What is light?

Light is a form of energy.

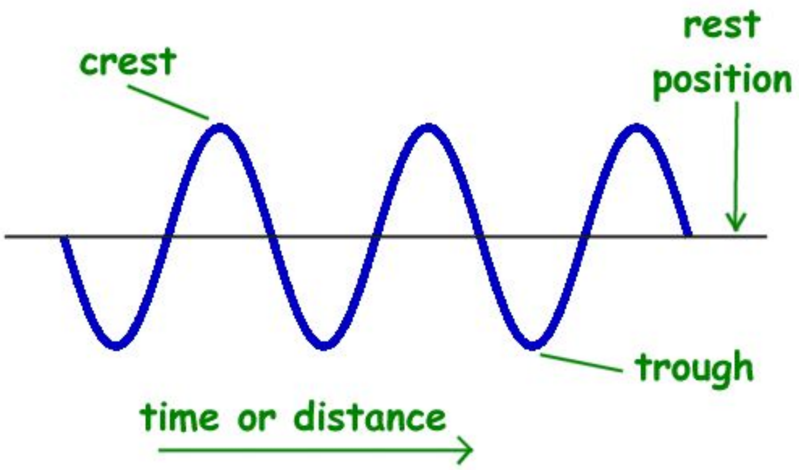
Most of our light comes from the Sun.

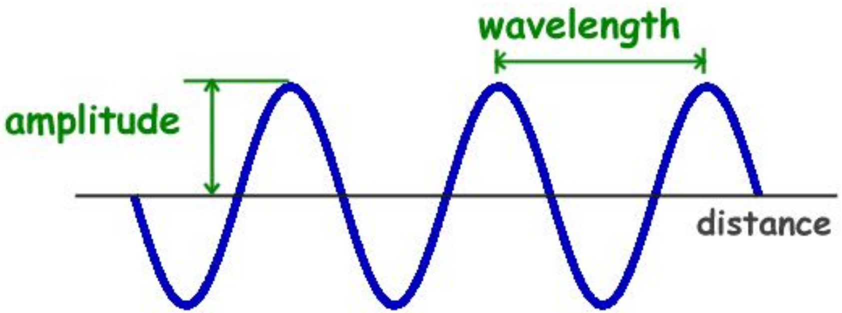
We have invented ways of having light when the Sun has gone down.

Light travels as a Wave

Waves have a frequency and a periodic time.

Frequency is how often the crest of a wave passes a chosen point in a second of time.

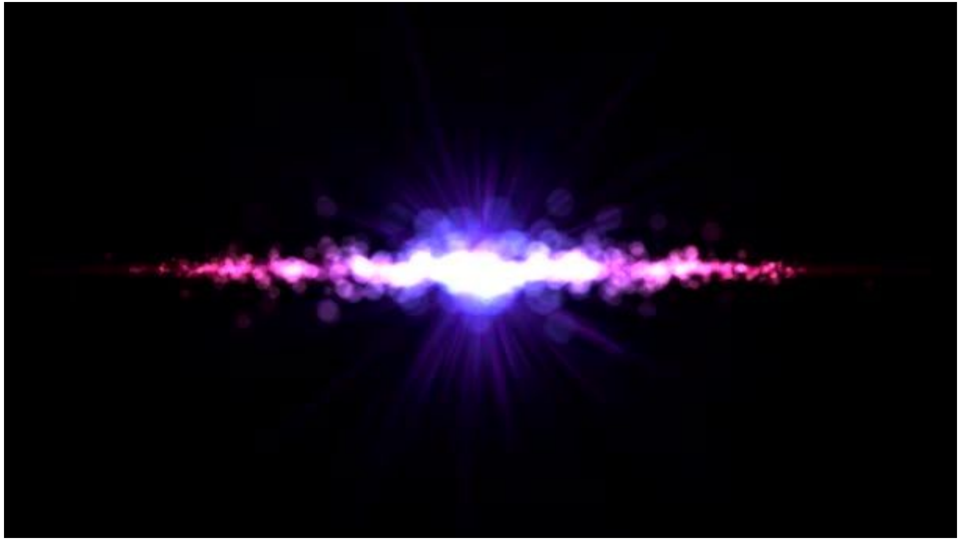




Light

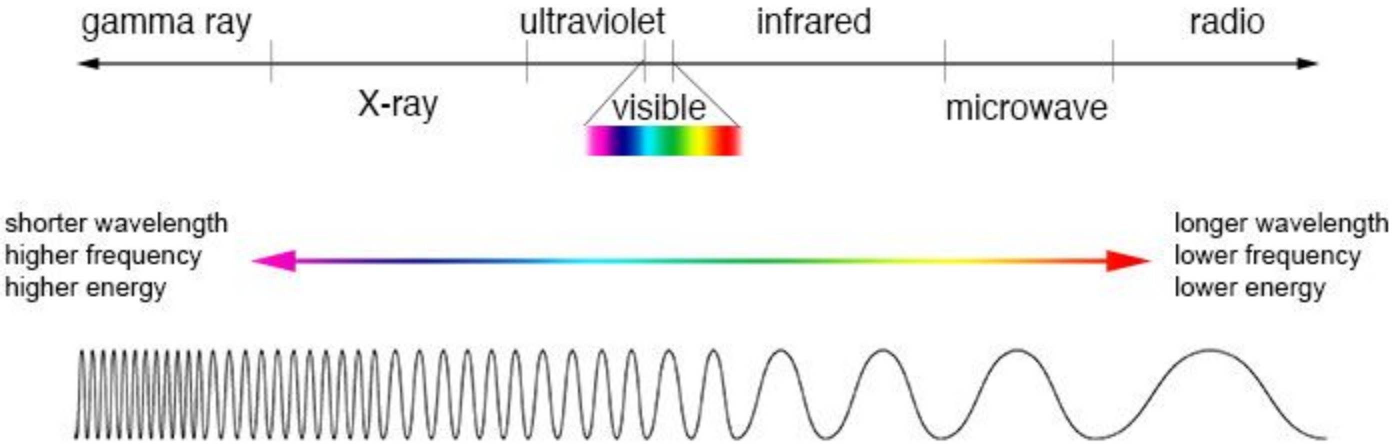
Light travels as a wave but it also acts as a particle. Strange but true!

Particles of light are little bundles of light energy and are called photons



Light

The electromagnetic spectrum- waves that travel at the speed of light

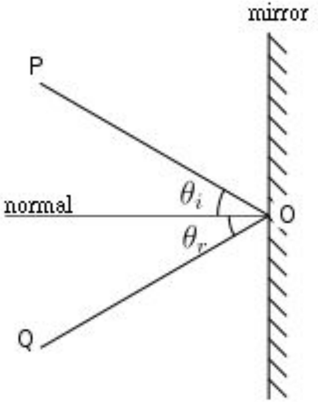


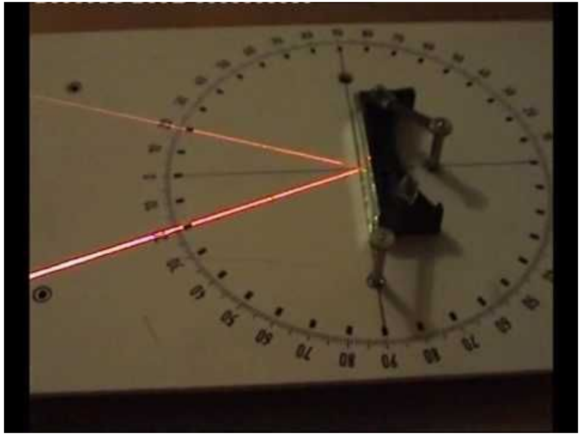
Reflection

Mirrors reflect light

When a ray of light hits a mirror, it is reflected back

The angle of incidence equals the angle of reflection



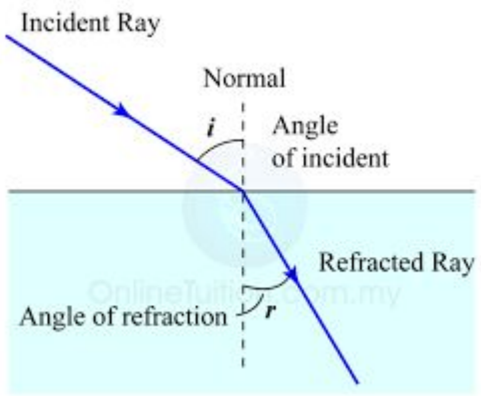


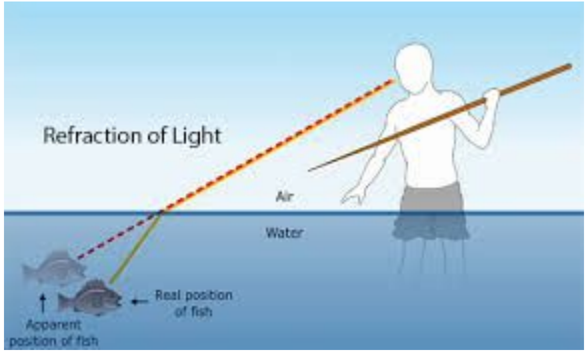
Refraction

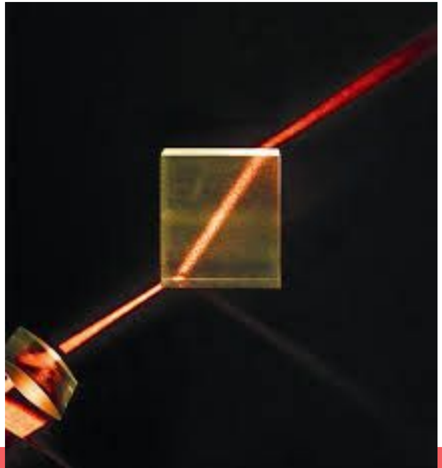
Light travels at different speeds depending on what it is travelling through.

Speed of light in a vacuum (like space) is 299,792,458 metres per second.

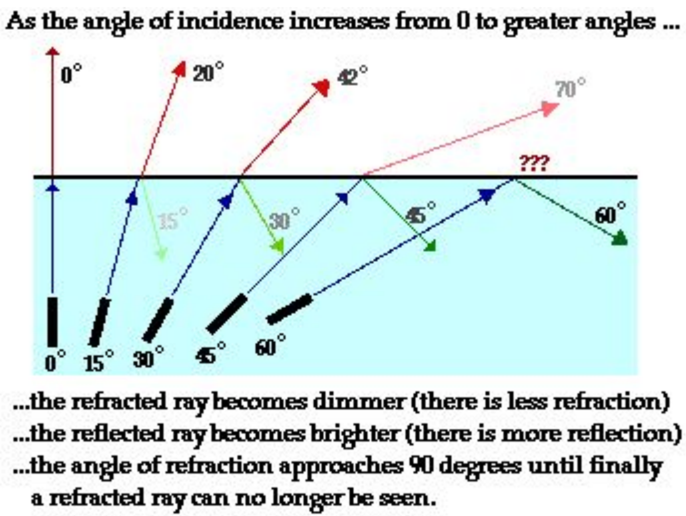
It slows down more the more dense the matter it is travelling through is.

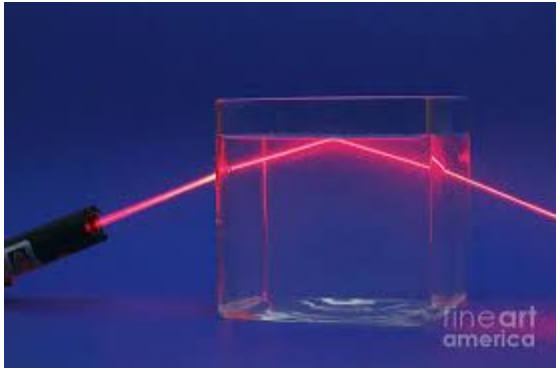


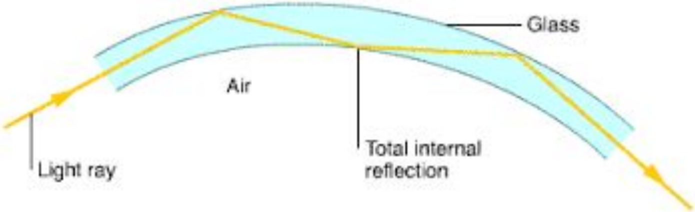




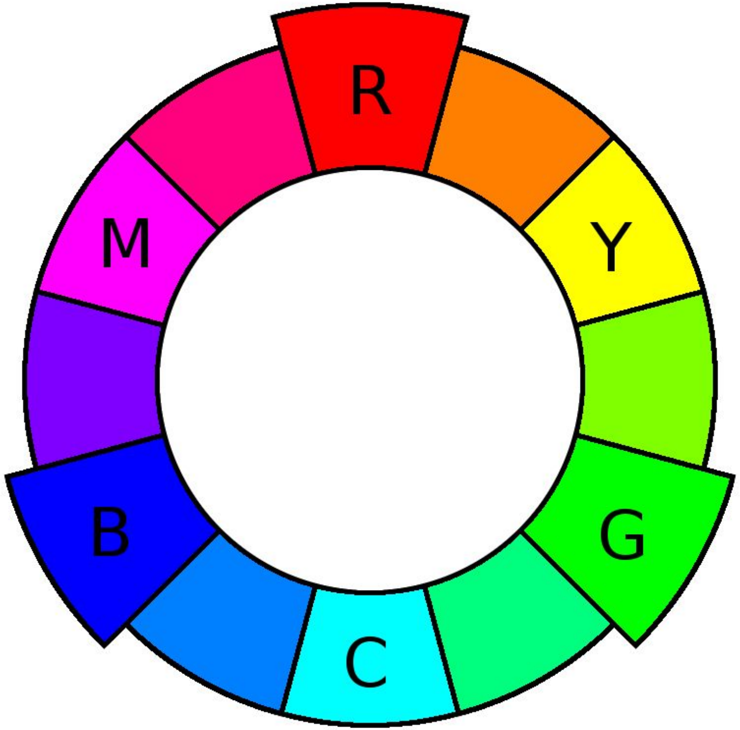
Total internal reflection

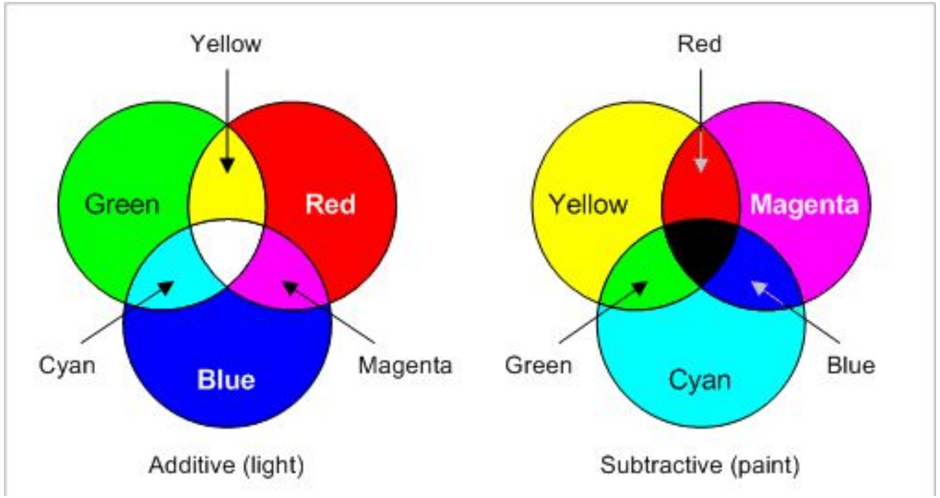






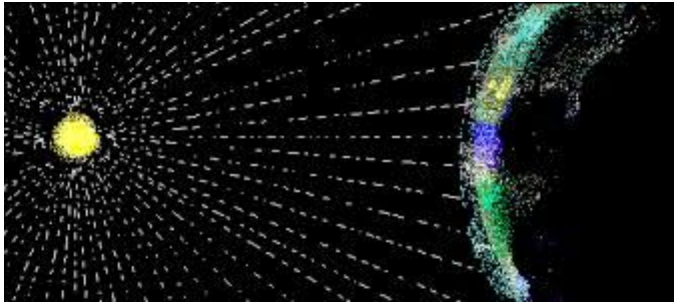
Additive and Subtractive Colours



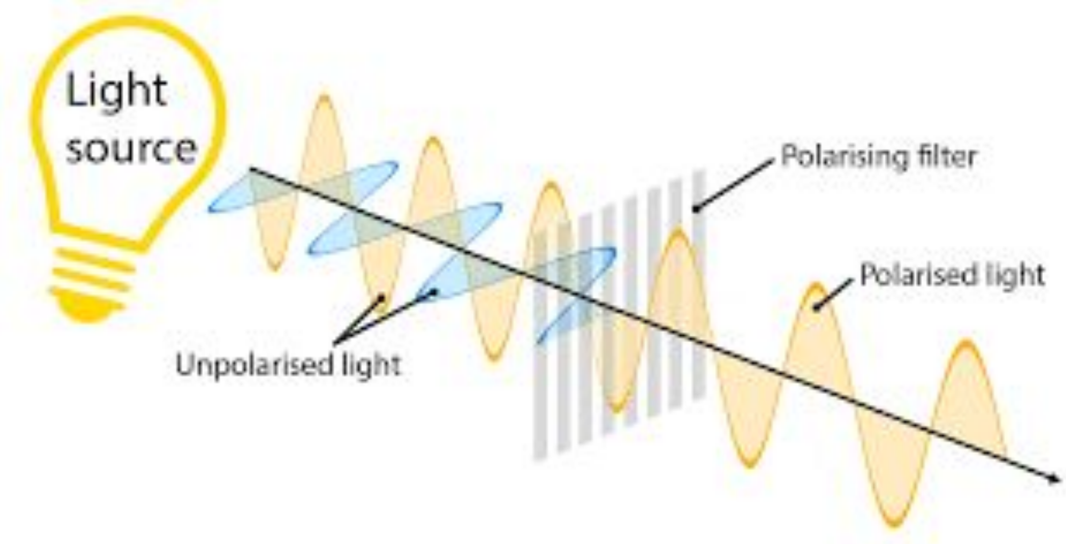


Polarisation

Light waves from the Sun come out in all directions.



They are also unpolarised. This means that the wave could be oscillating (going up and down) at any angle.

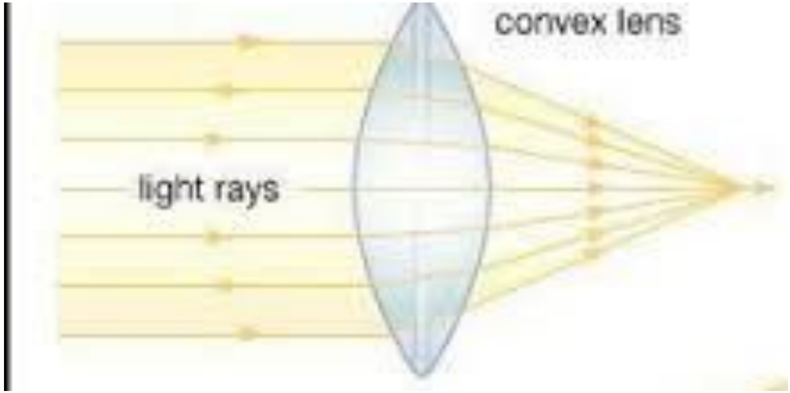


Can we see Ultraviolet light?

Usually, humans can't see UV.

The reason for this is that the lens inside our eyes filters out the UV.

But what if you didn't have a lens...?



Why can't humans see UV?

It is so that we can see fine detail.

UV scatters a lot so ends up making it hard to see the contrast between light and dark well.

If the lens in our eye let UV through, it wouldn't be focussed properly so the image would be blurred.

So, in order to be able to see fine detail - or with 'high acuity', we have lost the ability to see UV that many other mammals can still see.

Lenses

The eye

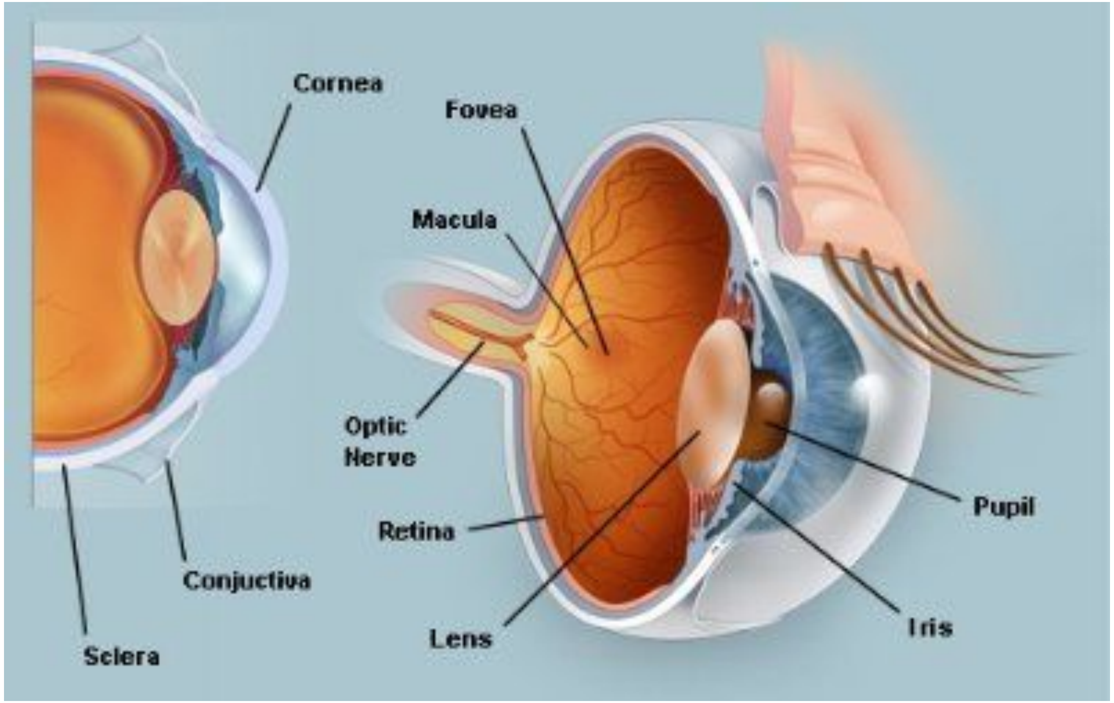
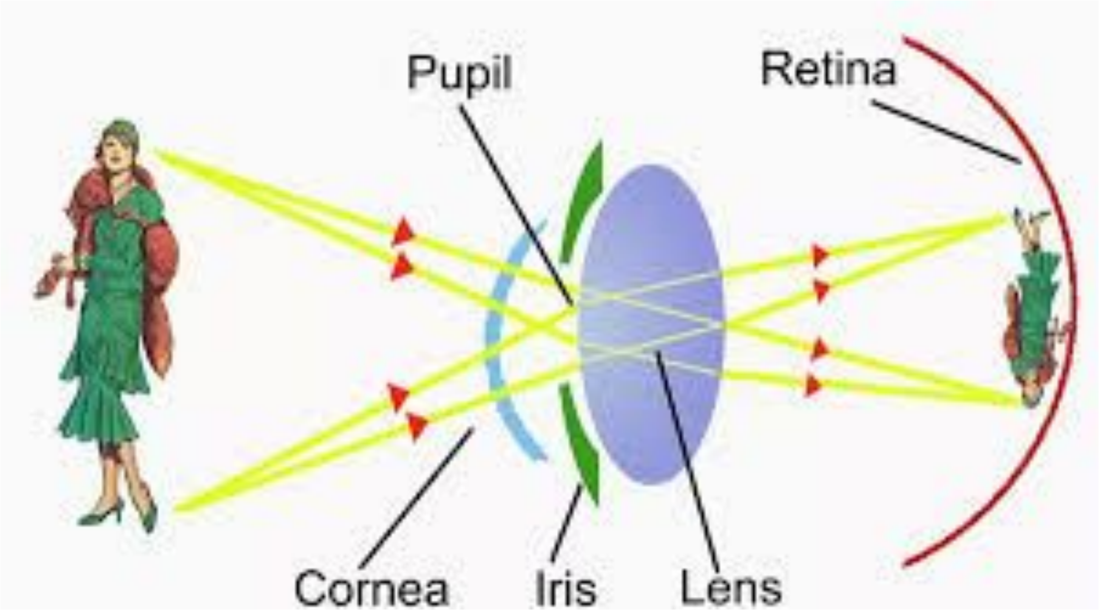


Image reversal in the eye



Focussing the lens in our eye

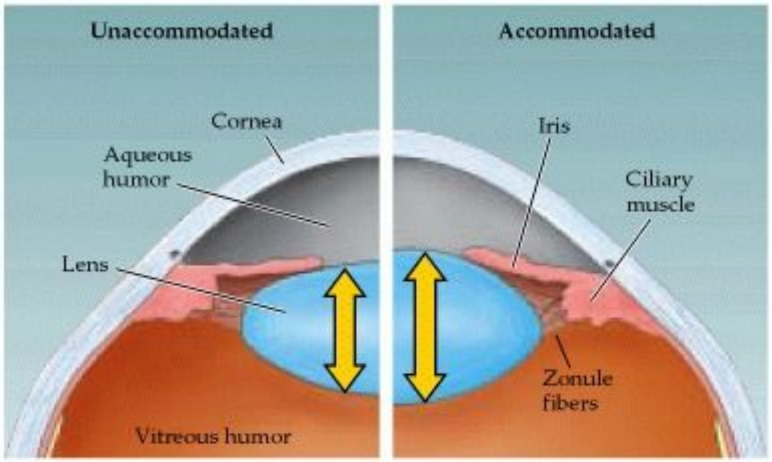
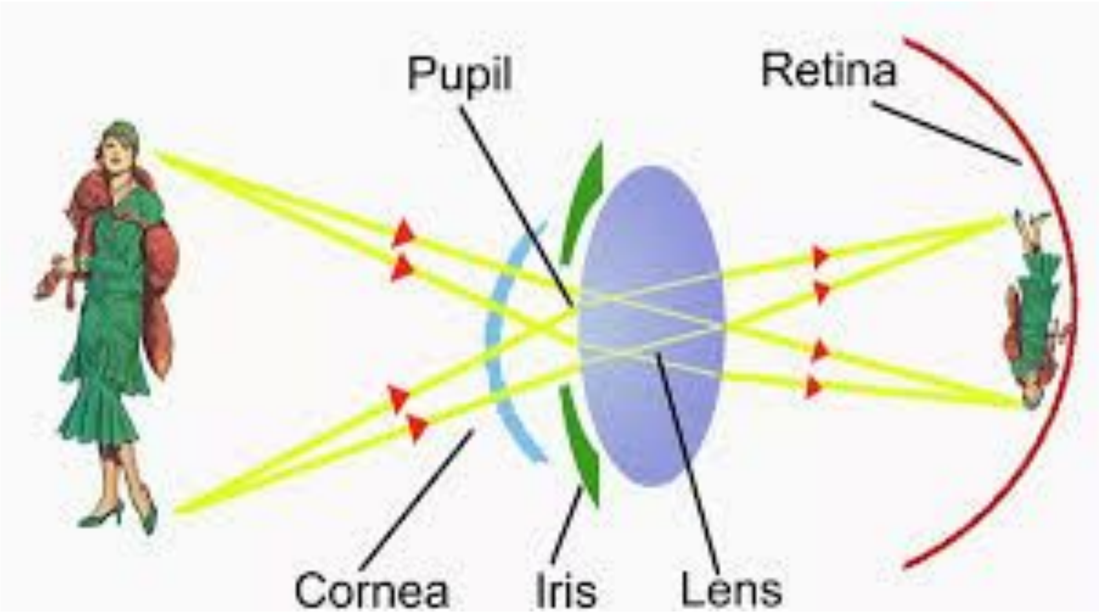


Image reversal in the eye



Turning the world upside down

What you need:

Cardboard cylinder

Plastic lid

Pin

Scissors

Tissue paper

Sellotape

Aluminium foil

What you do:

1. Draw a line 5 cm from the bottom of the tube, all around the tube, near the metal end.
2. Cut along the line
3. Use the pin to make one hole in the centre of the metal base of the cylinder
4. Cut a piece of tissue paper to fit into the plastic lid as perfectly as possible. Stick it just at the edges, not in the middle.
5. Put the plastic lid onto the cut end of the 5cm length of tube.
6. Join the two pieces of tube together, with the plastic lid being in the middle
7. Wrap aluminium foil around the length of the tube so no light can get in along it.
8. Look through the wide part of the tube at something very bright. You should see it on the tissue paper screen inside the tube, but it will be upside down.

Blind spot

What you need:

Paper

Pencil

What you do:

1. Draw a small circle on the left hand side of your paper
2. Draw a plus sign (+) on the right hand side of your paper
3. Hold the paper in front of you at arm's length and close your right eye. Look at the + sign with your left eye.
4. Bring the paper towards you slowly while still looking at the +. At a certain point, the circle will disappear. Bring the paper closer and it should reappear.
5. You can try it the other way around too: close your left eye and look at the circle and repeat the experiment.

In focus

Our eyeballs are constantly moving to get a sharp image of what we're looking at.

Put your arm out at arm's length in front of you. Look at your thumbnail. This is the size of the area that our eyes can have in sharp, perfect focus at any one time. If we want to see something bigger, our eyeballs have to move.

Our eyeballs are constantly moving rapidly without us realising it, in order to keep what we're looking at in focus.

Animal eyesight

Frogs don’t move their eyes rapidly.

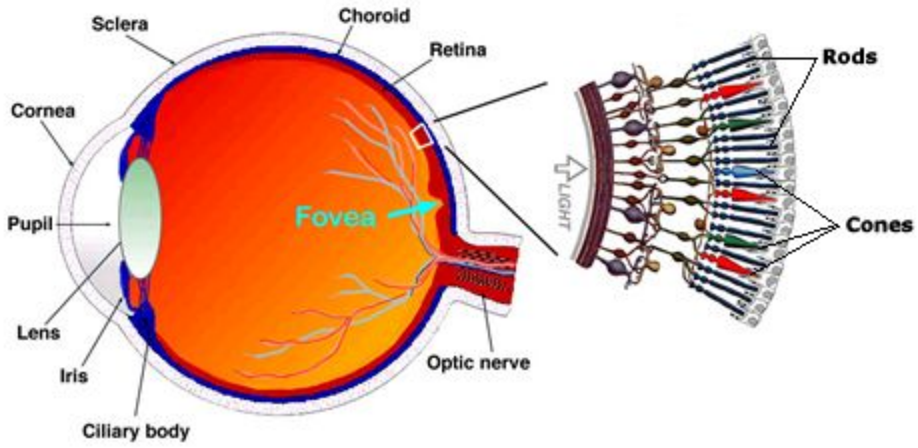
Their vision works differently to ours.

They aren’t worried about seeing large things in sharp focus.

Instead, their eyes let them see movement. Anything that moves stands out sharply so they can catch those flies or escape from a predator.

Fovea

The Fovea is where light is focussed on in the eye. There are loads of visual cells here, about 15,000 in a square millimetre. These cells are called rods and cones. There are more rods and cones spread out over the retina but at a much smaller density than at the fovea. The size and number of cells at the fovea enables us to see a thumbnail size sector of the world in sharp vision.



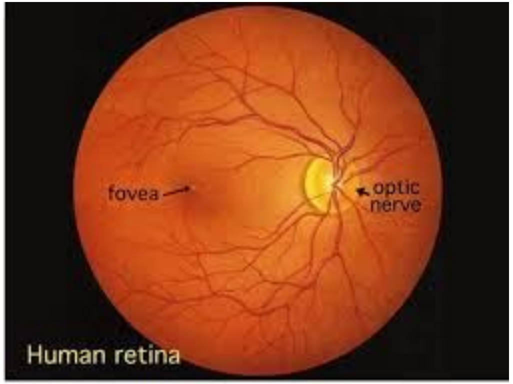


Figure 1. A view of the retina seen though an ophthalmoscope.

Animal eyesight

Lions have around the same number of cells in their foveas as humans do and they can see their prey when it is a kilometre away.

Animal Eyesight

Elephants and rhinoceroses have much fewer cells so they see their surroundings as blurred, just like the edge of our vision.

Animal Eyesight

Hawks and falcons have many more cells at their foveas - their vision is like us with a pair of binoculars that show things at 8 times their normal size.

Night time

When the light is dim, our eyes are less sensitive to colour- the cones in our retinas are not triggered.

Rod cells: for detecting movement and dim light

Cone cells: for detecting colour

Night Vision

Cats have much better night vision than we do.

Cats eyes contain a **tapetum**. This is a natural mirror that reflects light back out of the eye. Its job is to bounce the incoming light twice through the retina so the animal has double the chance to see things. Creatures that live in the dark tend to have much bigger **pupils** to let in more light.




LASER

What does laser stand for?

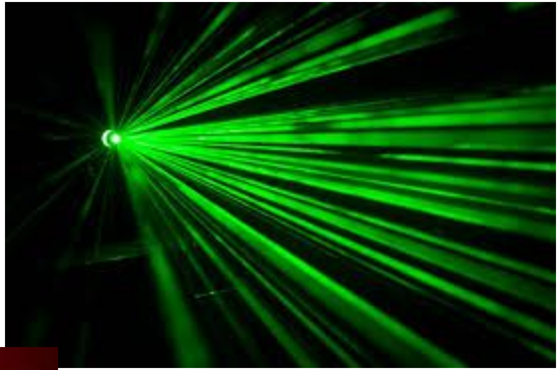
Light

Amplification by

Stimulated

Emission of

Radiation



LASER

Lasers were invented in 1958 and the first laser was built in 1960. They were developed from MASERs - which were exactly like lasers but they used microwaves instead of visible light.

Lasers are a coherent light source. This means that the light in a laser is all of the same wavelength and the waves are all lined up so that the peaks coincide.

Laser light can be focussed onto a very small spot and is a very narrow beam. Laser light beams can travel a long way without fading.

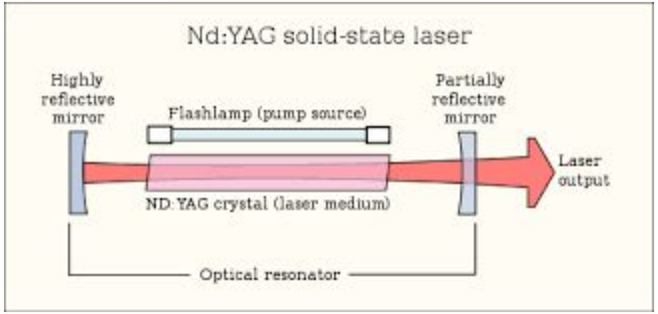
The power of a laser depends on the application - more about applications next time!

The parts of a LASER

LASERs need energy to work.

Light energy is pumped into a LASER and it is amplified by the gain medium in the LASER. The gain medium can be solid, liquid, gas or plasma. It could be a ruby crystal, a semiconductor or Carbon Dioxide.

There are mirrors and lenses inside a LASER that send the light through the gain medium and then focus the LASER beam. Some LASERS have polarising filters too.



In this LASER, the gain medium is Neodymium-doped yttrium aluminum garnet

Jelly optics

To investigate lasers, we can use jelly to make prisms, lenses and rectangles.

The jelly needs to be only made up with 100 mL of water, poured into a flat bottomed container and then cut into the shapes you want.

Then, if you have a laser, you can shine it through the jelly shapes. If you don't have a laser, get a small torch and cover the light with black paper with a pin hole in it. This will act a bit like a laser.