Visible Light and Colour

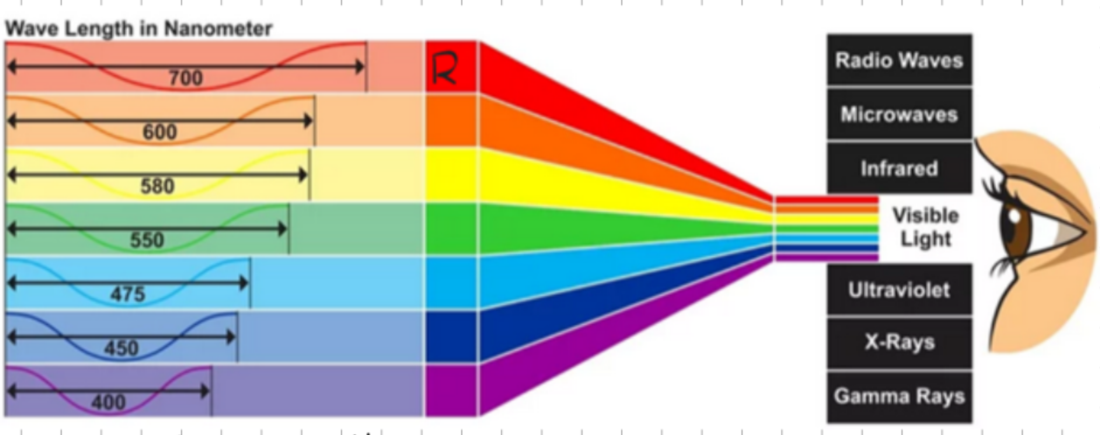
16th May

Red: $\lambda = \frac{700}{1000000000}$

$= 7\times10^{-7}\ m$

$v = f\lambda$

$3\times10^{8} = f \times 7\times10^{-7}$



$f = \frac{3\times10^{8}}{7\times10^{-7}} = 4.29\times10^{14}\ Hz$

Different 'colours' of visible light have different wavelengths (and frequencies).

Cells in the retina at the back of our eyes absorb energy from the light waves and interpret this energy as a certain colour.

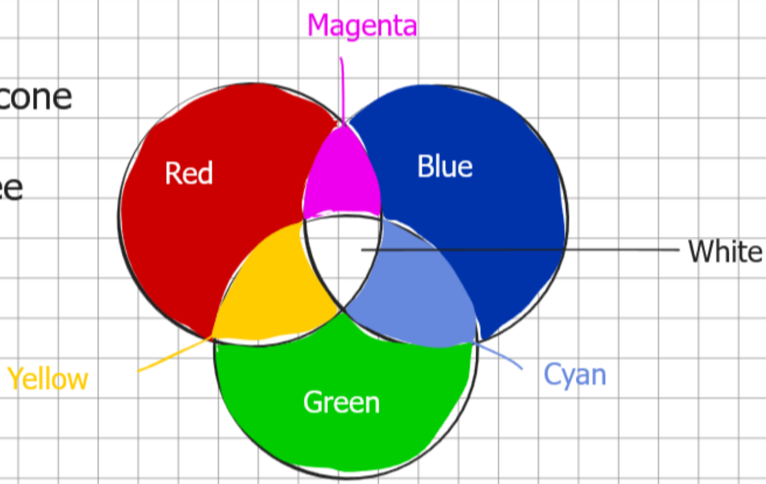
If different wavelengths of light are mixed together then multiple different cells can transmit a signal to our brain and we may see a different colour.

Different non-luminous objects appear different colours due to the wavelengths of light that they REFLECT.

e.g. an object that appears yellow when placed in white light is reflecting the yellow wavlengths and absorbing the rest.

It could also be reflecting both RED and GREEN...

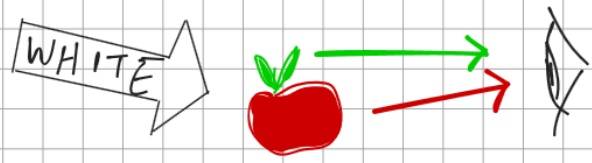
If all three types of cone cell receive a signal (R, G, B) then we see WHITE light.



Coloured Objects and Filters

3rd June

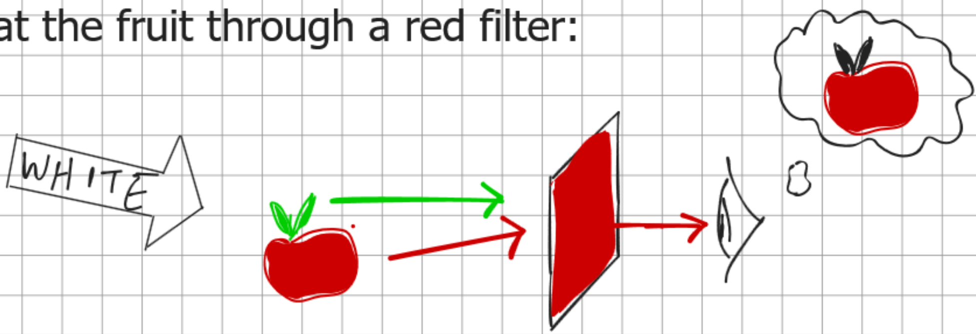
The colour that we perceive a non-luminous object to be depends on the frequencies of the light waves it reflects, and which of those light waves are detected by our eyes.



The leaves of the fruit only reflect the green part of the white light.
The body of the fruit only reflects the red part of the white light.

Hence, we see a red fruit with green leaves.

If we looked at the fruit through a red filter:

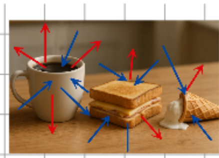


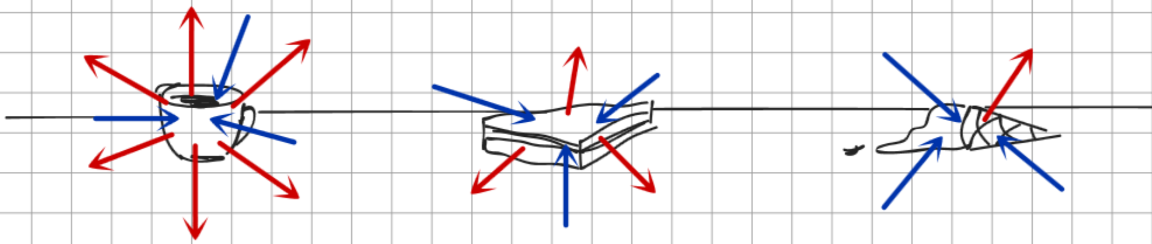
A filter only lets certain frequencies (colours) of light through. The red filter does not allow green light through. So we would not see any light coming from the leaves, so they would look black.

Thermal Equilibrium

3rd June

ALL objects emit infrared radiation. The rate at which they emit infrared can depend on things such as the temperature of the object, or the material it is made from.





- This hot drink is hotter than its surroundings.
- It emits more IR than it absorbs.
- Its internal energy decreases, and it cools down.

- The sandwich is the same temperature as the surroundings.
- It emits IR at the same rate it absorbs IR.
- It is in THERMAL EQUILIBRIUM.
- Its internal energy stays constant.

- The ice cream is colder than its surroundings.
- It absorbs more IR than it emits.
- Its internal energy increases.
- Its temperature increases.

The nature of the surface of an object can also affect its rate of infrared absorption and emission.

Shiny, smooth surfaces do not absorb infrared as well as matte, rougher surfaces.

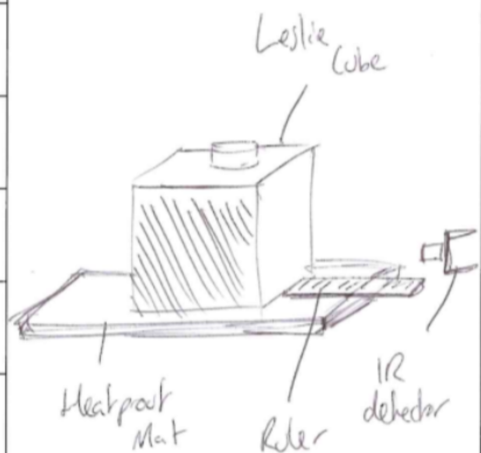
How does the type of surface effect the rate of emission of infrared?

Make your own summary notes for each practical based on this template

Independent Variable(s) The one you vary.	Dependent Variable(s) The one you measure.	Control Variables Kept the same for a fair test.
Type of surface	Rate of infrared emission	Distance from surface Starting temperature

Method		
Step 1	Set up as in diagram	
Step 2	Fill cube with very hot water (from kettle).	
Step 3	Record IR emission from each surface	
Step 4		
Step 5		
Step 6		
Step 7		

Diagram of set up.



Measurement	Instrument Used	How Instrument is used / How to minimise errors
Rate of IR emission	IR sensor / detector	Use a ruler to ensure sensor is same distance each time.

Matte, dark surfaces are also the best emitters of infrared radiation.
Shiny, light surfaces are the worst emitters of infrared radiation.

Lenses

6th June

Lenses REFRACT light and change the direction of light rays.

The shape of the lens, and its thickness, can change how much the direction of a light ray alters.

We deliberately shape lenses to manipulate the image that can be formed by rays of light.

We use lenses in cameras, our eyes, microscopes, telescopes etc.

There are two types of lenses:

Convex (converging)

View from side

Symbol in diagram

- Bends light rays towards each other.
- Used in cameras, microscopes, eyes, magnifying glasses

Concave (diverging)

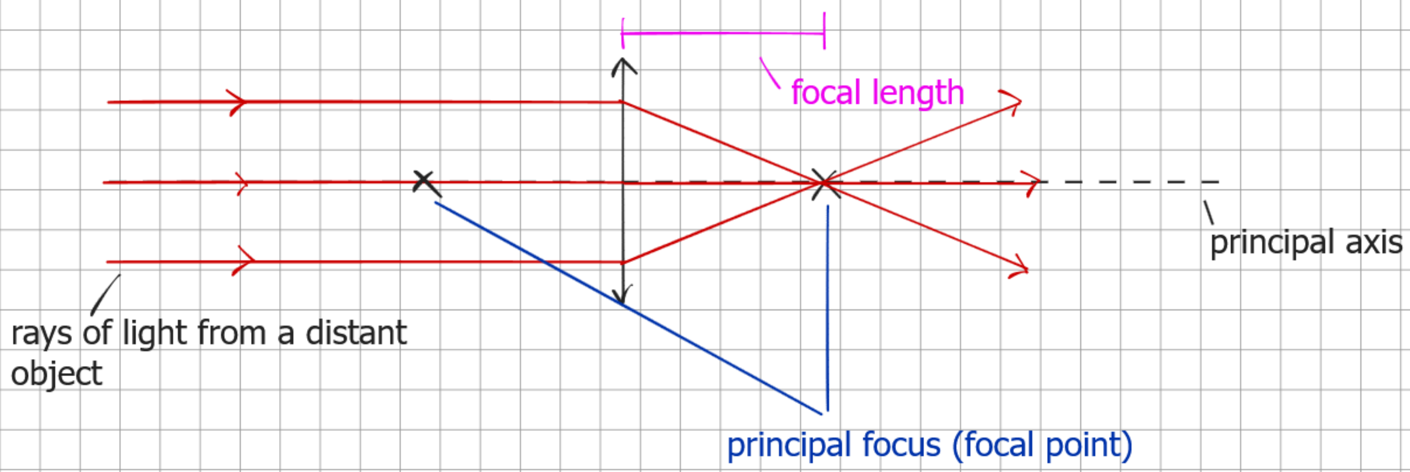
View from side

Symbol in diagram

- Bend light rays away from each other
- Used in vision correction i.e. glasses, contact lenses

The POWER of a lens tells us how much it bends light. More powerful lenses tend to be thicker and have greater curvature on their surface.

Diagrams of how lenses work tend to show a view from the side, showing us the object we are trying to form an image of, two or three light rays coming from that object and the image that is formed.



Any light ray passing through a convex lens that is PARALLEL to the PRINCIPAL AXIS will bend so that it passes through the PRINCIPAL FOCUS.

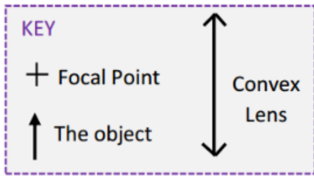
Converging (convex) Lenses

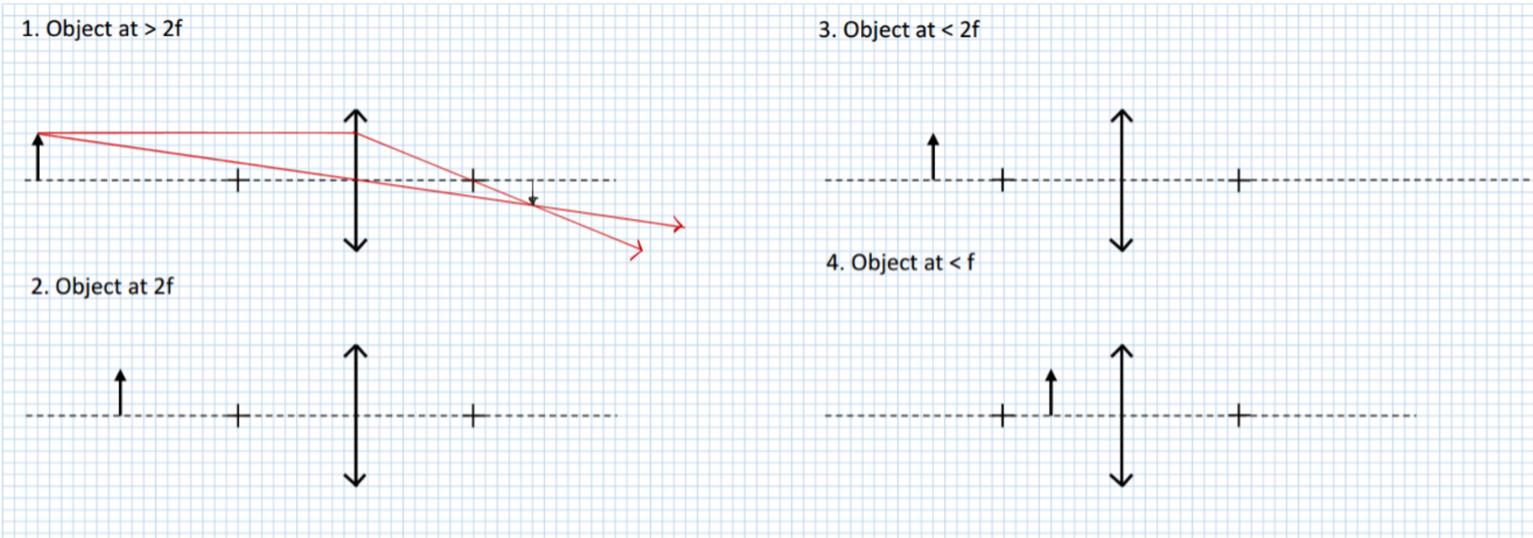
Rules for ray diagram construction		
	1. Parallel Ray:	A ray parallel to the optical axis passes through the focal point on the other side of the lens
	2. Focal Ray:	A ray that passes through the focal point emerges parallel to the optical axis on the other side of the lens
	3. Centre Ray:	A ray that passes through the centre of the lens continues with no change in direction

(You usually only need to use 2 of these rules to find the position and orientation of the image)

TASK:

- In each case construct a ray diagram to show where the image is formed.
- Describe the image formed (i.e. its orientation, whether it is real or virtual and how its size compares to the object)
- Give an example of where this lens may be used.



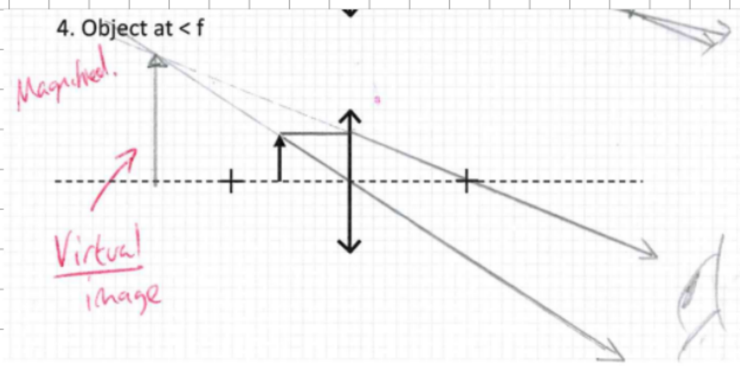


If we are drawing a ray diagram for a CONVEX LENS we can draw TWO light rays that pass FROM THE OBJECT and THROUGH THE LENS.

1) One ray passes from the top of the object PARALLEL to the principle axis, and through the PRINCIPLE AXIS at the FOCAL POINT/PRINCIPLE FOCUS on the other side of the lens.

2) The other passes from the top of the object, through the CENTRE of the lens and doesn't change direction.

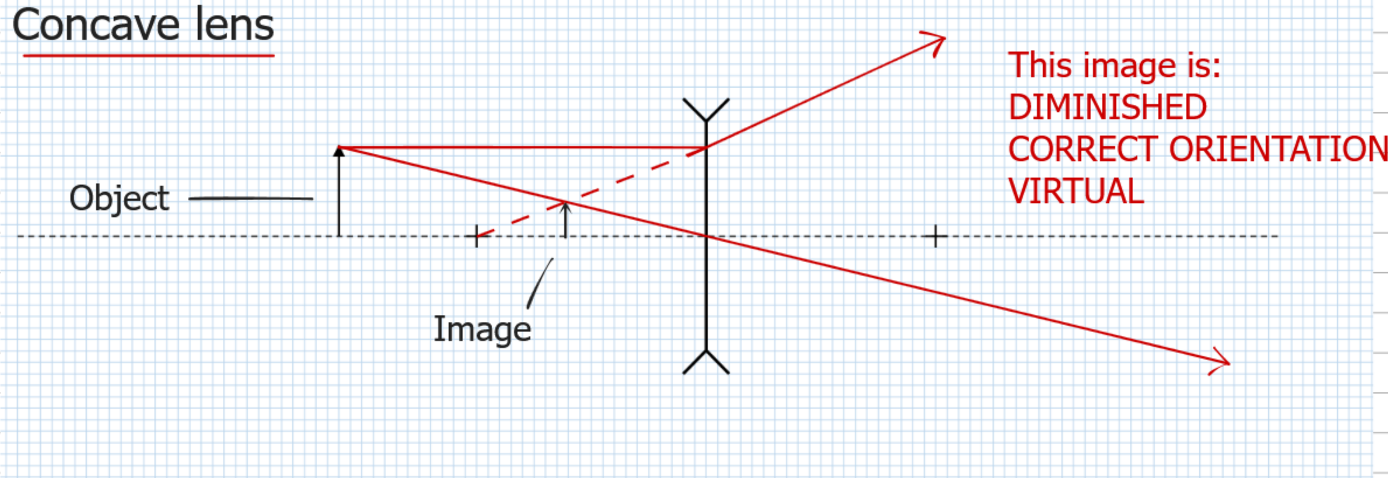
IF the rays meet, we draw the image where they meet. We class this as a REAL image that can be projected onto a screen.



If the rays DO NOT MEET (example 4) we TRACE THEM BACKWARDS and draw the image where these rays meet.

This would be a VIRTUAL IMAGE; we can't project this onto a screen.

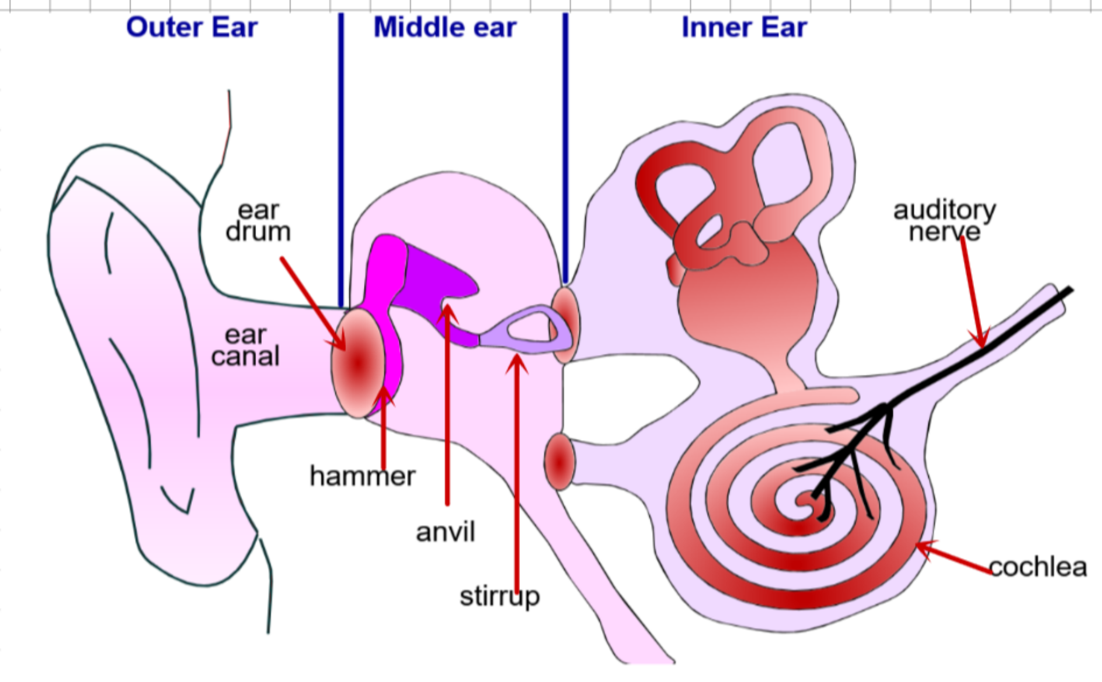
Concave lens



For a CONCAVE/DIVERGING LENS we still draw 2 rays. This time the ray that is parallel to the principle axis bends UPWARDS as if it came FROM the prinicple focus on the same side of the lens as the object.

Sound and Hearing

17th June



When a sound wave hits a boundary between two materials some of the energy from the wave will be ABSORBED by the new material.

This can transfer ENERGY to the material and cause it to HEAT UP.

Some of the energy from the sound wave will be REFLECTED (we call this PARTIAL REFLECTION). A reflected sound wave is called an ECHO.

Some of the energy from the sound wave will be TRANSMITTED, which causes particles in the material to OSCILLATE.

The sound waves that are transmitted may be REFRACTED if they change speed. Sound waves travel FASTER in more dense materials.

Ultrasound

20th June

Humans in general can hear sounds as low as 20 Hz and sounds with a frequency as high as 20,000 Hz.

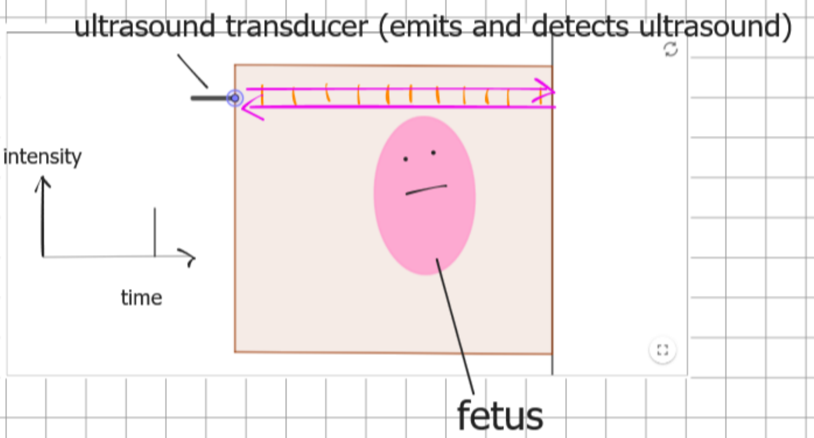
A sound with a frequency too low for us to hear is called INFRASOUND.

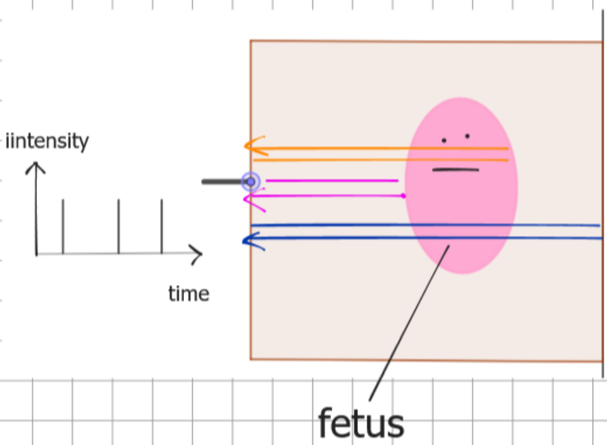
A sound with a frequency over 20 kHz is called ULTRASOUND.

When an ultrasound wave is transmitted through an object it can PARTIALLY REFLECT if it crosses a boundary i.e. from fat tissue to muscle tissue.

If we know the SPEED of the wave as it travels through the material and the TIME it takes for ECHO of the ultrasound to be detected, we can calculate the DISTANCE to the boundary.

One example of this use is FOETAL SCANNING:





If we record the time taken to receive the reflection of an emitted pulse we can calculate the TOTAL DISTANCE the sound wave travelled.

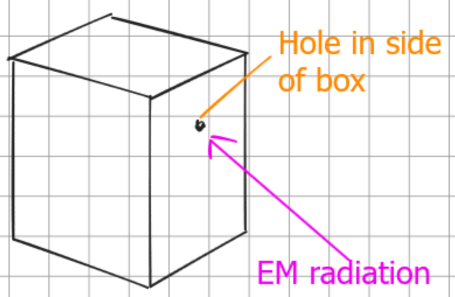
To find the actual distance to a boundary we would HALVE the time it takes to receive a reflected wave.

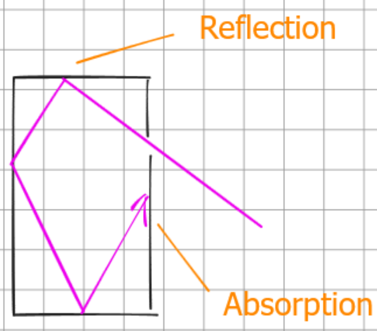
Black Body Radiation

1st July

A black body is the best possible absorber of electromagnetic radiation - it will absorb ALL EM radiation that hits its surface

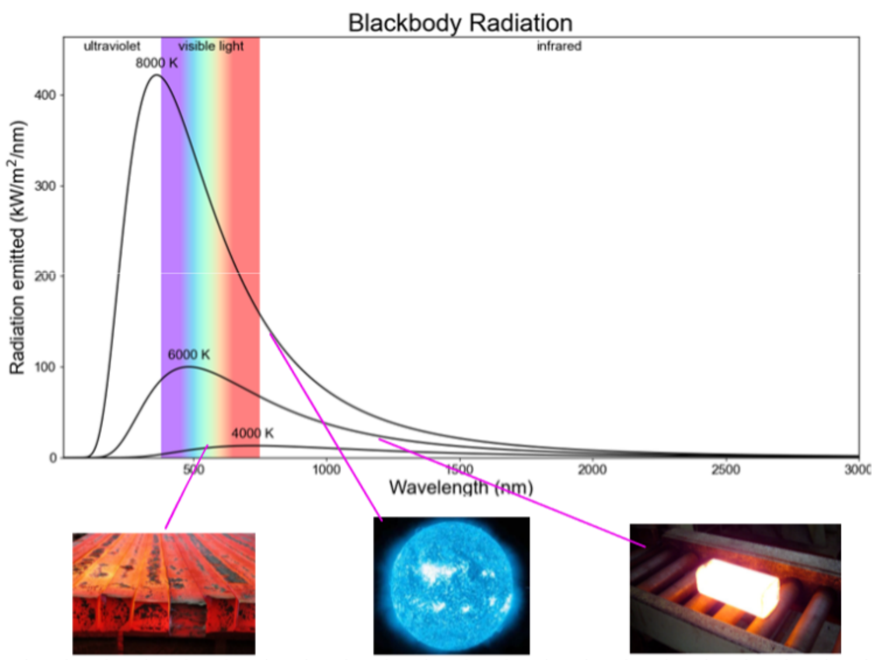
A black body is also the best possible emitter of electromagnetic radiation - it emits all wavelengths of EM radiation.





The light waves reflect multiple times from the inside of the box, and eventually are likely to be absorbed.

Little to no light leaves the hole, so it looks (very) black. The hole is a good model of a perfect black body.



This graph shows us how much (the intensity) of each wavelength of EM radiation is emitted by three objects of different temperatures.

- The higher the temperature the SHORTER the peak wavelength
- The higher the temperature the GREATER THE INTENSITY of ALL WAVELENGTHS emitted.
- At shorter wavelengths we have much greater rises in intensity (steeper up to the peak)

Seismic Waves

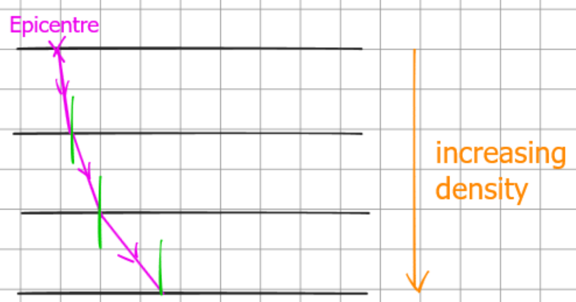
3rd July

Seismic waves are released during EARTHQUAKES.

There are two types:

P-waves. These waves are LONGITUDINAL and travel much quicker than S-waves (P waves are sometimes called compression waves).

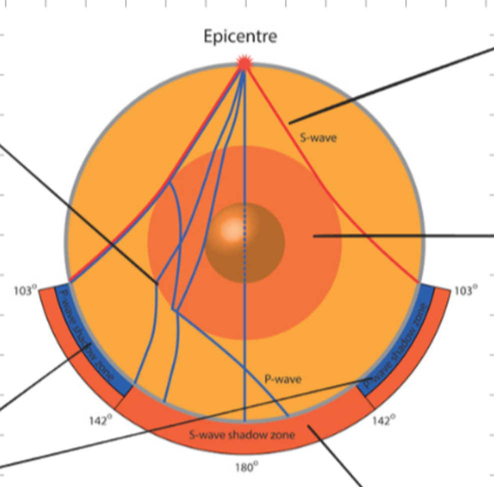
S-waves. These waves are TRANSVERSE (and are sometimes called shear waves)



Seismic waves increase speed when moving into a more dense material (similar to sound waves, and opposite to light waves)

If we know the path the waves travelled we can learn about the density of the material they travelled through.

Cross-section of Earth



Sudden change in direction (and partial reflection) means a sudden change in density

Curved path due to changing density and refraction

s-waves cannot travel through liquids

No p-waves detected here

No s-waves detected here

Key content from the topic

- Key definitions from the previous waves topic (longitudinal, transverse, frequency, period etc)
- Reflection and refraction
- EM spectrum
- Lens diagrams (rules for constructing, lens types, calculating magnification)
- Black body radiation
- Uses of ultrasound (wave speed calculations)
- Thermal equilibrium (rate of absorbing IR compared to rate of emitting IR)
- IR emission required practical