Waves 1 – Light and Sound

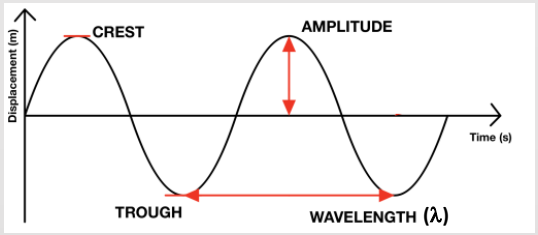
science physics

1) Waves

Waves **transfer energy** but without transferring matter. The energy is transferred **by vibrations or oscillations** in the material which the wave is travelling through.

Key definitions:

- **Peak/crest** – the top of a wave
- **Trough** – the bottom of a wave
- **Wavelength** (λ) – the distance between identical points on adjacent waves, measured in metres (m)
- **Amplitude** – maximum height (or depth) of a wave, measured in metres (m)
- **Frequency** - the number of waves passing a point per second, measured in Hertz (Hz)



There are two types of waves:

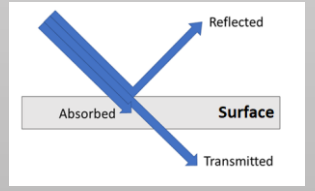
- **Transverse** – oscillations are perpendicular (at right angles) to the direction of energy transfer e.g. **light** waves
- **Longitudinal** – oscillations are parallel (in same direction) to the direction of energy transfer e.g. **sound** waves

2) Light Waves

Light waves travel in **straight** lines called **rays**. Light travels fast, around 300 000 km/s. We see objects because they **reflect** light into our eyes. When light is blocked we see **shadows**.

- A luminous object is one that produces light
- A non-luminous object is one that reflects light

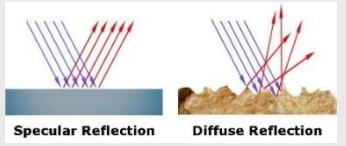
When light hits a surface it can be **absorbed** (doesn't pass through), **transmitted** (passes through) or **reflected**.



3) Reflection

There are two types of reflection:

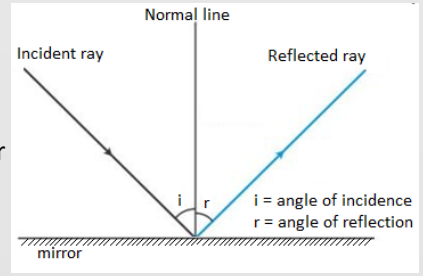
- **Specular** – at shiny surfaces
- **Diffuse** –at rough surfaces, light is scattered in all directions



The Law of Reflection:

When light reaches a mirror specular reflection occurs.

- **Incident** ray – light going towards mirror
- **Reflected** ray – light coming away from mirror
- **Normal** line – at 90° to the surface of mirror

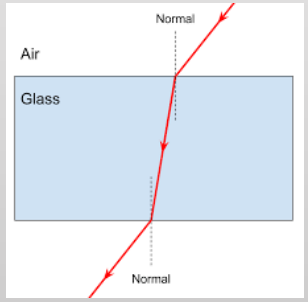


The **law of reflection** states that angle of incidence equals the angle of reflection, **i = r**.

4) Refraction

When light waves enter a material that has a different **density** the waves **change speed** and this causes them to **change direction**. This is called **refraction**.

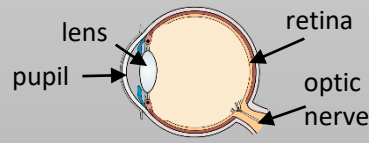
- When light enters a more dense material e.g. glass, it will slow down and bend towards the normal line
- When light then leaves the more dense material it will speed up again and bend away from the normal line



5) The Eye

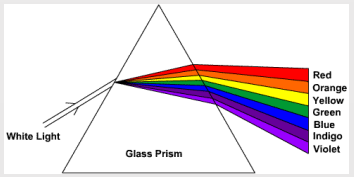
When light enters the eye via the **pupil**, the **retina detects the light** and sends the information to our **brain** via the **optic nerve**.

The **lens** in our eye **focuses** the light that enters our eye so that it meets at a single point on the retina.



6) Seeing Colour

White light is a mixture of red, orange, yellow, green, blue and violet (**ROYGBIV**).



White light can be split into the spectrum of colours using a **prism** as different colours **refract by different amounts**. This is called **dispersion**.

Red, green and blue are **primary colours** in light. All other colours you see are made by combining these in various ways. Yellow, cyan and magenta are secondary colours.

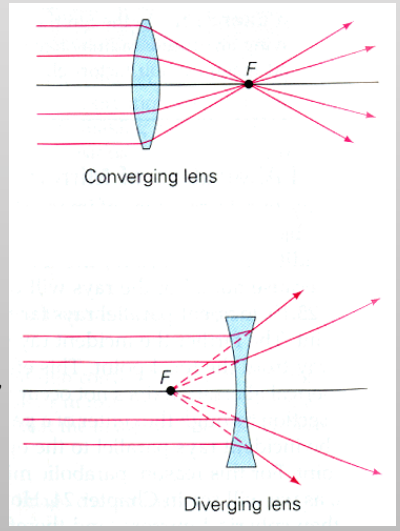
An object will only reflect the colour of light that it is and all other colours are absorbed.

e.g. red surfaces reflect red light into our eye, white objects reflect all colours of light into our eye, black objects absorb all light and reflect no colours.

7) Lenses

A lens is an optical device that either focuses or disperses a beam of light by refraction.
There are two basic types:
Convex lens
Concave lens

Lenses can be found in cameras, telescopes, glasses, mirrors, medical equipment and our eyes.



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7) Sound Waves

Sound waves are caused by **vibrations** and **need particles** to travel through. Sound can't travel through a vacuum as there are no particles. Sound waves **travel slower than light** waves – in air they travel 330 m/s. Vibrations form a wave of compressions (C) and rarefactions (R).

Sound waves **travel the fastest in solids** as particles are closer together, so vibrations are more easily passed on.

Making Sound Waves:

- String instruments make sounds by vibrating the strings
- Longer strings make a lower pitch sound, shorter ones make a higher pitch
- Vibrating the strings harder makes a louder sound

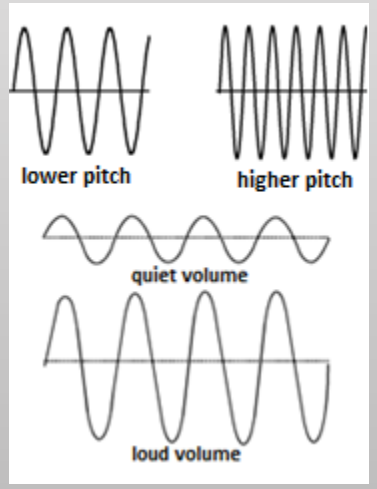
8) Pitch and Loudness

The **pitch** of a sound is linked to the **frequency** of the sound wave.

- **Higher pitched** sounds have a **higher frequency** (and therefore a shorter wavelength)

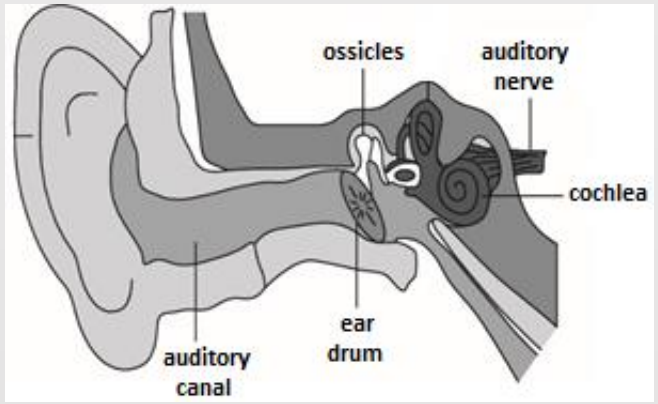
The **loudness** of a sound is linked to the **amplitude** of the sound wave.

- **Louder sounds** have a **larger amplitude**



9) The Ear

We can **detect sound** using our ears. Sound waves enter our ear and travel down the **auditory canal**. The sound waves make the **ear drum vibrate**.

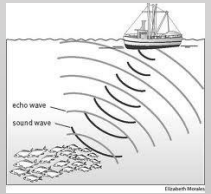


These vibrations are passed through the **three small bones** (called ossicles) to the **cochlea**. Tiny hairs in the fluid in the cochlea detects the vibrations and passes the information to the **brain** via the **auditory nerve**.

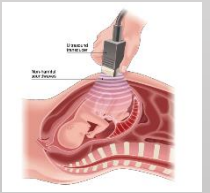
10) Echoes

Sound waves can reflect off surfaces, We hear sound reflections as echoes. Hard, smooth surfaces are good at reflecting sound waves.

Used by animals such as bats for **echolocation**



Used in ships **sonar** to find fish or the seabed



Used in medicine for **ultrasound scans**

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