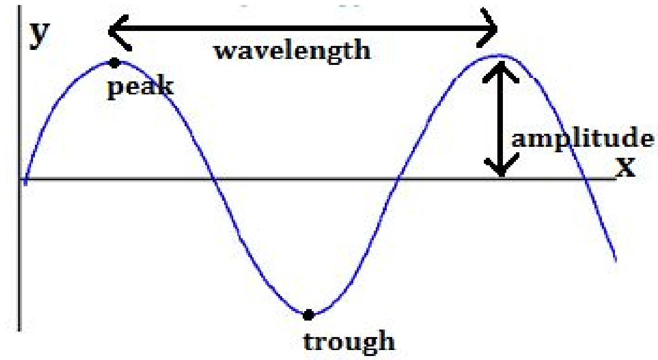
Waves

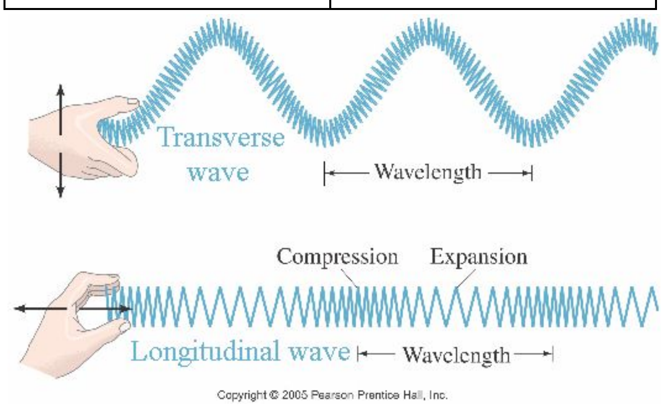


-Waves have a number of common features:

- -Peak: the top of the wave
- -Trough: the bottom of the wave
- -Amplitude: distance between the peak ad the resting position
- -Wavelength: distance from peak to peak, or trough to trough
- -Frequency: the number of waves that pass a fixed point per second

-There are two main types of waves:

Transverse	Longitudinal
Direction of motion is at 90º to the plane of propagation	Direction of motion is in the plane of propagation
Do not need a medium to travel through (can travel through a vacuum / space)	Needs a medium to travel through as energy is passed on through vibrations of particles
E.g. electromagnetic waves	E.g. Sound waves



-Wave equations link frequency (Hz), wavelength (m) and speed (m/s):

$$\lambda = v / f$$

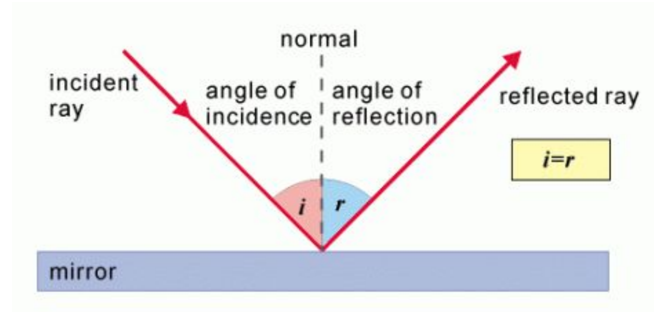
Wavelength = velocity / frequency

$$T = 1/F$$

Period = 1 / Frequency

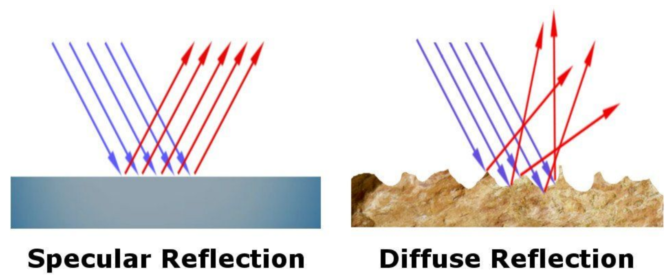
Reflection

-The law of reflection states that the angle of incidence will be equal to the angle of reflection:

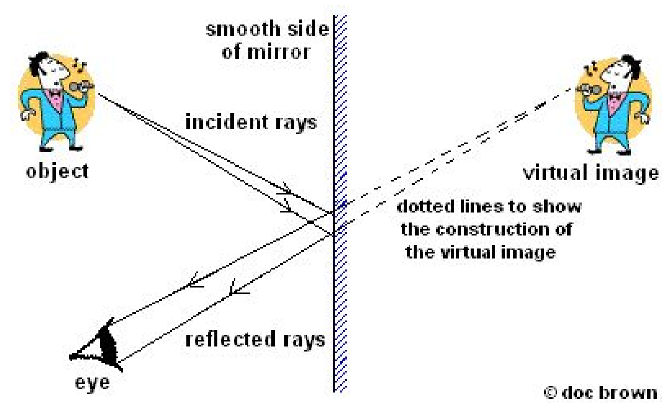


-There are two types of reflection:

- -Specular reflection is reflection where the waves will reflect to form a clear image
- -Diffuse reflection occurs off of a rough surface, resulting in the scattering of light



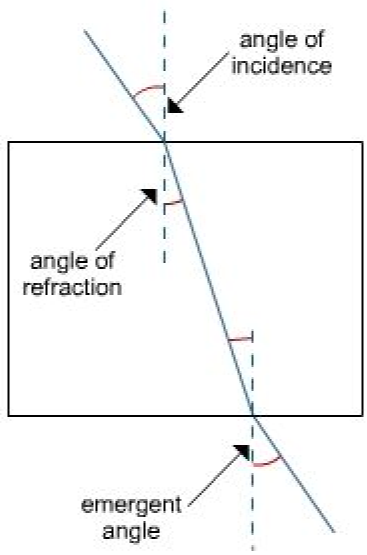
-A virtual image may be created as a result of reflection, this is where we would perceive an object to be, however the light rays will not travel here, and hence dotted lines will be used to represent this



Refraction

-Refraction is a change of angle of a wave when it hits the boundary between two substances at an angle (refraction does not occur when the wave strikes at 90º - this means no refraction will occur when it hit a semi circle)

-When the wave enters a more dense material, it bends towards the normal, when the wave enters a less dense material, it moves away from the normal

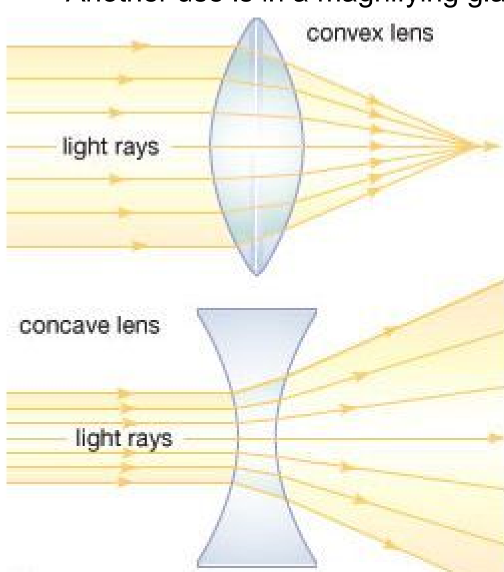


Lenses

-There are two types of lenses:

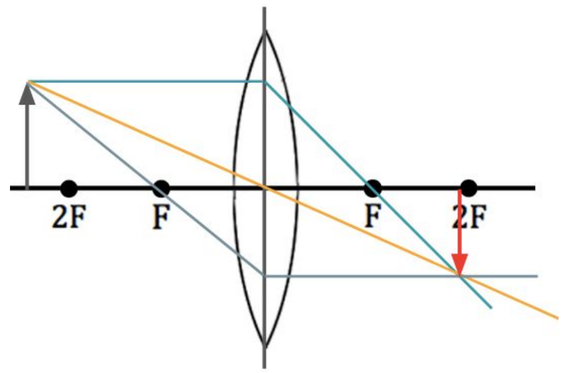
-Concave (diverging) lenses cause light rays to spread out, they always make a virtual image, examples of uses include glasses (short sightedness), peep holes and binoculars.

-Convex (converging) lenses converge the light rays, bringing them together to form a real image, uses of converging lenses include cameras and projectors as they will project an image onto a screen. Another use is in a magnifying glass



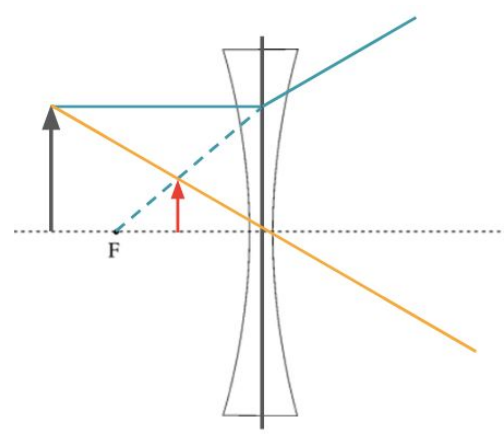
-Ray diagrams for a convex lens can be constructed in the following way:

1. Draw a ray from the top of the object through to the normal, then bend this through the focal point
2. Draw another line straight from the top of the object to the point where the two axis meet
3. Draw a line from the top of the object through the focal point on the same side, once this has reached the normal, draw a parallel line



-Ray diagrams for convex lenses can be constructed in the following way:

1. Draw a ray from the top of the object through the normal, then connect this to the focal point with a dashed line, continue the line outwards on the other side of the normal
2. Draw another line straight from the top of the object through the point where the axis meet



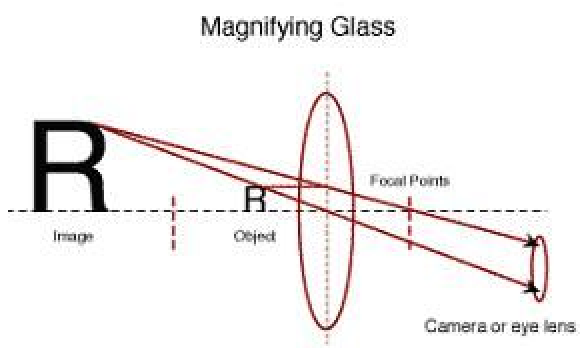
-The location of the object can affect the image formed in the following ways:

Location of object	Description of image formed
Beyond 2f (>2f)	Real, inverted, diminished, between f and 2f
At 2f	Real, inverted, same size as the object
Between f and 2f (<f)	Real, inverted, magnified, further than 2f
In front of f (<f)	Upright, virtual, magnified on the same side
Diverging lens	Virtual, upright, diminished, closer to the lens than the object

Magnification

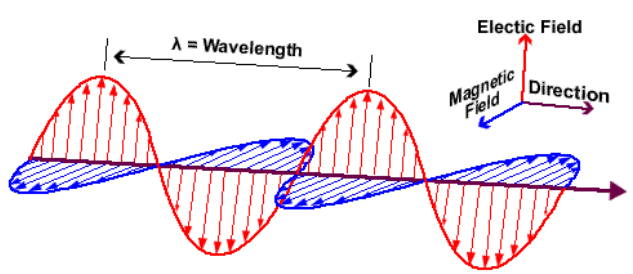
-Magnification is a ratio which indicates the ratio of the size of the image and the object, it has no units

Magnification = image size / object size



Electromagnetic spectrum

-Electromagnetic waves are electric and magnetic disturbances which can transfer energy from an emitter to a absorber, they have both magnetic and electric aspects to them



-They are on a continuous spectrum, meaning that they follow on from another in terms of wavelength and frequency, these can also overlap

-Radio waves:
- -Wavelength of 1 mm - km
- -Frequency of 300 GHz - 3 Hz
- -Used for broadcasting and communications, theur longer wavelength means that they can travel further in the Earth's atmosphere, reflecting off hills and the upper atmosphere

-Microwaves:
- -Wavelength of 1 mm - 1m
- -Frequency of 300 GHz - 300 MHz
- -Used for cooking food, microwaves are absorbed by water molecules causing them to vibrate and heat up
- -Can also be used for satellite communication as their wavelength can penetrate the atmosphere

-Infrared:
- -Wavelength of 750 nm - 1 mm
- -Frequency of 405 THz - 300 GHz
- -Used for heating, night vision cameras and television remote controls

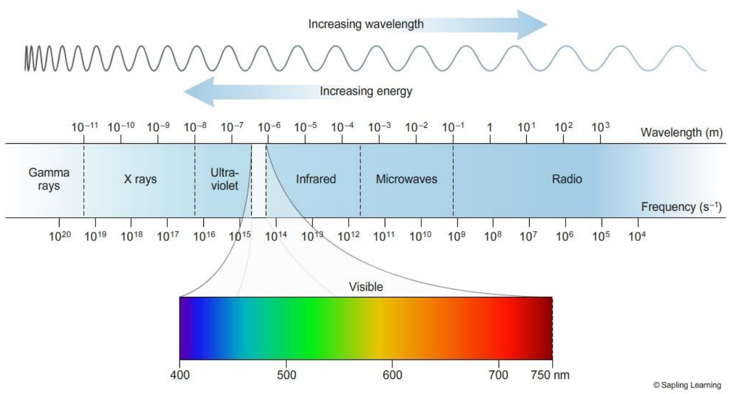
-Visible light:
- -Wavelength of 390 nm - 750 nm
- -Frequency of 730 THz - 405 THz
- -Used for human vision, photography and optical fibres, it is the only part of the spectrum that we can see

-Ultraviolet:
- -Wavelength of 10 nm - 400 nm
- -Frequency of 30 PHz - 790 THz
- -Ionising
- -Used for fluorescent lamps, they have chemicals inside which absorb ultraviolet rays and convert the energy to visible light

-X-rays:
- -Wavelength of 0.01 nm - 10 nm
- -Frequency of 30 EHz - 30 PHz
- -Ionising
- -Used for medical imaging, they enable us to see internal structures by being obstructed by bones, there needs to be a photographic plate put underneath the bone to develop an image
- -When using these, there must be safety precautions put in place

-Gamma rays:

- -Wavelength of less than 0.01 nm
- -Frequency of more than 10 EHz
- -Ionising
- -Used for sterilising food, medical equipment and killing cancer cells, they are highly penetrative and can kill
- -When using these, there must be safety precautions put in place



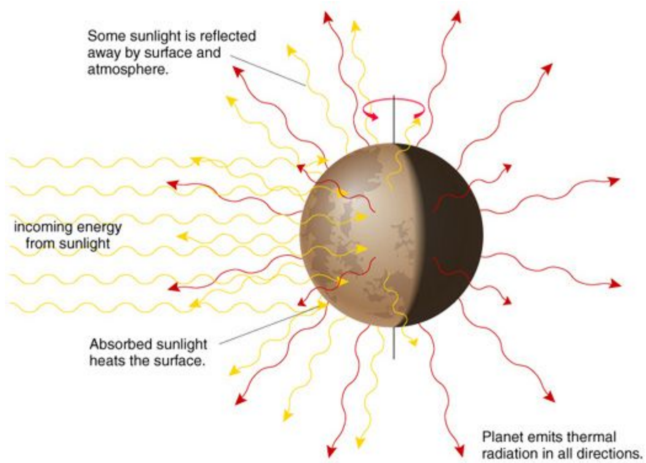
Infrared radiation

-Infrared radiation is a type of electromagnetic radiation that is associated with thermal energy

-Dark matte surfaces absorb and emit more infrared radiation, and white shiny surfaces emit and absorb less infrared radiation

-A perfect black body absorbs all infrared radiation which falls on it, it is also the best possible emitter of infrared radiation

-Radiative equilibrium is the state of the Earth when it absorbs as much infrared radiation from the sun as which it emits



-The existence of infrared radiation can be proved as shown below:

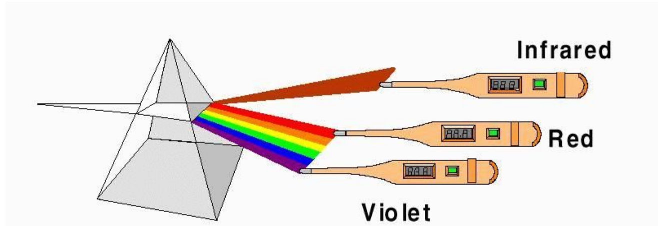


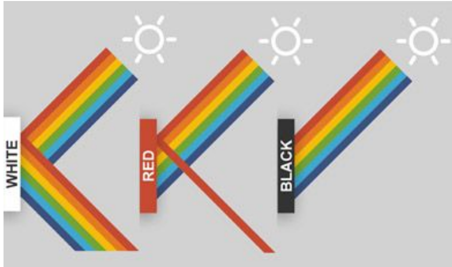
Fig. 1: Herschel used a prism and thermometers in his experiment that eventually led to the discovery of the infrared region of the electromagnetic spectrum.

Colour

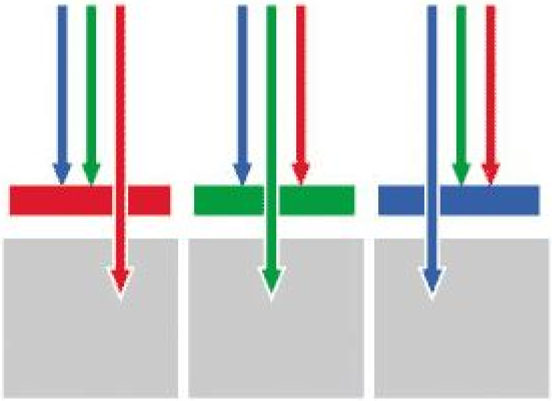
-Objects appear to be coloured as they absorb all colours apart from the one that it appears to be

-White objects reflect all wavelengths of light

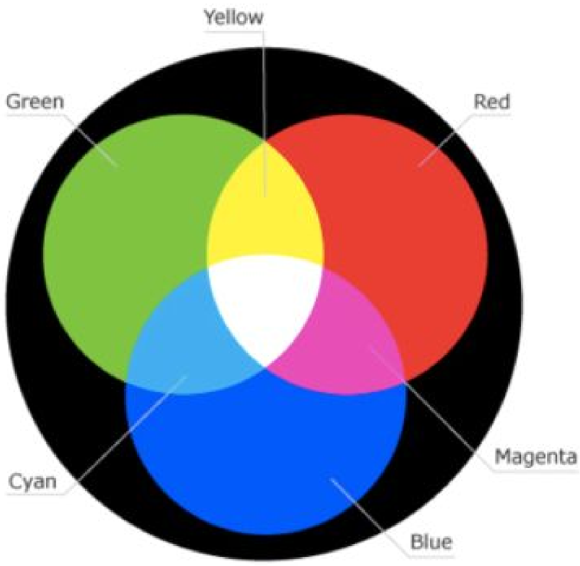
-Black objects absorb all wavelengths of light (not emitting any



-Filters work by absorbing every colour apart from what they are, allowing the wavelength of light through which is the same colour as the filter



Chapter Six: Waves



-When we add different wavelengths of light together we get different colours:

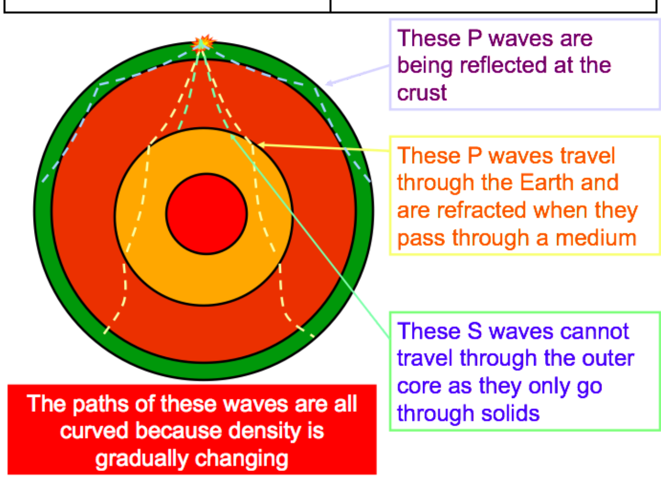
- Green + red = yellow
- Red + blue = magenta
- Blue + green = cyan
- Blue + red + green = white

Seismic waves

-Seismic waves are produced by earthquakes (rubbing together of two tectonic plates)

-There are two types of seismic waves:

Primary P Waves	Secondary S Waves
Longitudinal	Transverse
Travels through both solid and liquid	Only travels through solids
8 km/s	4.5 km/s



-Knowledge of these seismic waves can help determine the location of the epicentre of an earthquake, as well as the depths of different layers of the Earth

Ultrasound

-Ultrasound is a wave with a frequency of above 20 000 Hz, human hearing range is 20-20 000 Hz

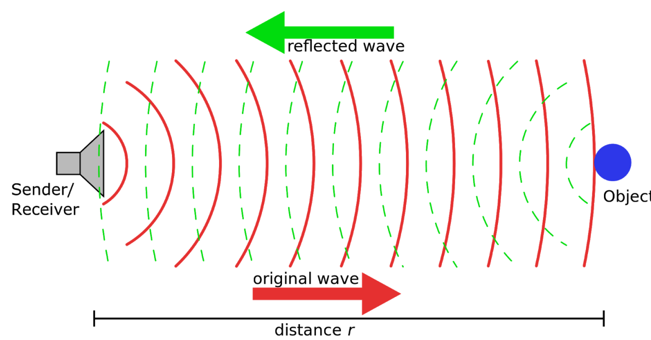
-Ultrasound can be used for:

-Breaking down kidney stones into smaller pieces before it can be passed out (high frequency)

-Radar, a pulse is sent out from a transmitter and the time taken for it to come back can be used to work out the distance of the object

-Ultrasound scans, waves partially reflect back at boundaries between different substances, meaning that a live image can be formed showing the different depths

-Echolocation is the process of determining the distance of an object by sending out a sound wave, and measuring the time for the echo to return



-The total distance calculated needs to be divided by two as this is the distance to the object and then back to the receiver

s = v x t

Distance = speed x time

Speed of sound in air = 343 m/s