What are Waves?

23rd April

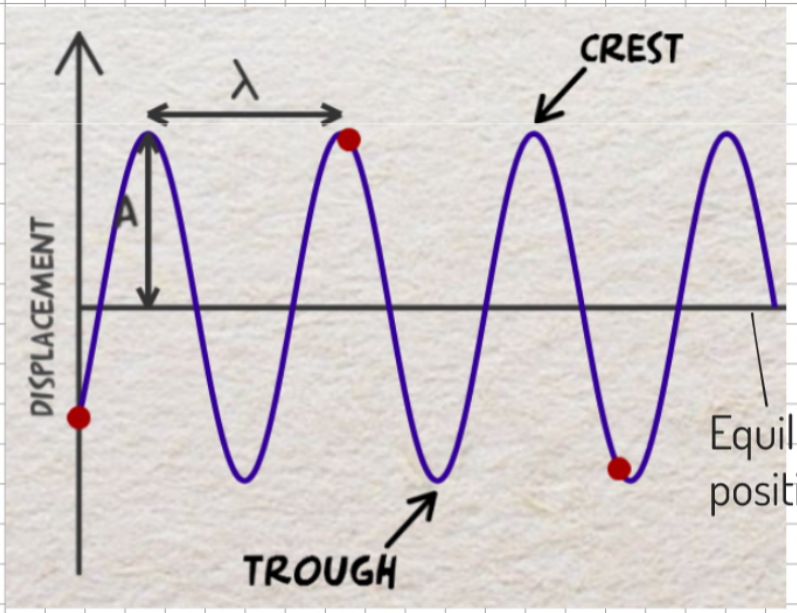
A wave is a DISTURBANCE that PROPAGATES (travels) through space, transferring ENERGY but NOT MATTER.

All waves feature OSCILLATIONS (a repeated motion similar to a vibration).

If the OSCILLATIONS are PERPENDICULAR to the DIRECTION OF ENERGY TRANSFER then we call the wave TRANSVERSE.

If the OSCILLATIONS are PARALLEL to the DIRECTION OF ENERGY TRANSFER then we call the wave LONGITUDINAL.

Transverse	Longitudinal
Light	Sound
Water	Seismic P Wave
Seismic S Wave	



λ (the greek letter lambda) represents WAVELENGTH.
This is the distance from a point on one wave to the same point on the next wave (in this case crest to crest).

'A' is the AMPLITUDE. This is the maximum distance from the rest position.

The FREQUENCY of a wave is the number of complete waves that pass a point per second.

It is measured in Hertz, where 1 Hz = 1 wave per second.

Sound Waves

24th April

A sound wave is produced by an object vibrating (oscillating).

Sound waves are the vibrations of particles in the material the wave is travelling through.

Sound waves must have a material (a medium) to travel through. They cannot pass through a vacuum.

Sound waves are longitudinal waves.

The FREQUENCY of a sound wave determines the PITCH that we hear.

A higher frequency sound has a higher pitch, and a lower frequency sound has a lower pitch.

The AMPLITUDE of a sound wave determines the VOLUME that we hear.

A higher amplitude means a higher volume.

Sound spelling test: SOUND, PITCH, VOLUME, FREQUENCY, VIBRATION, AMPLITUDE
MEDIUM, VACUUM, REFLECTION, TRANSMISSION

Hearing

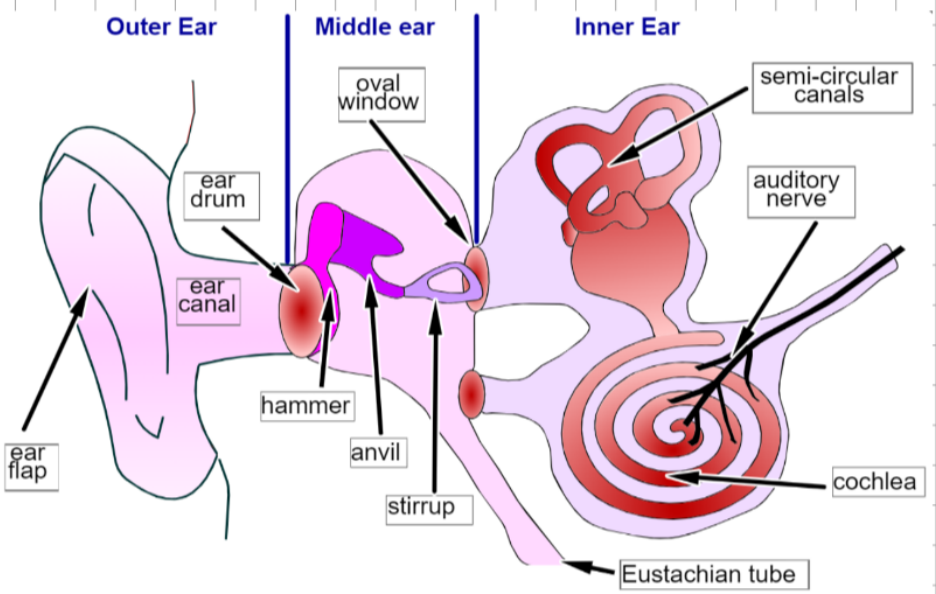
29th April

Humans are typically able to hear sounds with fequencies in the range 20 Hz to 20 kHz (20,000 Hz).

Note: Sounds with a frequency lower than 20 Hz are typically INFRASOUND. If a sound has a frequency above 20,000 Hz it is called ULTRASOUND.

The upper limit of human hearing varies from person to person and tends to get lower with age.

Uses of ultrasound include SONAR and scanning of unborn babies.



Sound travels as sounds waves through air.

The sound waves enter the ear canal and travel down to the eardrum.

The sound waves cause the eardrum to vibrate, which in turn causes three tiny bones in the middle ear to oscillate.

The motion of the bones causes fluid in the cochlea to oscillate, which bends the hair cells in the cochlea. The motion of the hair creates electrical impulses which are transmitted to the brain down the auditory nerve.

Our brain interprets the impulses as sound.

Visible Light and Colour

30th April

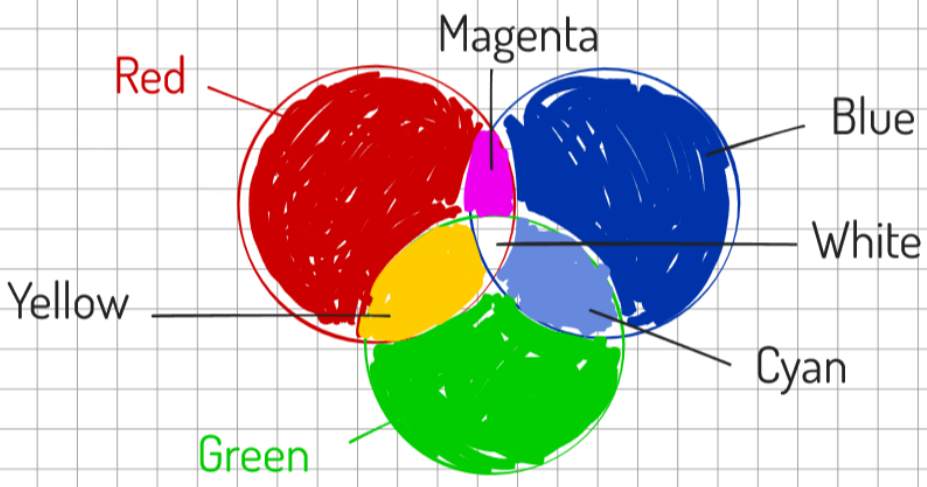
A LUMINOUS object is one that gives out its own light. We see luminous objects because light travels from them and into our eyes.

A NON-LUMINOUS object does not give out light. It can only be seen if light reflects from it and then enters our eyes.

Different colours of light have different wavelengths

Red light has the longest wavelength in the visible range and violet light has the shortest wavelength.

White light is a mixture of all the different colours (wavelengths) of visible light.



When different wavelengths of light mix, we interpret the mixture of wavelengths as different colours.

Colour

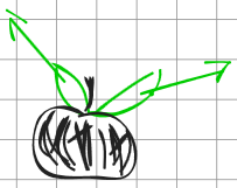
1st May

Non-luminous objects appear the colour they do because of the wavelengths of light that they REFLECT.

A white object (that is, an object appears white in white light) reflects all colours and absorbs none.

An object that is green (in white light) only reflects green light, and absorbs all other colours.

If an object absorbs all colours and reflects none then it appears black.

In white light	In green light	In red light
		
We see: green leaves red fruit	We see: green leaves black fruit	We see: black leaves red fruit

A colour filter only allows certain wavelengths of light through it, for example a red filter only allows red light to pass through.

The red filter only allows the red light to pass through.

Reflection

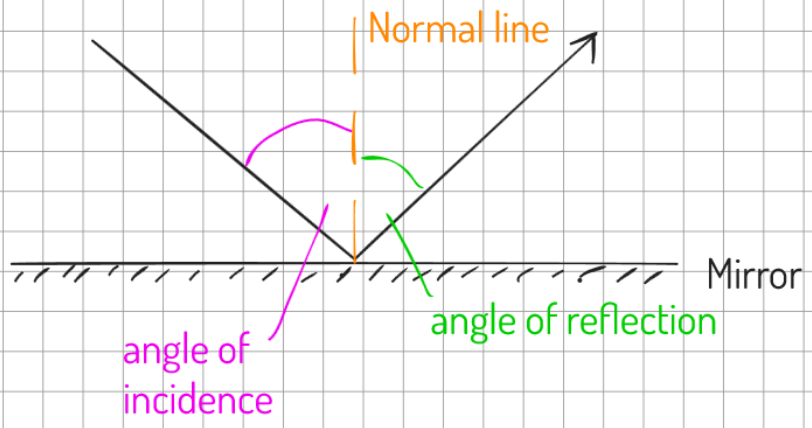
3rd May

When a wave hits a surface it can be:

Absorbed: energy from the wave is transferred to the surface

Reflected: the wave bounces away from a surface

Transmitted: the wave passes through the material (which can lead to refraction)



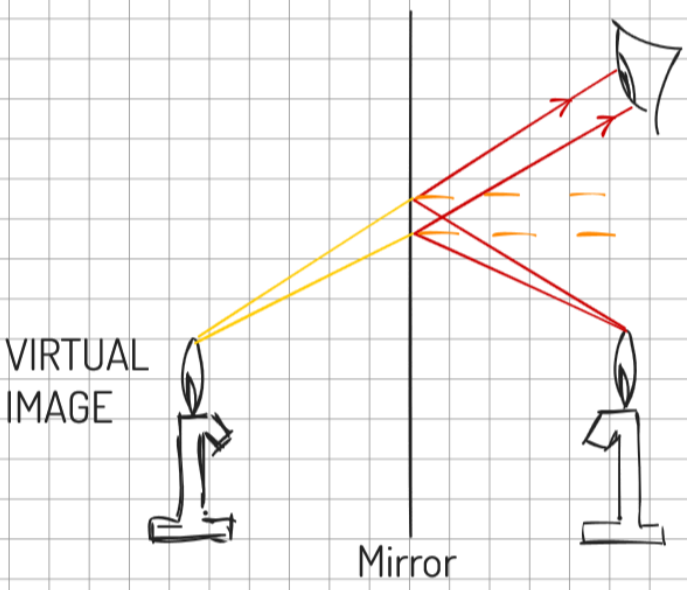
Note: whenever we draw a wave we must draw a NORMAL line wherever the wave hits a BOUNDARY (i.e. a mirror). This is a line that is PERPENDICULAR TO THE BOUNDARY.

All angles are ALWAYS measured between the wave and the normal.

The LAW OF REFLECTION always applies:

angle of incidence = angle of reflection

If a surface is very smooth we get SPECULAR reflection.



When an image is formed in a mirror it is:

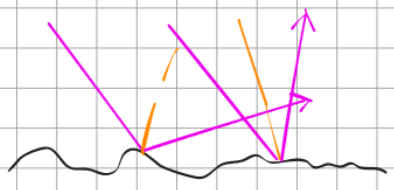
- Upright (correct way up)
- Virtual (the light rays only appear to be coming from the image)
- Laterally inverted (flipped left to right)

Specular

Smooth

- Rays stay parallel
- Surface appears shiny or an image may be seen

Diffuse

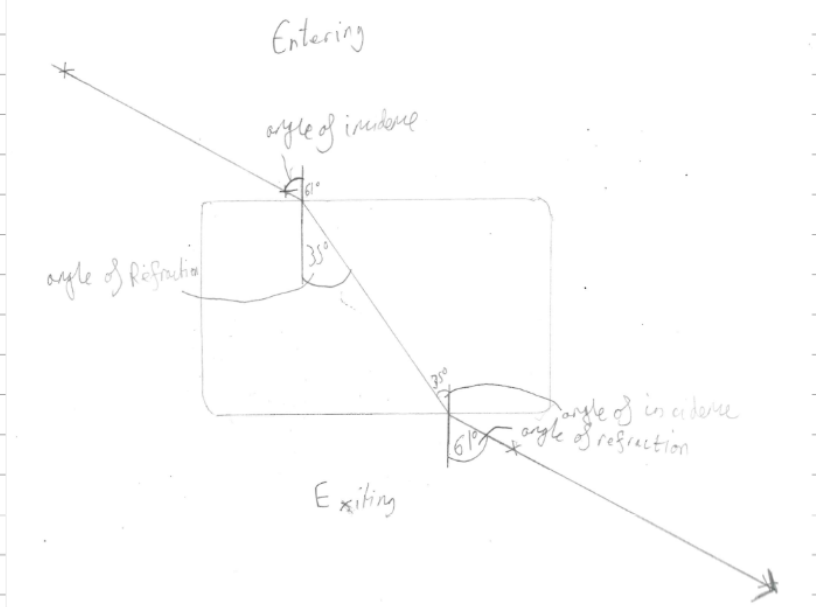


Rough

- Rays reflect in different directions
- No image seen, and surface may appear matte

Refraction

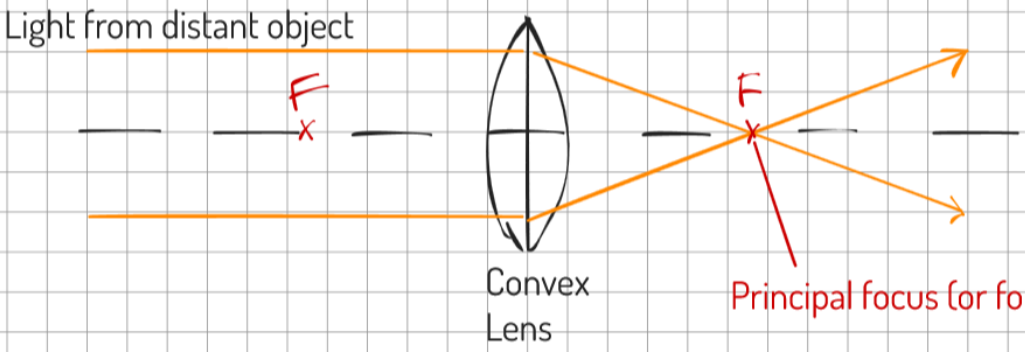
8th May



- As a ray enters a MORE DENSE substance (where speed is lower) it bends TOWARDS THE NORMAL.
- As a ray enters a LESS DENSE substance (where speed is greater) it bends AWAY FROM THE NORMAL.

Lenses

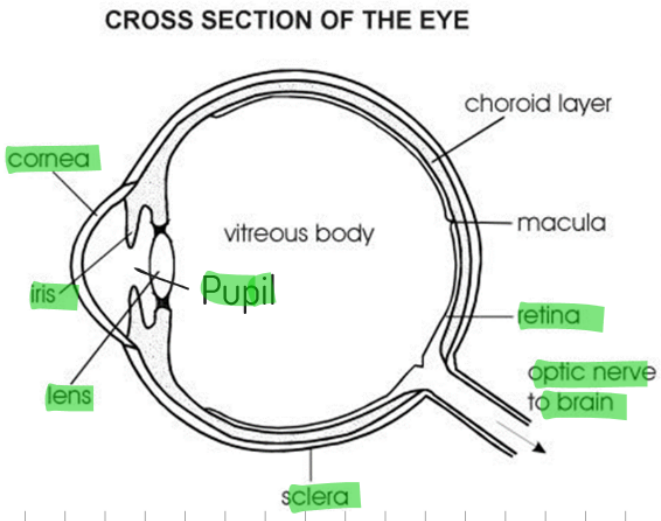
13th May



- Principal focus: is the point where parallel rays meet after passing through the lens
- Focal length: distance between the lens and the principal focus

The Eye

14th May



Cornea: transparent surface at the front of the eye (light can pass through it)

Iris: coloured part of the eye with a hole in the centre called the pupil. It changes size to adapt to different light conditions

Sclera: a white opaque (does not allow light to pass through) structure that helps the eye keep its shape.

Retina: contains rod cells and cone cells to absorb light

Optic nerve: sends information from the retina to the brain

The lens in the eye refracts light to produce an image on the retina. Muscles can change the shape of the lens depending on whether the object is nearby or far away.

The Electromagnetic Spectrum

21st May

This is a range of waves that can travel through a vacuum (space).

They have a range of FREQUENCIES and WAVELENGTHS.

They are all TRANSVERSE WAVES.

They all travel at the speed of light in a vacuum; 300,000,000 m/s.

Radio Waves — Microwaves — Infrared — Visible Light — Ultraviolet — X-rays — Gamma Rays

Lowest Frequency

Longest Wavelength

Highest Frequency

Shortest Wavelength

Type of Wave	Uses	Dangers
Radio Waves	Communications; Radio and TV signal	None
Microwaves	Heating food; satellite communications; mobile phones	Internal heating of body tissues
Infra Red	Thermal imaging; cooking food; optical fibres	Can burn skin
Visible Light	Seeing; photography; LASERs, optical fibres	Can damage eyes
Ultra Violet	Security markings; forensics	Sunburn; skin cancer; eye damage
X Rays	Medical imaging; airport security	Cell mutation and cancer
Gamma Rays	Cancer treatment; sterilising surgical equipment	Cell mutation and cancer

What you need to know:

- What waves are
- Difference between longitudinal and transverse waves, with examples of each
- Definitions of wavelength, frequency and amplitude
- How the amplitude and frequency link to volume and pitch
- How sound waves affect the ear drum
- The law of reflection and how to draw diagrams of reflection
- How to draw diagrams of refraction, and explain what happens when waves speed up and slow down
- How to drawn lens diagrams, and how we describe images
- How we see objects of different colours, and how filters work