel in straight lines (it cannot bend around corners)

Light travels in straight lines (it cannot bend around corners). Shadows form because light cannot bend round behind an object

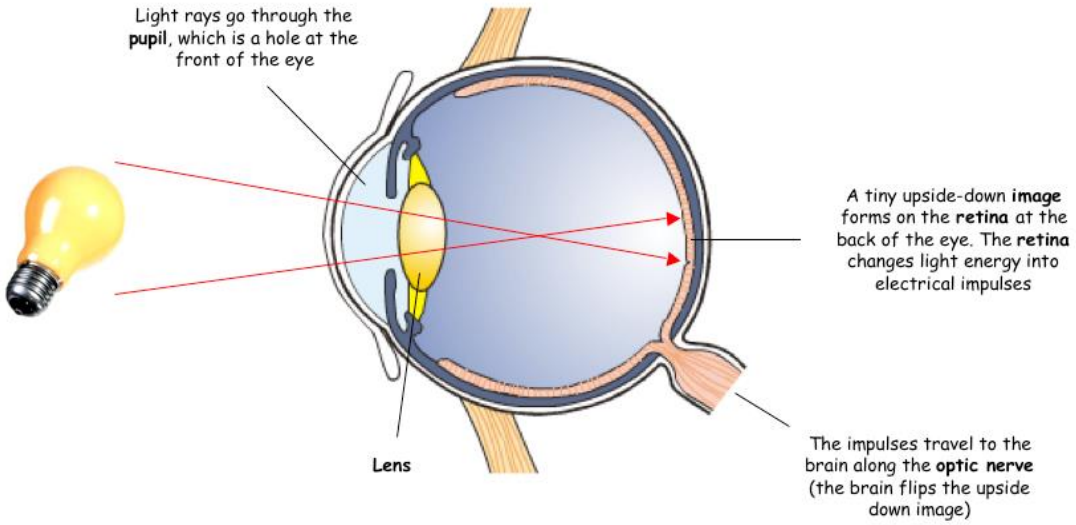
A luminous object gives out light (a light source), such as fires; light bulbs; stars (e.g. the Sun)

A non-luminous object does not give out light. We see non-luminous objects by light from a luminous object hitting the non-luminous object and reflecting into our eye

Opaque - materials which do not allow light to pass through them (e.g. a brick wall)

Transparent - materials which do allow light to pass through them (e.g. a glass window)

Translucent - materials which only allow part of the light to pass through them (e.g. paper)



- Retina - the light-sensitive part of the eye, covered in light receptors called rods and cones

- Optic nerve - carries impulses from the light receptors to the brain

- Lens - focuses light onto the retina
- Pupil - the hole in the iris where light passes through

- Suspensory ligaments - control the shape of the lens, along with the ciliary muscle
- Ciliary muscle - controls the shape of the lens, along with the suspensory ligaments

- Cornea - refracts (bends) light into the eye
- Iris - changes the shape of the pupil to control how much light enters the eye

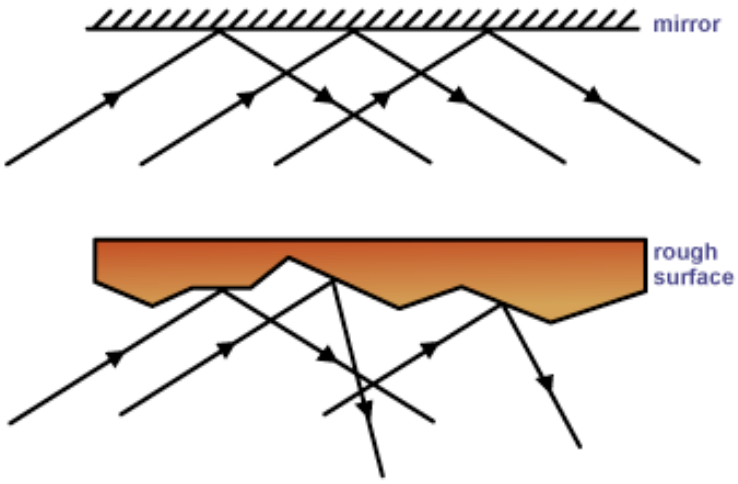
Reflection & Refraction

Light is able to bounce of surfaces - this is known as reflection

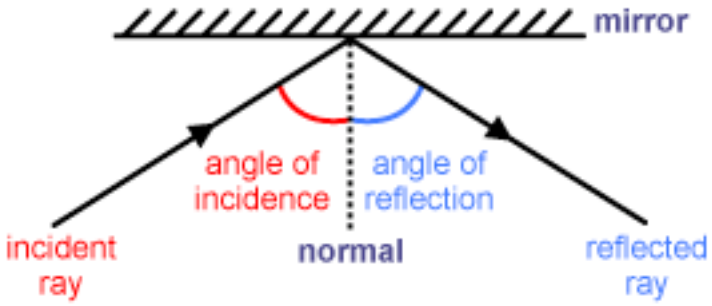
There are two types of reflection: clear & diffuse

Light can reflect off an even surface (such as a smooth and shiny mirror) where all the light is reflected off at the same angle - this is a *clear reflection*

Light can also reflect off uneven surfaces (such as a piece of paper) at lots of different angles - this is *diffuse reflection*

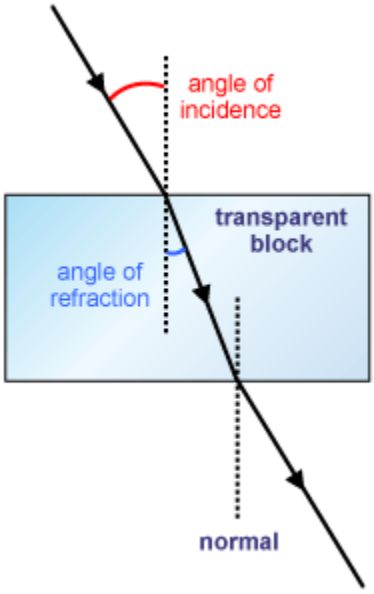


The angle of incidence = the angle of reflection



Light travels in straight lines. Light can **bend at the boundary** between two materials with different densities - this is called **refraction**

- The light ray bends towards the normal as it enters
- The light ray bends away from the normal as it leaves
- The ray entering the block is parallel to the ray leaving the block, if the block has parallel faces
- A ray entering the block at 90° is not refracted



The speed of light waves depends on the material they are travelling through

If light waves enter a different material (e.g. travel from glass into air) the speed changes, causing the light to bend or refract

Spectrum

White light can be split up to form a **spectrum** by using a prism (a triangular block of transparent material) – this is dispersion

The different colours of light have different wavelengths, this means they are bent (refracted) by different amounts (red has longest wavelength, violet the shortest wavelength)

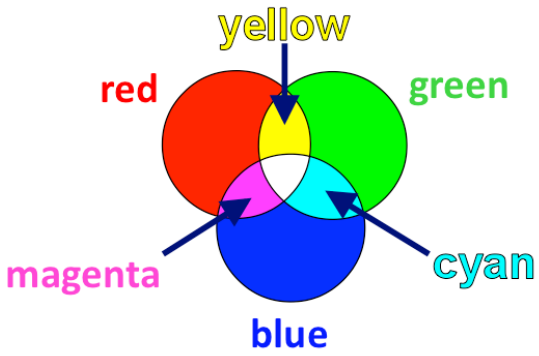
Colours are made by mixing other colours of light

Coloured objects reflect some colours and absorb others, e.g.

- A red dress absorbs all colours except red, which it reflects
- A green apple absorbs all colours except green, which it reflects
- Objects appear white if they can reflect all the colours of the spectrum
- Objects appear black if they absorb all the colours of the spectrum

The three **primary colours** of light are: red, green, and blue

Secondary colours may be made by mixing two primary colours together – these are: magenta, yellow, and cyan



Filters let certain colours of light pass through, but absorb all other colours

This is because they only let a certain type of light through (e.g. red filters only let red light pass)

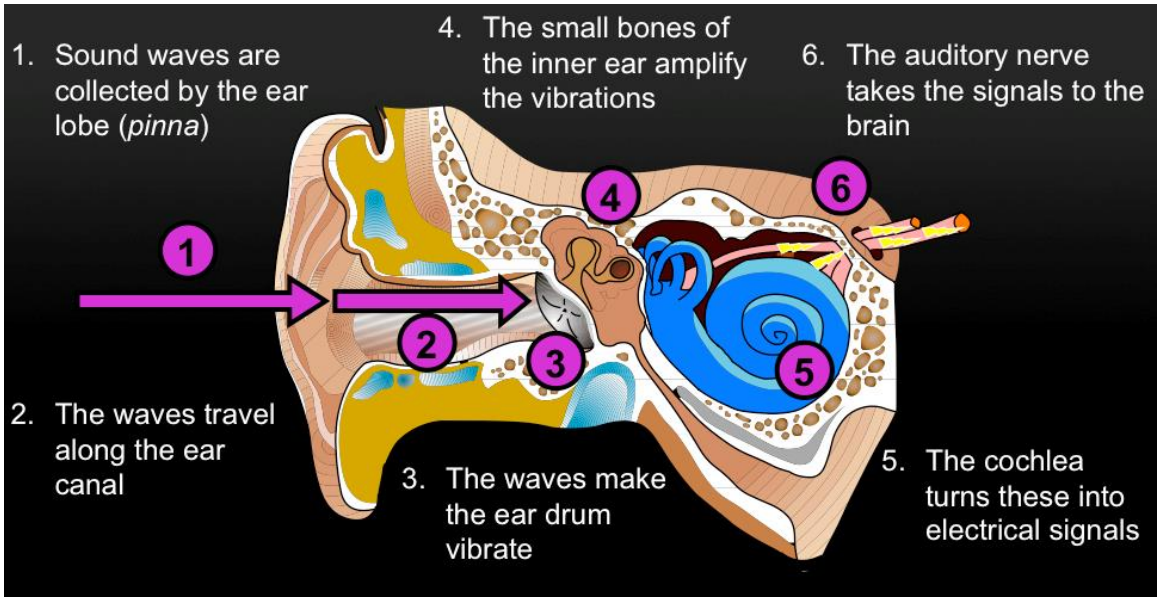
Sound

Sound is a form of energy, produced whenever an object vibrates (a guitar string / vocal cords / loudspeaker etc…)

Sound travels as a wave, similar to light, but for sound to travel it needs to vibrate particles. Sound cannot travel through a vacuum (no particles to vibrate) - in space, no-one can hear you scream!. Sound travels by vibrating one particle, which vibrates it neighbours, which vibrate theirs etc…

Sound waves travel **fastest** through **solids** - the particles in a solid are closer together than in a gas or a liquid meaning vibrations are more easily passed from particle to particle and so sound travels faster

Ears change sound energy into electrical signals, which are sent to your brain. Vibrating sound waves travel through the air, into the ear, making the **eardrum** vibrate. The **eardrum** vibrates the inner ear bones (anvil, hammer, and stirrup). These vibrations then reach the **cochlea**, where they are changed to electrical impulses, which travel to the brain

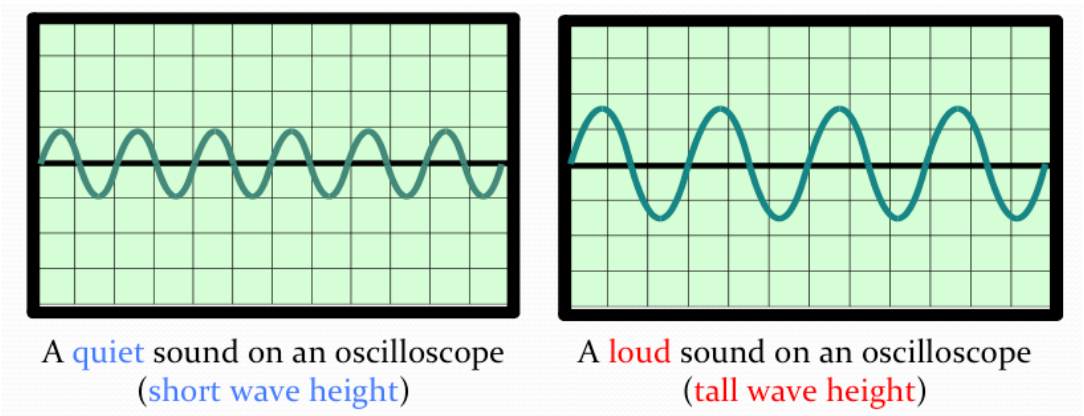


The ear is very delicate (thin membranes and tiny bones which can be damaged easily). Persistent levels above 90dB can result in hearing damage. Levels can be measured in decibels – more than 130dB will causes pain. Above 140dB even short exposure can results in hearing loss

Pitch & Volume

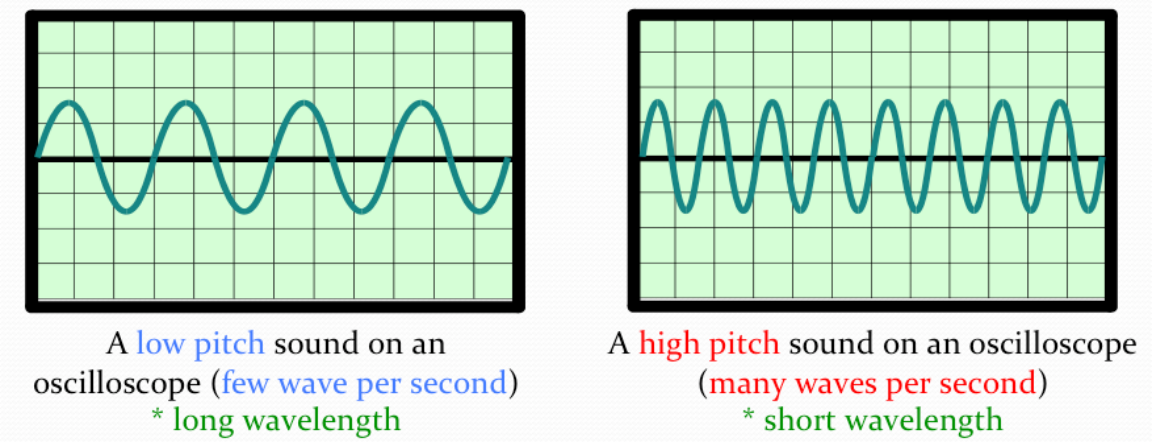
A sound can be quiet or loud

Amplitude is a measure of how loud a sound is (how much energy the wave carries) – a big amplitude means a loud sound



A sound can be low (mooing cow) or high (squeaking mouse)

Pitch depends on the frequency of the waves (number of complete vibrations each second, measured in hertz (Hz))



A low pitch sound on an oscilloscope (few wave per second)
* long wavelength

A high pitch sound on an oscilloscope (many waves per second)
* short wavelength

Human Hearing Range & Noise Pollution

Sound can be measured by a sound intensity meter – measuring the loudness of a sound in decibels (dB)

The threshold of hearing is the quietest sound we can hear (0dB), with pain beginning about 80dB and at 180dB the ear drum breaks!

Noise is any unwanted sound (noise is interpreted differently by different people). Noise can causes hearing problems, as well as headaches, nausea and deafness

We hear a range of sounds from low pitch to high pitch – this is the audible range

The audible range is roughly between 20 Hz and 20,000 Hz (but different people have different audible ranges). Remember, one hertz is one wave per second

Many animals have a much wider range of hearing, such as dogs, dolphins and bats…

Echoes & Ultrasound

Sound can **reflect** from the surface of an object this is called an **echo**

Hard surfaces reflect sound better than soft surfaces

As the sound wave travels some energy is lost, so you usually hear your echo with less amplitude (volume)

You can work out how far away something is using the reflection of waves

Distance = Speed x Time

*Remember to halve your distance, as the echo is from you to the object **and b**ack again!

Ultrasound is sound with a higher frequency than we can hear (i.e. above 20’000 hertz)

In nature some organisms, including bats, utilise ultrasound (they produce very high pitched squeaks, and convert the echoes into a picture of their surroundings, which is why they can fly at night)

Ultrasound waves pass through some materials better than others

Different parts of the body reflect the sound waves differently (echoes)

A computer picks these reflected waves up, and processes them into a image so we can see inside the womb

It is not known for sure if ultrasound is entirely safe, but it is certainly safer than using X-rays!