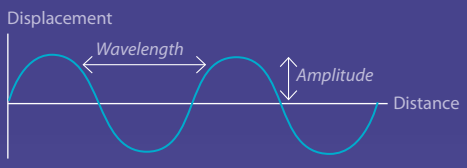
Throughout time many ideas were formed of how light works and what it is...

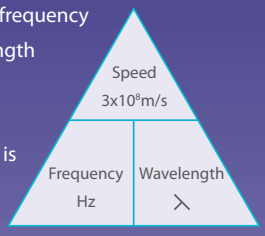
THE Nature and laws of light

For our purposes we use the dual wave-particle theory: in some ways light behaves like a particle and in some ways like a transverse wave. All waves carry energy, so light is fundamentally a moving form of energy. In transverse waves the particles vibrate perpendicular to the movement of energy. Now you can easily picture the wave-particle duality (picture above).



To compare waves we need to be able to describe their characteristics, these include: amplitude, wavelength, time period, frequency.

There is a simple relationship between speed, frequency and wavelength. Speed = frequency x wavelength
This can be put into an equation triangle:
You must use the correct units for each value: Speed is in m/s, wavelength is in m, frequency is in Hz. The speed of light is always a constant at $3x10^8$ m/s. Light waves obey four basic rules: reflection, refraction, dispersion, diffraction.

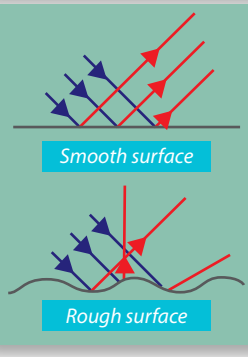


reflection

When you see an object, light is bouncing off that object into your eye. Rough and smooth surfaces look different because of the way light bounces off them.

When light hits a mirror it bounces off the mirror. This is called **reflection**. The ray of light hitting the mirror is called the incident ray. The ray of light bouncing off is called the reflected ray. There are three rules of reflection:

1. The angle of incidence is always the same size as the angle of reflection.
2. The image is always the same distance behind the mirror as the object is in front.
3. The image in a mirror is always the same size as the object but inverted.



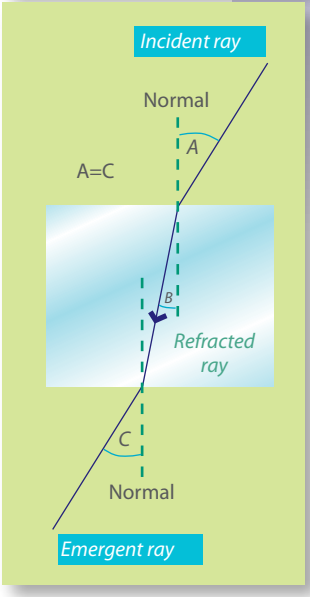
refraction

Why do swimming pools look shallower than they are?

Why do straws look bent when they're in a drink?

How can we bend light?

All these questions can be answered by looking at **refraction**. Refraction is the change in *direction* and *speed* of a light wave as it crosses boundaries between mediums.



dispersion

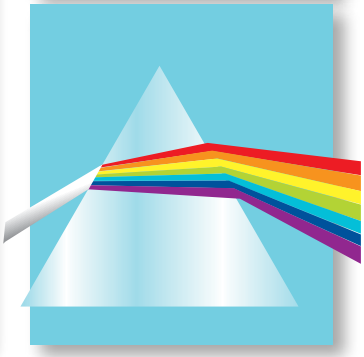
As light moves between mediums, it gets refracted. Different coloured light has different frequencies.

The higher the frequency of the light wave the more it is slowed down and the more it is bent or refracted.

This leads to the splitting up of white light into its different components

Red has a low frequency so is only bent a little. Violet has a much higher frequency so is bent more.

This splitting of light into its components due to refraction is called **dispersion**.



diffraction

Have you ever tried squashing plasticine through a small hole? You may have noticed that it makes a bulge as it comes through the hole. The same thing happens to waves as they travel through small holes, or push past obstacles.

In the picture we use water waves to illustrate. As the water waves go through the gap in this picture they spread out, this is called **diffraction**. The longer the wavelength of the wave the larger the amount of diffraction. The greatest diffraction happens when the gap size is about the same size as the wavelength.

Light waves have a very short wavelength compared to water waves. Therefore, to diffract light the gap needs to be extremely small, in fact around one thousandth of a millimetre.