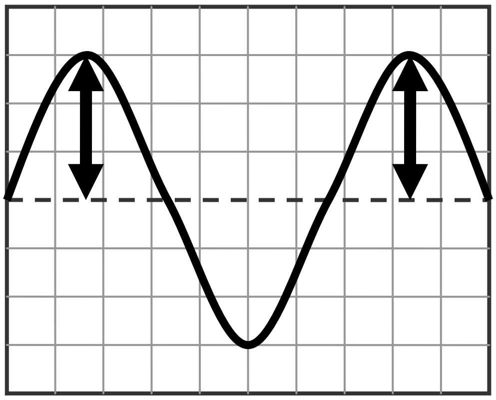
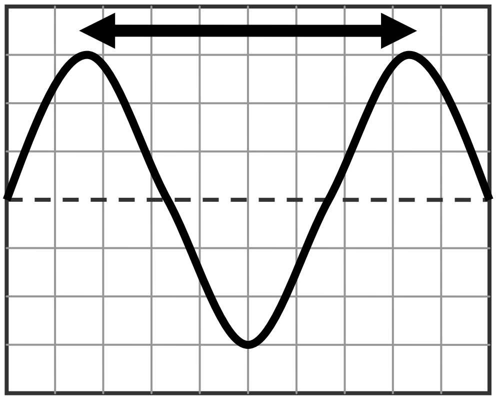
1. Wave Properties

What is a wave?
Waves are a way of transporting energy from one place to another. They do this through some form of vibration. We see waves all the time, for example, ripples on a pond or waves in the sea. Sound and light are both types of wave.

Describing Waves

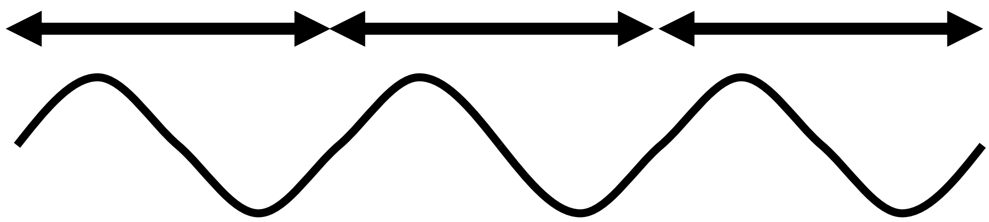
Amplitude
The height of a wave is called its amplitude. The size of a wave is to do with how much energy it has.
The amplitude is the distance measured from the middle of the wave to the top of the wave.





Wavelength
This is simply the length of a single wave, measured in metres from one peak to the next peak.

For example , the wave below is made of three single waves:



Frequency
The number of waves that pass each second is known as the frequency. Frequency is measured in Hertz.
So if 4 waves pass in one second the frequency is 4 Hertz.

2. Light

Reflection

Waves can reflect. The only reason we can see anything is that light reflects off objects into our eyes.

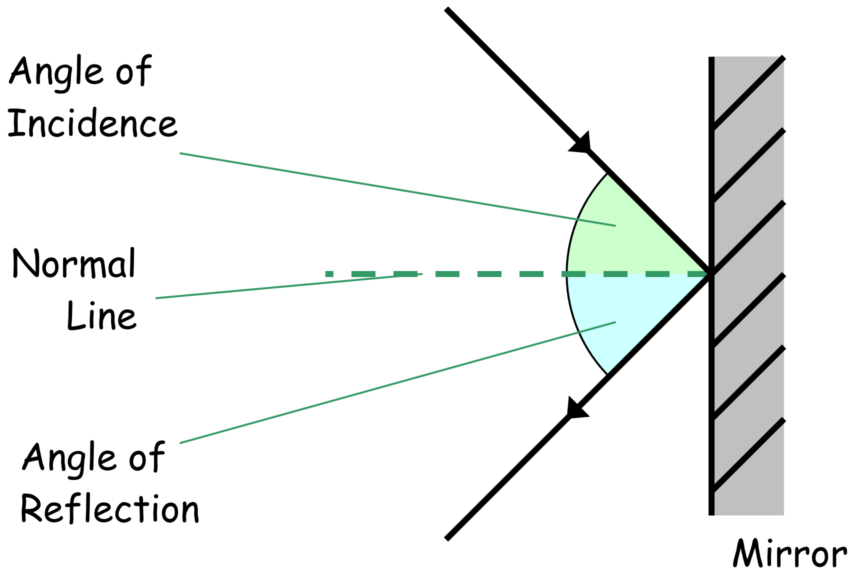
Often the surface involved is very smooth such as polished metal or a mirror.

The law of reflection

When light is reflected from a smooth polished surface like a mirror it follows the Law of Reflection.

In the study of light, we often draw a "NORMAL LINE" where a ray of light meets a surface. This line is always drawn at 90° to the surface. All important angles are measured from this line. This is shown in the diagram below. Note that both angles are measured from the normal line.

The law of reflection states that the angle of incidence will always be equal to the angle of reflection.



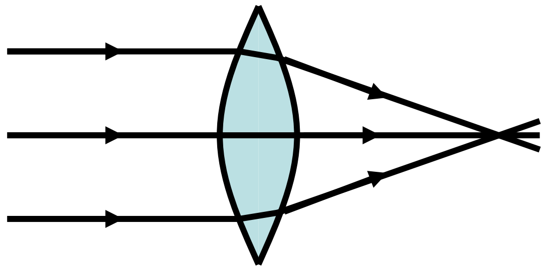
Refraction

Light travels in straight lines but when it passes from air into a glass or perspex it can change speed and direction.

Curved shapes of glass can be used to focus light onto a point or spread it out. We need to know about two types of lenses.

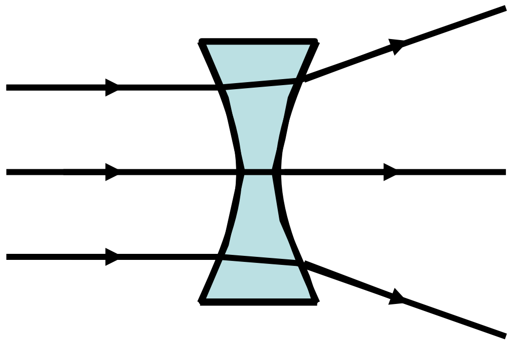
Converging Lenses

A converging lens (sometimes called a convex lens) is wider in the middle than at the edges and brings the light together.



Diverging Lens

A diverging lens (sometimes called a concave lens) is thinner in the middle than at the edges and spreads light out.

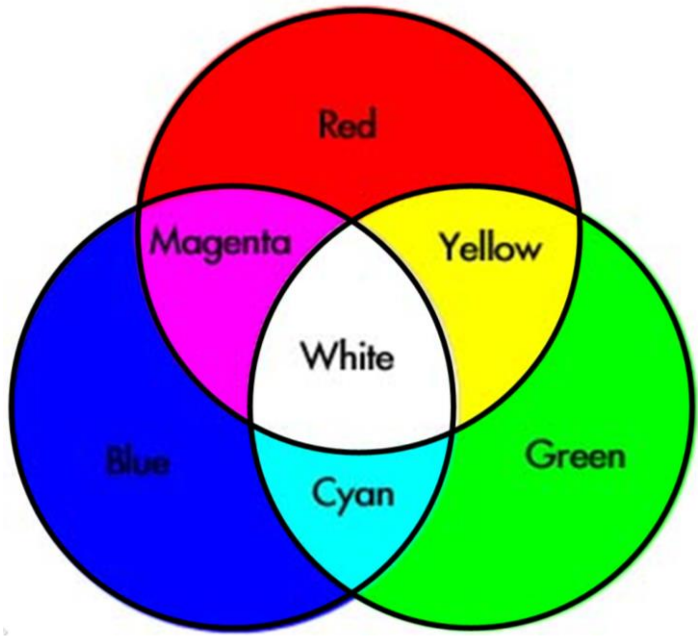


3. Colour

We often say there are three primary colours:

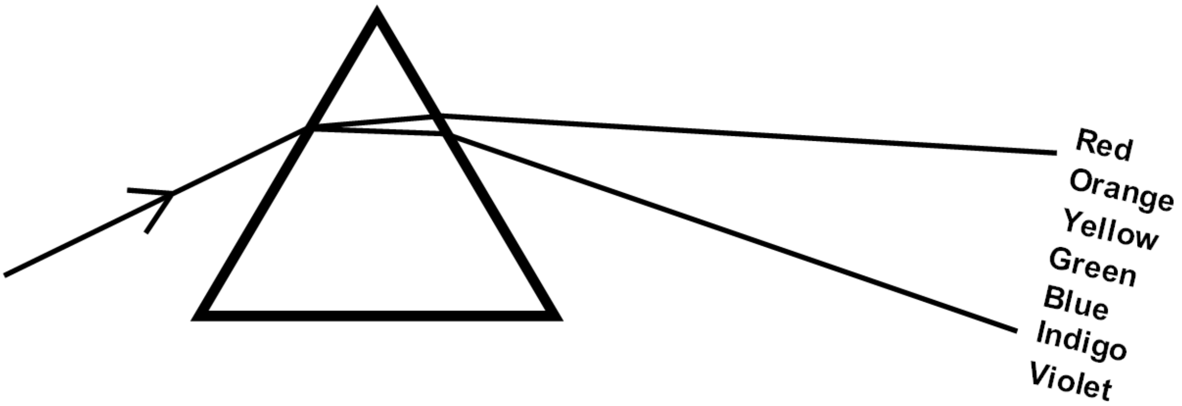
Red **Green** **Blue**

When the eye sees two or more of these the brain sees this as a different colour. This diagram shows how the colours mix:



We see white when all colours are present.

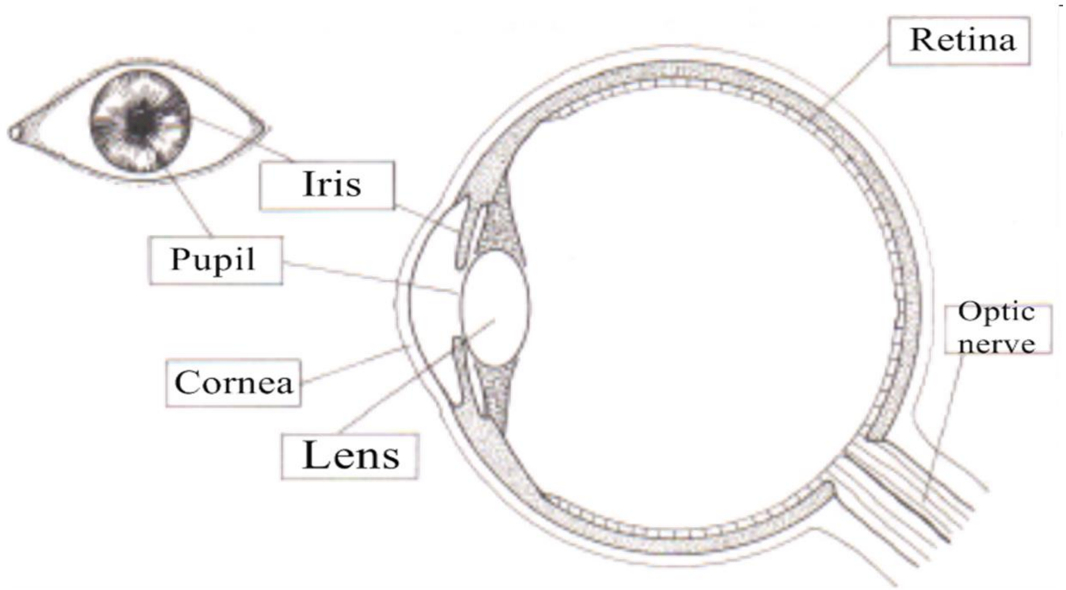
We can split light using a prism. This shows us the orders of colours in the spectrum.



4. Optical Instruments

The Eye

The parts of the eye are as shown:



The lens focusses light onto the retina.

Cameras also contain lenses but instead of a retina they use film or light detectors.

Microscopes are used for looking at small things. They also contain lenses.

5. Electromagnetic Spectrum

Electromagnetic Waves

Light is only one type of electromagnetic wave. There are other types. Together all these types of wave make up the electromagnetic spectrum.

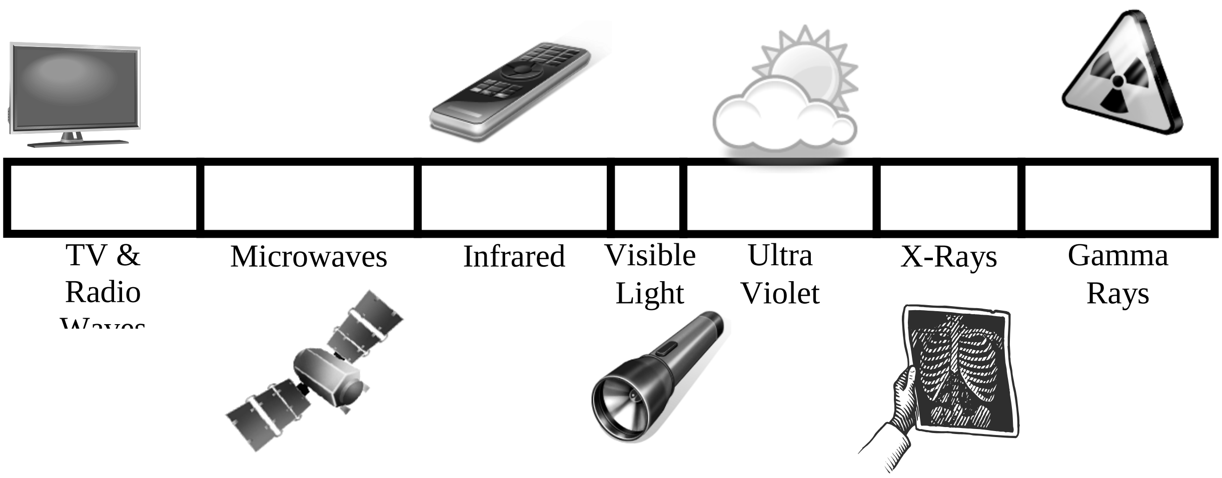
We use electromagnetic waves for a variety of purposes in communication, health and industry.

The EM Spectrum

The diagram below shows the different sections of the EM spectrum. It is important that you remember the names and order of the different types of EM radiation.

All the waves in the EM spectrum move at the speed of light

The pages which follow give information about the parts of the EM spectrum and their uses.



Radio Waves

Radio waves are used for communication, for example for traditional radio stations or in two way radios.

Television Transmission

Some radio waves waves are used to carry TV transmissions.

Microwaves

Microwaves are used for communications and (at higher strength) in microwave ovens for cooking. In communications they are used for satellite communications.

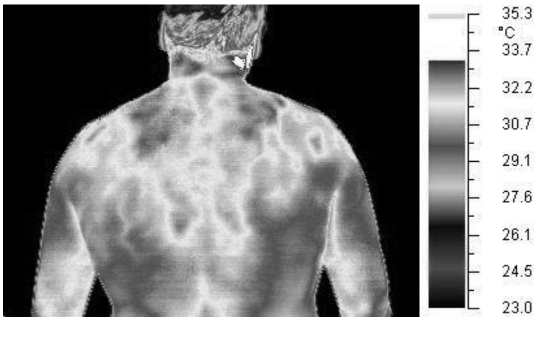
In microwave ovens, very high power microwaves are created inside and the energy is absorbed by the food causing it to heat up. For safety, the construction of a microwave oven prevents any of the microwave energy escaping.

Infrared Radiation

Infrared radiation is given out by all objects that are warm.
Special cameras can be used to detect this radiation and use it to find out the temperature of the object.
Infrared is also used for short range communications such as in TV remote control handsets.

In medicine, infrared radiation can be used to look for tumours.
They tend to be hotter than the surrounding tissue.

Infrared lamps emit infrared radiation which heats the skin and the muscles beneath. This can be used to heat injured muscles which can help injuries to heal faster.



Visible Light

We use visible light all the time to see. This is the only part of the EM spectrum our eyes are capable of detecting. Because of this there are many ways that visible light is used. A few examples are listed below,

Lasers are used throughout medicine to apply intense heat to a very small area. They can be used to correct eyesight, remove tattoos or burn away tumours. Some operations even involve the use a of a laser scalpel to cut flesh. In industry lasers can be used to weld metal and cut wood with great precision.

These incredibly thin transparent fibres are used in hi-tech communication systems. They are capable of transmitting far more information down a single fibre than traditional electrical wires and have brought technology like high speed broadband internet into everyday use.

Ultraviolet

UV radiation is given out by then sun, and although our atmosphere blocks most of it, some still gets to us on the surface. UV radiation is the part of sunlight which causes a sun tan. When exposed to too much UV, the skin is damaged, which we call sunburn. In cases where people are regularly sunburned, they can develop skin cancer.

UV radiation is also used in medicine in lower strengths to treat some skin conditions although exposure must be carefully monitored.

Some chemicals glow when exposed to UV light. Many "invisible inks" appear invisible until UV light is shone on them. This is used for security marking on bank notes. Some people also write their postcode onto their bike in this ink in case it is ever stolen.

X-Rays

X-ray radiation passes through most materials. Where it is absorbed it will damage the material and can, in high doses, damage and even kill living cells. A person's exposure to X-ray radiation must be carefully monitored.

Doctors have been making good use of X-ray technology for many years. The radiation passes through most muscle and tissue in the body, but is absorbed by bone. X-ray radiation can be directed through a patient and onto a detector which is usually either electronic or a piece of photographic film. This will reveal a picture of the bones inside the patient which can be examined to determine the condition of fractures prior to treatment.

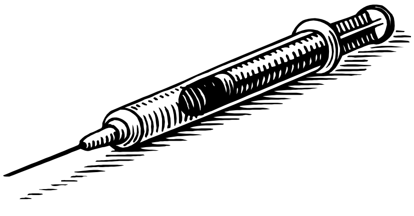
In large doses, X-ray radiation can kill cells or cause dangerous mutations which can result in cancer. For this reason, doctors who work with X-ray machines on a regular basis are required to stand behind protective screens while X-ray photographs are taken. This limits their exposure to the radiation. Most individual patients are limited to a small number of X-ray examinations per year for safety.

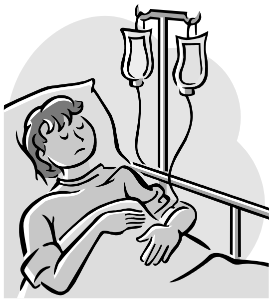
Gamma Radiation

Gamma rays are a type of nuclear radiation. They are emitted by substances which are unstable and cannot be turned on and off like X-ray generators or UV lamps.

Gamma rays pass through most materials including the human body. At low strength they pose little risk to health, however, high strength gamma rays kill living tissue.

Doctors use gamma rays for both diagnosis and treatment. Radiation Therapy (sometimes called Radiotherapy) is where high strength gamma rays are used to kill living tissue deliberately. Focussed gamma rays are directed towards a tumour and will kill the cells there. This treatment can help to cure cancer, but also severely damages the surrounding tissue.



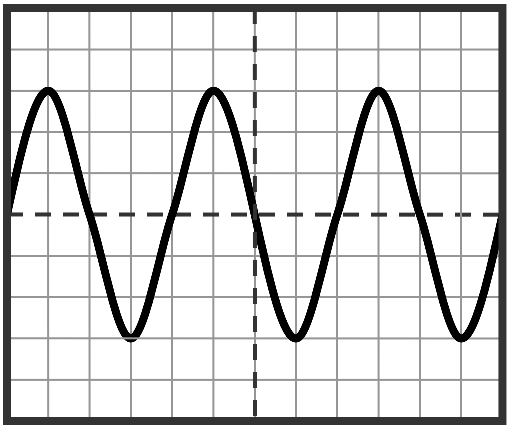


6. Sound

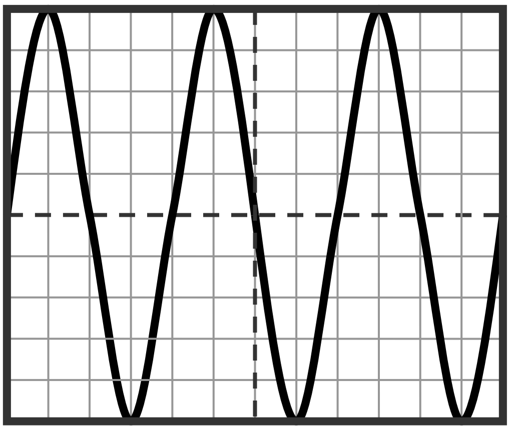
Sound is a vibration in a material like air or water. Sound can travel through materials but cannot travel through a vacuum. If there is nothing to travel through the sound cannot pass.

<u>Changing Amplitude (volume)</u>

For a sound wave the volume is determined by the volume.
The louder the sound, the greater the amplitude.



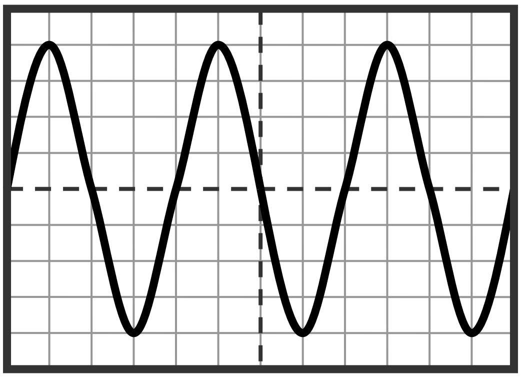
Quieter Sound (smaller amplitude)



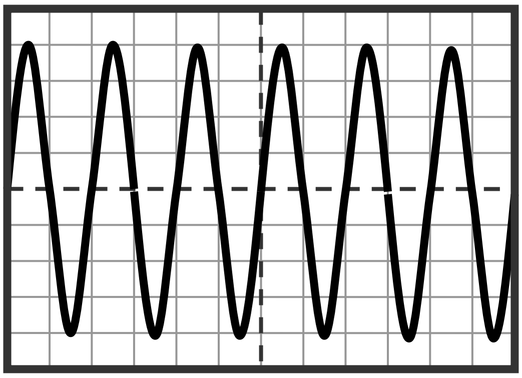
Louder Sound (larger amplitude)

<u>Changing Frequency (pitch)</u>

For a sound wave the pitch is determined by the frequency. The higher the frequency the higher the note which is heard.



Lower Frequency (Lower pitch)
(3 waves shown on screen)



Higher Frequency (higher pitch)
(6 waves shown on screen)