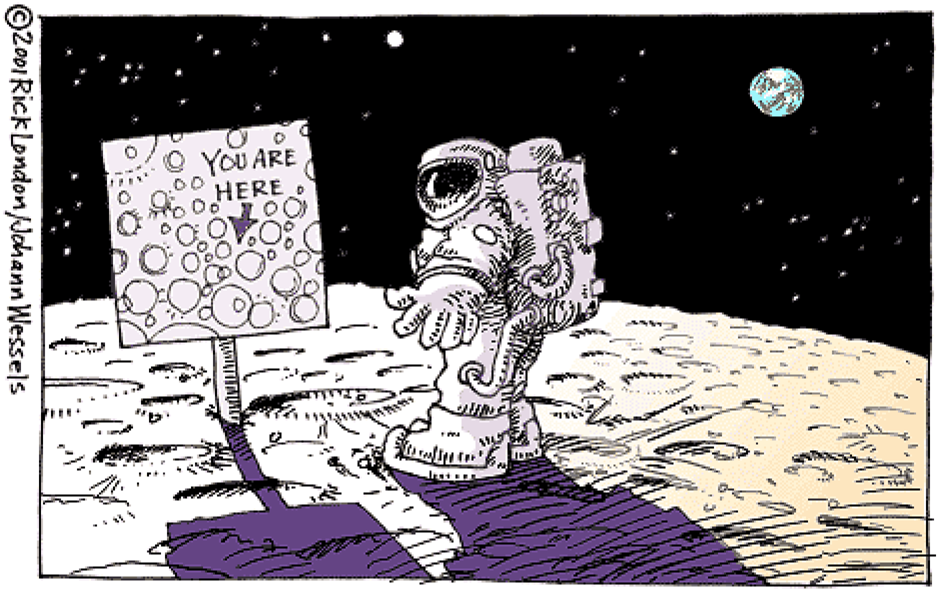

Physics Notes for CE Year 7

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Units

In this booklet you will learn about some of the units that are needed for common entrance and how to measure them. You may well come across others as the course progresses.

Remember: - when doing calculations

You must show FULL working with units at every stage of the calculation to get full marks.

Prefixes

Prefixes go before a unit to help indicate the size of the unit. It is very important that you use the correct symbol as lower case and upper case letters change the meaning completely.

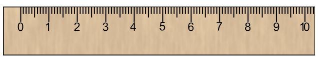
E.g. 1mm = one thousandth of a metre.

1Mm = 1 million metres

SI prefixes:

Prefix	Symbol	Multiplication factor	
giga	G	1 000 000 000	10^9
mega	M	1 000 000	10^6
kilo	K	1000	10^3
centi	C	0.01	10^{-2}
milli	M	0.001	10^{-3}

Length



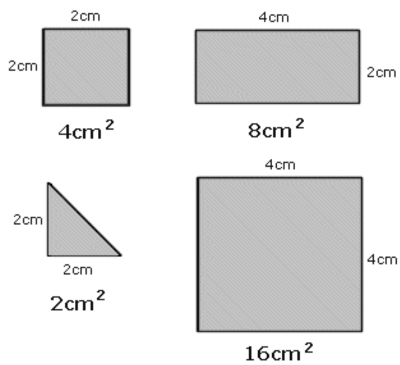
Length is one dimensional. It can be measured using a ruler or tape measure. Longer distances can be measured using an odometer fitted to cars or bikes.

Units of length include

Metric		Imperial (not used in CE)		
Millimetres	(mm)	Inch	(in)	
Centimetres	(cm)	Foot	(ft)	(12 inches)
Metres	(m)	Yard	(yd)	(3 feet)
Kilometres	(km)	Mile	(mi.)	(1760 yds.)

Area

Area is two dimensional (or 2D). It is flat like a piece of paper. It can be measures using a ruler or tape measure. The surface area of a square or rectangle can be calculated by multiplying the length and the width together. Remember as the numbers have been multiplied together so must the units.



Eg1. 2cm x 2cm = $4cm^2$.

(The little ^{2} after the cm shows that this is short for cm x cm).

Other geometric shapes have their own formulae.

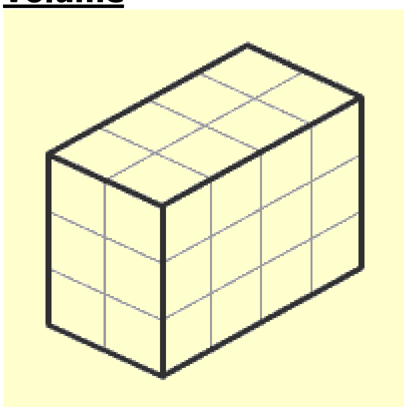
An easy way to remember this is to remember that as a surface is flat or 2D then a little ^{2} is used after the unit.

Units of area include mm^2, cm^2, m^2, and km^2

Calculate the area of the front of this booklet.

Area = length x width
= 29.7cm x 21.0cm
= 623.7 cm^2

Volume



Volume is three dimensional (or 3D). There are several ways to measure the volume of an object. If it is regular then the length, width and height are all measured then the results multiplied together.
E.g. 2cm x 3cm x 4cm = $24cm^3$

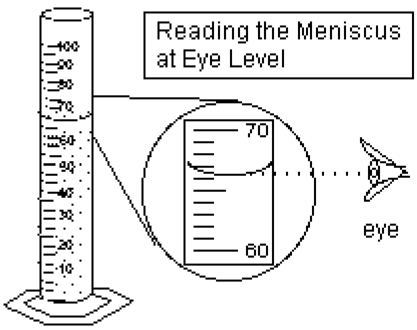
(The little ^{3} after the cm shows that this is short for cm x cm x cm).

An easy way to remember this is to remember that as the object takes up space or is said to be 3D then a little ^{3} is used after the unit.

An easy way to remember this is to remember that as a surface is flat or 2D then a little ^{2} is used after the unit.

Units of volume include mm^3, cm^3, and m^3.

If the object is irregular then its volume can be determined by placing it in water and see how much water is pushed out of the way. The volume of the object and the amount of water that is pushed out of the way are equal.



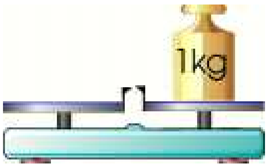
If the object is lowered into a measuring cylinder then care has to be taken when reading the result. Inside the measuring cylinder the water surface is curved. This is called the Meniscus. The reading is taken from the bottom of the meniscus. The reading in the tube above is 66 cm^3.

Force

The force (on an object) is a measure of the amount of a push or a pull exerted on an object and is measured in Newtons (N).

Mass

Mass and weight commonly get mixed up in everyday life. As a result examiners like questions on mass and weight.



Mass is measured using a **Balance** whereby an object's mass is compared to another object whose mass has been defined.

A **balance** is used for measuring **mass** because a balance *compares* an object's mass to a set of standard masses.

Mass is the amount of matter inside an object.   The units we will use in Physics are grams (g) and kilograms (kg). This matter can be packed closely together as in solids or spread out as in gases. As long as matter is neither added to, nor deleted from, the object, then the mass NEVER CHANGES. It always stays the same even if it were to go from the earth to the moon or deep space

Weight

The weight (of an object) is the local force of gravity on an object and it is measured in units of Newtons using a spring scale.

A spring Balance is used for measuring weight because a spring balance measures the *force of gravity* pulling objects downward.

Important

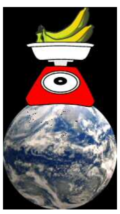
It is incorrect to specify weight in any units other than Newtons

Consumer items *should* have their contents labelled

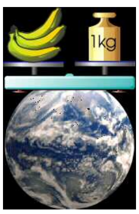
Mass 10kg or Weight 100N

Mass vs. Weight

An object's mass is a universal constant, whereas an object's weight depends upon its location

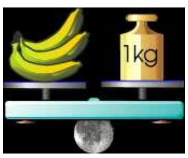


On earth these bananas have a weight of 10N.



On earth these bananas have a mass of 1kg.

On the Moon these bananas have a weight of 1.7N



On the Moon these bananas have a mass of 1 kg

Time

Time is one of the few units that is not decimal. Remember that

There are 60 seconds to 1 minute (min)
There are 60 minutes in 1 hour (hr)
There are 24 hours in one day.
There are 365 ¼ days in one year.

Density

Density is mass per unit volume. (How concentrated the mass is.) It is measured in $\frac{g}{cm^3}$ or $\frac{kg}{m^3}$

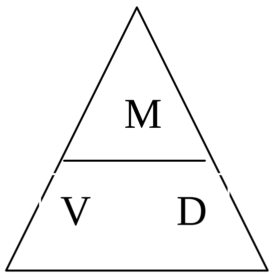
One cubic centimetre of water has a mass of one gram so the density of water is one gram per cubic centimetre or 1 $\frac{g}{cm^3}$ for short. It can also be expressed as kilograms per metre cubed so water has a density of 1000 $\frac{kg}{m^3}$.

The formula that links density mass and volume is

$$Density = \frac{Mass}{Volume}$$

This can be remembered

with the triangle



Rearrange the formula to find volume or density

The formula can be rearranged:
mass = volume x density
volume = $\frac{\text{mass}}{\text{density}}$
density = $\frac{\text{mass}}{\text{volume}}$

For example, the density of 22 carat gold is 17.5 g/cm^3. The density of 9 carat gold is 11.3 g/cm^3.
If you have a piece of gold jewellery, you can find out whether it is 22 carat or 9 carat by weighing it, and finding its volume. If it weighs 5 g, and has a volume of 0.286 cm^3, then:

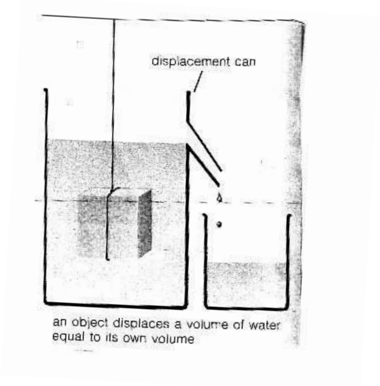
density = $\frac{\text{mass}}{\text{volume}}$
= $\frac{5\text{ g}}{0.286\text{ cm}^3}$
= 17.48 g/cm^3
So it must be 22 carat gold.

Archimedes used this method to find out if the King's jeweller had made a crown out of pure gold. Pure gold has a density of 19.3 g/cm^3. So a 386 g crown should have a volume of $\frac{386\text{ g}}{19.3\text{ g/cm}^3}$

This works out as 20 cm^3.
When the crown was put into water, it should displace 20 cm^3 of water. This should make it weigh 20 g less in water than in air. But it did not. Archimedes proved that the gold had been mixed with cheaper metal.

Fig. 42.2 A formula triangle can be used to rearrange a formula. If you cover up the quantity you want to find, the arrangement for the other two is shown.

The volume of an object can be calculated either by measuring the length, width and height then multiplying them all together or lowering it into a displacement can. The water pushed out is equal to the volume of the object.



Energy

Energy is the ability to do work. It exists in many different forms.
It can be converted from one form to another and we make use of these changes in everyday life.

Energy cannot be created or destroyed. It can only be transferred from one form to another.

THIS IS CALLED THE LAW OF CONSERVATION OF ENERGY

The unit of energy is the Joule (J) or kilojoules (kJ).

Types of energy:-

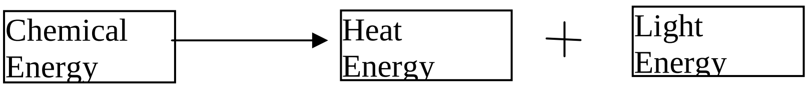
Name	Definition	Example
Electrical	An electric charge or current	A lamp
Thermal	Heat energy	A fire
Chemical	Energy stored in chemicals	Food / coal
Kinetic	Energy imparted by moving objects.	A car moving quickly
Gravitational potential	The potential to fall due to gravity	Water stored behind a dam
Elastic potential	Energy stored in stretched elastic items	A bow drawn and ready to fire
Light	Energy in electro magnetic waves.	UV / infra red / microwaves
Sound	Energy in sound waves	Ultra sound / loud rock concert
Nuclear	Energy stored within atoms	Nuclear power stations

Object	Type of energy 1	Is converted into	Type of energy 2
Electric fire	*Electrical*	Is converted into	*thermal*
Microphone	Sound	Is converted into	Electrical
Loudspeaker	Electrical	Is converted into	Sound

Energy Transfer Diagrams
Block diagrams

Energy transfers can be illustrated using 2 different types of diagram, a block diagram and a Sankey diagram, (Sankey diagrams will not be in the exam)

Let us take for example a battery powered torch.

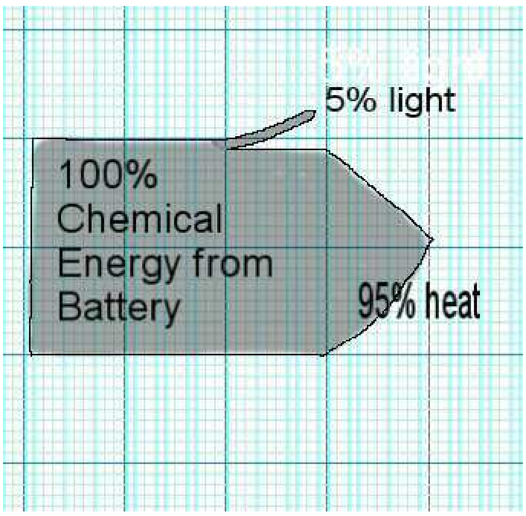


Energy transfers and efficiency

When energy is transferred it changes from one form to another.

The law of conservation of energy states that energy cannot be created or destroyed it can only be transferred from one form to another.

Energy efficiency is the amount of useful energy out compared to the total amount of energy put in. (This is usually expressed as a percentage.)
Take for example our battery powered torch again. For every 100J of energy supplied by the battery 5 J goes into producing light the other 95% goes into heating up the bulb. This is unwanted. As only 5% of the energy used goes into what the bulb was intended for we say that the bulb is 5% EFFICIENT.



Sankey Diagrams illustrate this.
The thickness of each arrow is drawn to scale to show the amount of energy (in this case each small square represents 5% on a vertical axis.) The total amount of energy at the start is the same as at the end. We can say that the energy is conserved

Thermal energy

Temperature is measured in degrees Celsius (°C)
Heat is a form of energy and is measured in Joules (J)
The hotter something is the more thermal energy it contains but heat and temperature are not the same thing.

Specific Heat Capacity

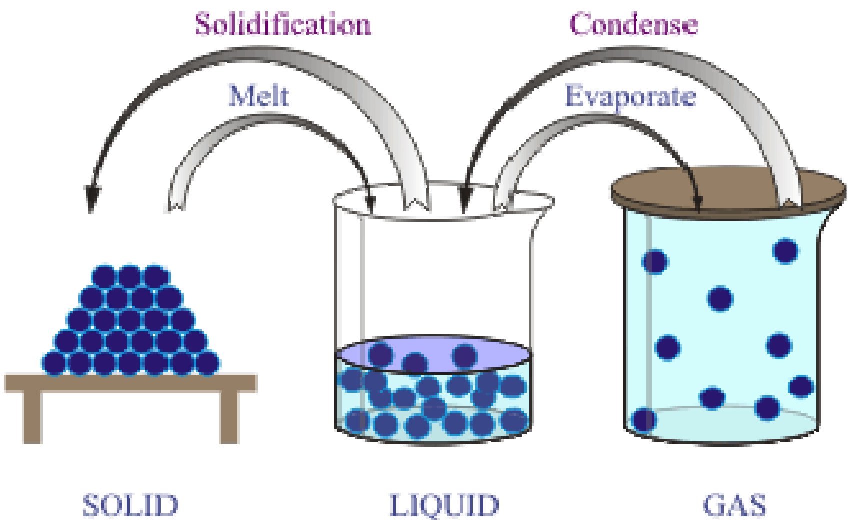
The particles that make up a substance are moving randomly. Heating a substance gives the particles more internal energy thus increasing the temperature. If I heat 1kg of copper I will need to put in 390J of energy to raise the temperature from 20°C to 21°C (a rise of 1°C). To raise temperature of 1kg of aluminium by the same amount would take 910J of thermal energy. Thus we can say that the aluminium has a higher specific heat capacity than the copper. By comparison 1kg of water needs 4200J of energy to raise it by 1°C.

Thermal energy can be transferred by four different ways, conduction, convection, radiation and evaporation.

Conduction

This is the main type of energy transfer in solids. Thermal energy travels from hot regions to cold regions. Solids where heat travels quickly though them are called thermal conductors. If the heat travels slowly through them they are known as thermal insulators.

Particle theory



Solids – The particles are closely packed together in a regular manner. They vibrate slightly. They have a fixed shape and volume.

Liquids – The particles have more thermal energy so can move around more. They begin to break the bonds joining them so lose their shape. They take the shape of their container but still have a fixed volume.

Gases – The particles have even more thermal energy than the other two states and move around completely free of each other. They do not have a fixed shape or volume.

Heating an iron bar

Cold **Hot**

As the particles in the bar gain more thermal energy they vibrate more. This causes them to spread out SO THE SPACES BETWEEN THE PARTICLES GETS BIGGER. (The particles themselves do not change size). Overall the bar expands.

Bi metallic strip

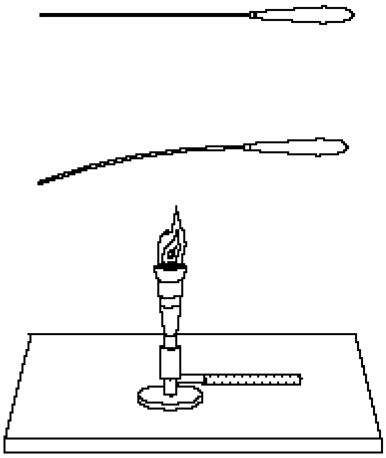
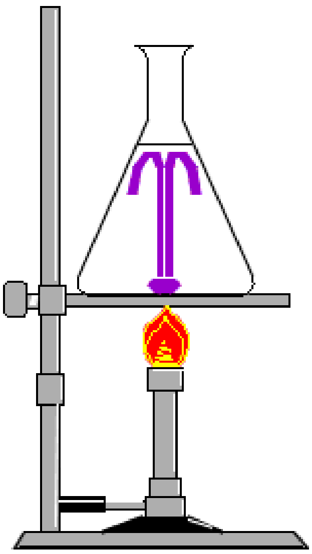


Diagram 1 (cold)

Diagram 2 (Hot)

The bimetallic strip is made up of two different metals copper and iron. When heated, both metals gain the same amount of thermal energy. However as the copper has a lower specific heat capacity, its temperature increases at a greater rate. The particles in the copper vibrate faster than in the iron so the spaces between them get proportionally bigger. Overall the copper expands more than the iron. As the two metals are riveted together the strip bends with the copper on the outside as this is the greater distance.



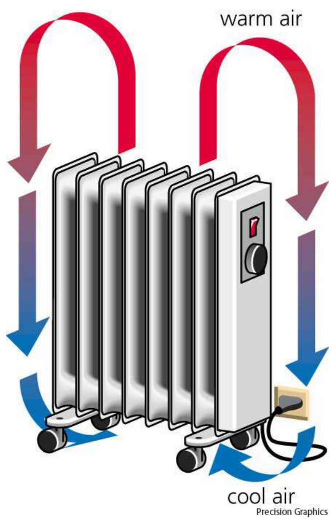
Convection

When the particles in a liquid or gas gain thermal energy they vibrate more. As a result they spread out becoming less dense.

Potassium Manganate VII demonstration

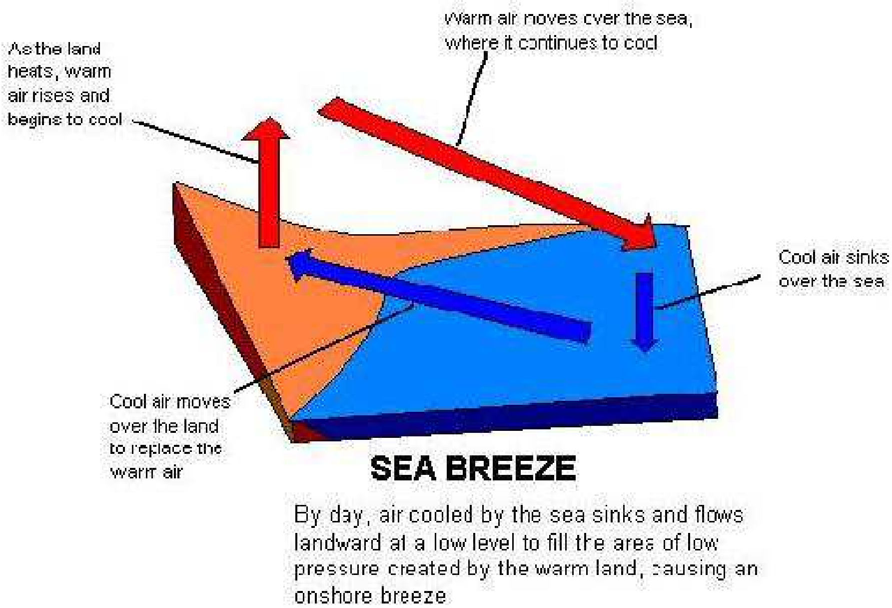
The apparatus was set up and some potassium manganate VII (purple crystals) was placed in the beaker. The beaker was heated gently under the crystals and the results recorded.

Land and sea breezes

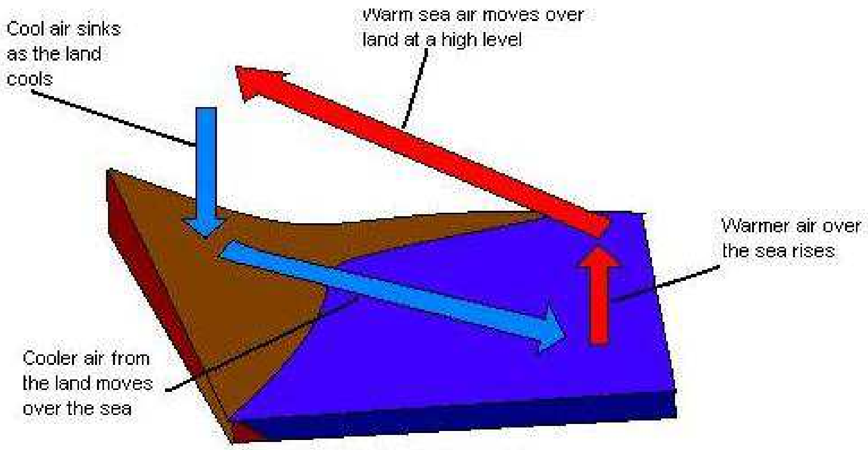


Complete diagrams below to show theses processes in action.

During the day the land heats up quicker than the sea therefore the hot air rises. Cooler air from the sea moves in to 'fill the space' so to speak. This is called a sea breeze.



Although the land heats up quickly it also cools down quickly so at night the sea is warmer than the land so the air above the sea rises and the cooler air from the land moves to fill the space. This is called a land breeze



LAND BREEZE

During the evening the land cools much faster then the sea. Cool air sinks over the land and flows seaward at a low level.
Warmer air rises over the sea and moves landward at a high level to replace it. This is called a land breeze.

> Fun - Cut a spiral of silver foil out and suspend it from a thread above a heat source eg a beaker of hot water or radiator. And watch it spin.
>
> If you are very careful, *AND ASK FOR ADULT HELP,* suspend it over a candle (about 30 cm from the flame to the bottom of the spiral) in a darkened room and watch the shadows.

(Black Body) Radiation

Heat can be transferred as radiation when it travels as an electro magnetic wave e.g. visible light, infra red and ultra violet energy. This is the ONLY way thermal energy can travel through space from the sun to earth.

In hot countries houses are painted white to help reflect the heat. So they are poor absorbers of thermal energy. Dark colours on the other hand are good at absorbing heat. This is why solar cells are black .

Evaporation

A puddle on the pavement will disappear even though the temperature of the water has not reached boiling point (100°C). When this occurs the process is called evaporation. When water is boiled water throughout the beaker turns to gas and bubbles of steam rise through the liquid. If the water is less than boiling point water will still evaporates from the surface until there is no more water left. Evaporation is a surface effect whereas boiling occurs throughout the liquid.

When you get wet thermal energy from your body is transferred to the water on your skin by conduction. This speeds up the rate of evaporation. In this way thermal energy is transferred from your body to the air, making you feel colder. This is why we sweat in hot weather to cool down. If you remove the water by drying yourself then you will feel warmer.

Reducing heat loss

Many insulating materials contain trapped air. Air is a poor thermal conductor. To be a good insulator the air needs to be trapped, otherwise the air will transfer thermal energy by convection. Wool jumpers help people keep warm because air is trapped between the fibres. Animals have feathers or fur to trap the air and keep them from the cold. E.g. a rabbit has fur.

Reducing thermal energy losses from the home

In colder countries keeping a house warm can use a lot of energy.
Not only is this expensive, it is it is also a waste of the world's valuable energy resources. Using less electricity for lighting, televisions, computers and other electrical appliances can also save a lot of energy in the home.

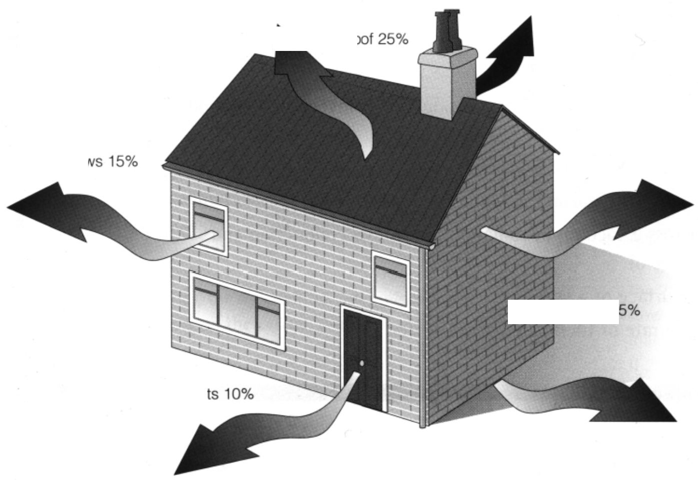


Figure 2.17 *How heat is lost from a poorly insulated house.*

Method of heat loss	**Notes**	**Insulation method**
Doors	Convection currents cause draughts. Hot air escapes and is replaced by colder air from outside.	Draught excluders
Windows	Heat is lost through the pane of glass by conduction through it.	Double glazing.
Walls	Foam or fibres injected into the cavity between the two outside walls. This traps air for increased insulation.	Cavity wall insulation
Roof	Insulating materials laid between the ceiling rafters and also on the inside of the roof.	Loft insulation

Energy Resources

Renewable	Non renewable
Wind	Coal
Geothermal	Oil
Solar	Gas
Wave	Nuclear
Tidal	
Hydro electric	
biomass	

All energy has come from the sun originally.

Renewable energy resources will never run out they can be reused again and again.

Non renewable energy resources are limited and will eventually run out.

Fossil fuel	Where is it from
Coal	Fossilised trees
Oil	Fossilised sea creatures
Gas	Fossilised sea creatures

Fossil fuel waste products

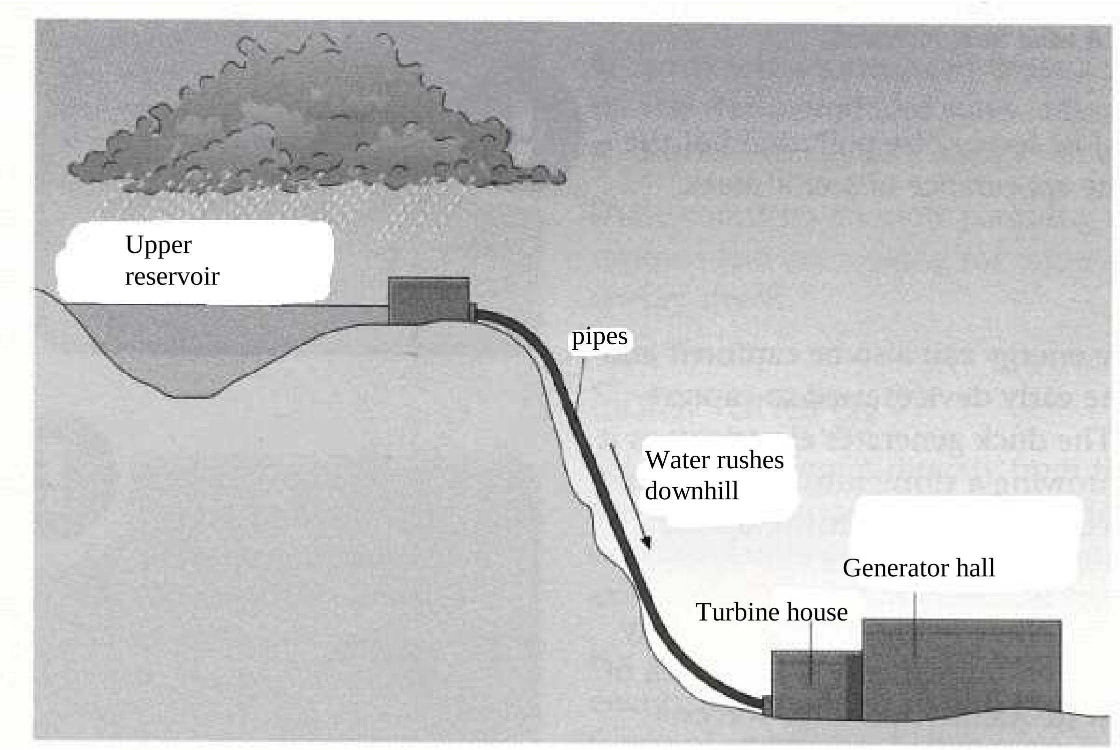
Fuel	Waste product	What pollution does it cause
Oil / Gas	Carbon dioxide	Greenhouse effect / global warming
	Sulphur and nitrogen oxides	Acid rain
Coal	Carbon dioxide	Greenhouse effect / global warming
	Sulphur and nitrogen oxides	Acid rain
	Soot	Smog

Solar energy
Photo voltaic cells convert sunlight directly into electricity. Solar panels on houses can be used to heat up water so reduce the electricity bill for hot water. Solar power stations use mirrors to reflect the sunlight onto a water boiler. This creates the steam to drive the turbines which are connected to the generator to make electricity.

Wind Energy
Kinetic energy from the wind blows a propeller around. This is connected to a generator which creates electricity.

Biomass
Biological matter is burnt to boil water. This creates the steam to drive the turbines which are connected to the generator to make electricity.

Hydro Electric energy
Water is stored in an upper reservoir. When it is released it rushes downhill, through turbines which are connected to the generator to make electricity.



A hydroelectric power station.

Space

Gravity

Why do you weigh more on earth than on the moon? Why do satellites not fall down to earth? It is all due to gravity. We all talk about weighing so many stone or kilograms. This is incorrect. Stone and kilograms are units of **mass.** One is the old imperial unit and the other metric. The only unit of **weight** is the Newton (N).

To start with what is the difference between weight and mass?

Weight is the force of gravity pulling your matter down to earth. Your weight can change depending whether you are on the moon, in a high speed lift etc. The only unit of weight is the Newton (N).

Mass is the amount of matter that is in a object. It is measured in a variety of units. The metric unit of mass is the kilogram. THE MASS OF AN OBJECT DOES NOT CHANGE if you go from the earth to the moon or deep space.

Two people standing next to each other both have a mass and these two masses will be attracted towards each other by a gravitational force. The attraction will not be noticeable as the masses are so small compared with the mass of a planet like the earth. The greater the mass the bigger the gravitational pull.

On earth a mass of 1kg will experience a gravitational force of 10N and is said to weigh 10N. If a pupil had a mass of 40kg on earth what would their weight be?

Weight = mass x gravitational field strength

$= 40 \text{ kg} \times 10 \frac{N}{kg}$

=400N

The mass of the moon is much smaller than that of earth so the pull of gravity is less. A 1kg mass on the moon will weigh 1.7N. What will our pupil weigh on the moon?

Weight = mass x gravitational field strength

$= 40 \text{ kg} \times 1.7 \frac{N}{kg}$

=68N

On a planet like Jupiter which is much larger than the earth 1kg mass has a weight of 27N.

As you get further away from the earth the effect of gravity goes down. To travel away from the earth a rocket needs a force to push against the earth's gravity.

Our solar system

Our solar system consists of one star and 9 planets. Some of these planets have moons. There are also smaller rocks found in regions called asteroid belts and occasionally comets visit from further out in space.

At the centre of the solar system is a star which we call the sun, then the inner planets. These are hard and rocky and are relatively small. Further out are the outer planets and are very much larger.

Mercury	**My**	⎤
Venus	**Very**	Inner planets
Earth	**Elegant**	⎥
Mars	**Mother**	⎦
Jupiter	**Just**	⎤
Saturn	**Served**	⎥
Uranus	**Us**	Outer planets
Neptune	**Nine**	⎥
Pluto	**Prunes**	⎦

Check out my intranet site on space to find out more about the individual planets

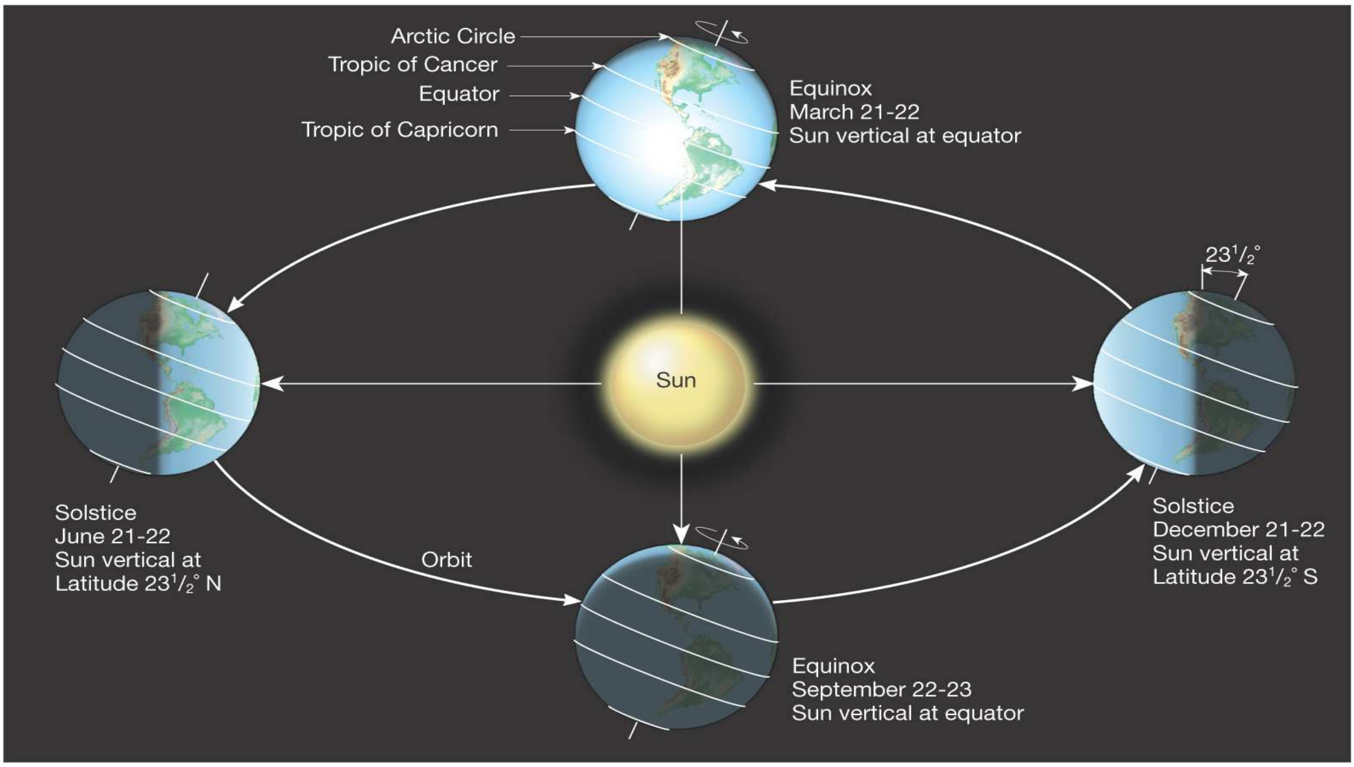
We see the other planets and the moon because the light from the sun is reflected off these bodies and back to us. The only source of light in our solar system (apart from what we generate on earth) is the sun.

Our solar system is part of a galaxy called the milky way and there are many millions of systems like ours in our galaxy. The universe contains many hundreds of thousands of galaxies like our own. As space is so large we need special units of measurement. These are light years. We have already looked at how fast light travels in 1 second in kilometres. As space is so large using kilometres is pointless as using millimetres to measure the distance from London to Sydney. The light from the sun takes just over 8 minutes to travel 149million kilometres to us here on Earth. The nearest star to us other than the sun is Proxima Centuri at 4.3 light years away.

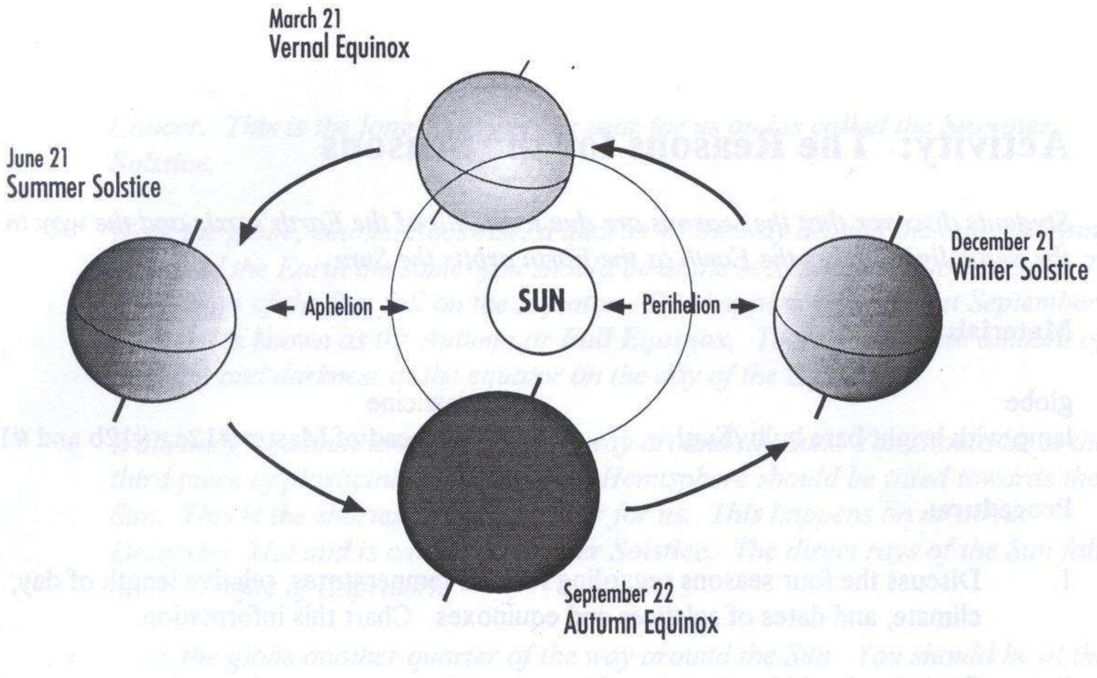
The movement of the Earth Sun and Moon

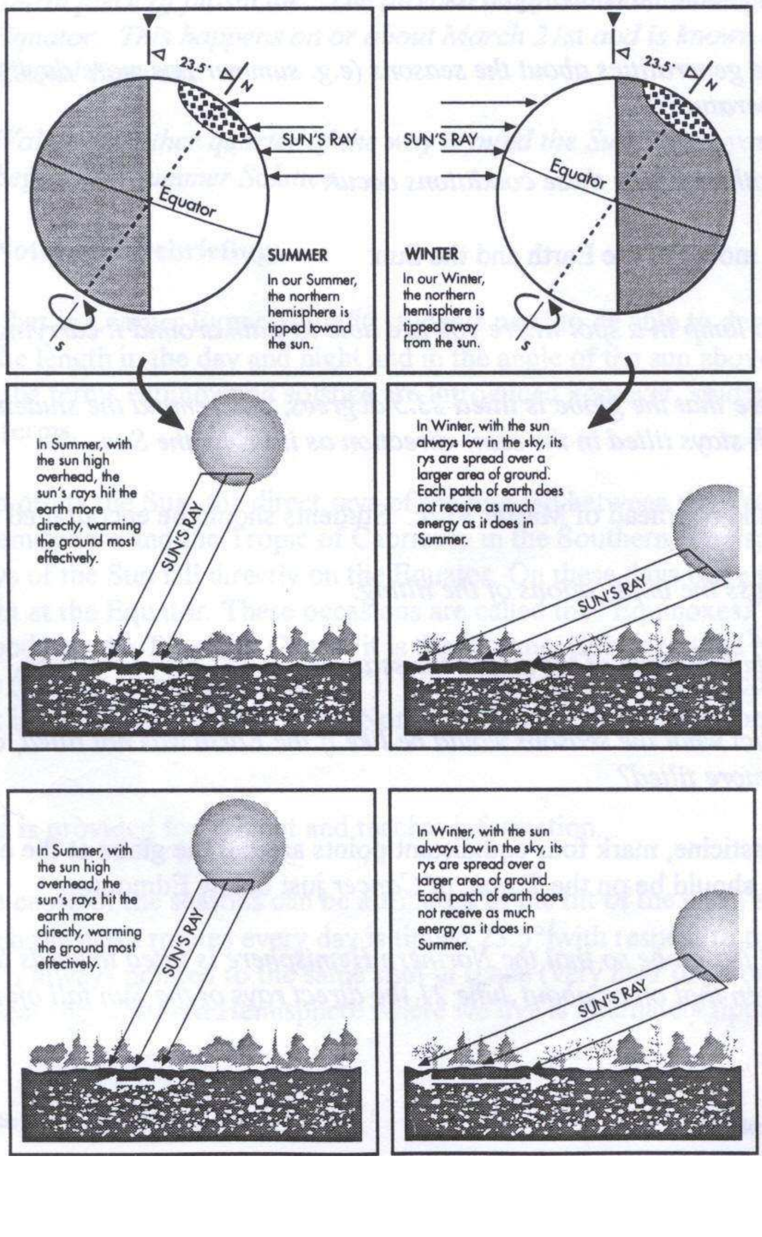
The Earth spins on its own axis once every 24 hours. It goes around the Sun once every year (365$\frac{1}{4}$ days). The Moon goes around the Earth every 28days it also spins on its own axis once every 28 days. This means that we always see the same side of the Moon.

A year is defined as the time taken for a planet to orbit the sun once.
A day is defined as the time taken for a planet to spin once on its own axis.

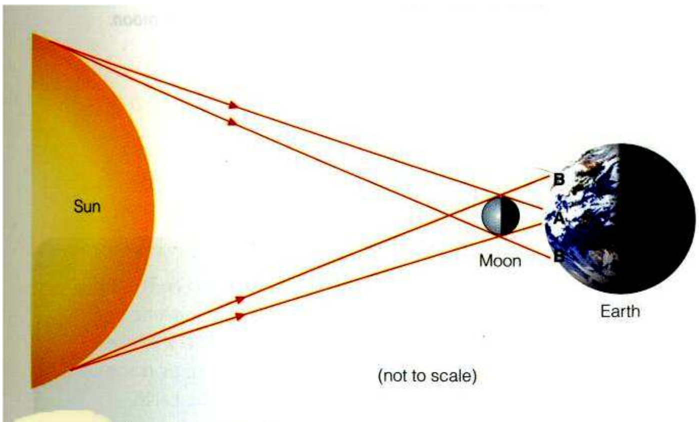


The Earth is tilted over so during the summer we get more sunlight so the days are longer. In winter they are shorter. At the poles however there is a period of time when the sun never sets during the summer and never rises in the winter.

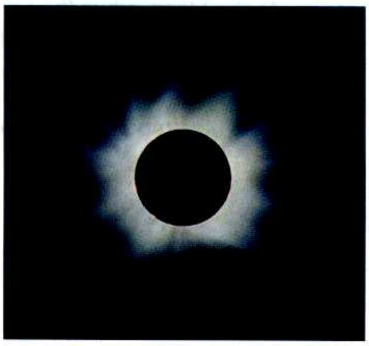

March 21
Vernal Equinox
June 21
Summer Solstice
December 21
Winter Solstice
Aphelion
SUN
Perihelion
September 22
Autumn Equinox


23.5°
N
S
SUN'S RAY
Equator
SUMMER
In our Summer, the northern hemisphere is tipped toward the sun.
WINTER
In our Winter, the northern hemisphere is tipped away from the sun.
In Summer, with the sun high overhead, the sun's rays hit the earth more directly, warming the ground most effectively.
In Winter, with the sun always low in the sky, its rys are spread over a larger area of ground. Each patch of earth does not receive as much energy as it does in Summer.
SUN'S RAY
In Summer, with the sun high overhead, the sun's rays hit the earth more directly, warming the ground most effectively.
In Winter, with the sun always low in the sky, its rys are spread over a larger area of ground. Each patch of earth does not receive as much energy as it does in Summer.

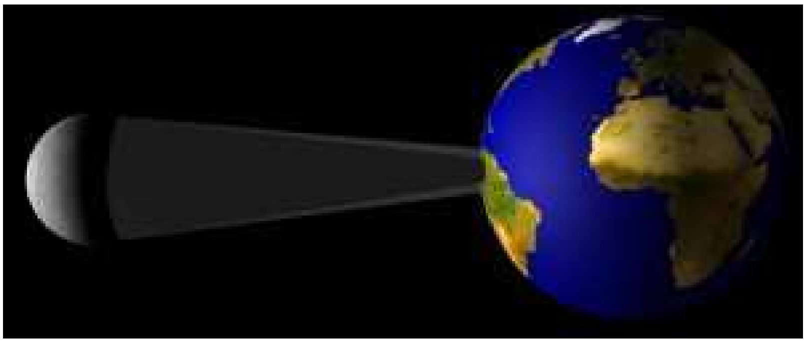
Solar Eclipses



An eclipse of the Sun.


The Sun in total eclipse.

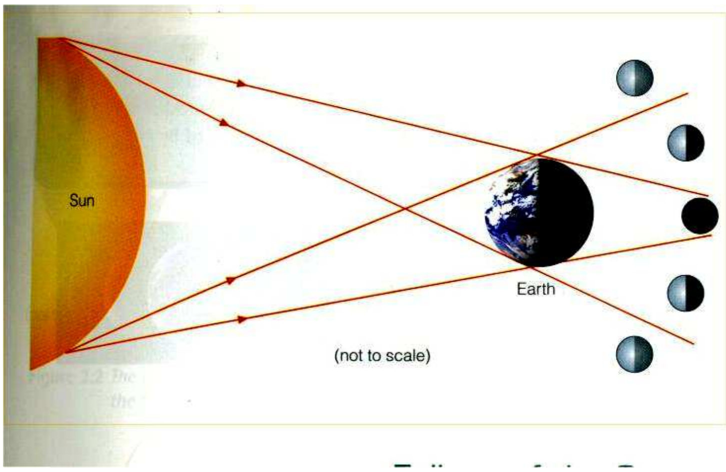
A solar eclipse happens when Earth passes through the Moon's shadow. The Moon always has a shadow, and if the Earth, sun and Moon are lined up just right, the Moon's shadow passes over Earth and we get to see a solar eclipse.



Although the Moon is very small compared to the Sun it is very much nearer to us. This is why if you are looking out to sea and see an ocean liner you can block it out with your thumb held in front of your eye. The ratios are just right that the Moon will block out the Sun completely.

Lunar eclipses

As we discussed earlier we se the moon due to the light reflected from the sun. Occasionally the Sun, Earth and Moon line up in such a way that the Earth casts a shadow over the Moon. This is a lunar eclipse.



Eclipse of the moon.

Satellites

The largest satellite orbiting the Earth is the Moon. This is held in its orbit by the force of gravity between the Earth and Moon. Without gravity the Moon or any other satellite would fly off into space. Man made satellites also orbit the Earth. They are held in place by gravity. The time it takes a satellite to orbit the Earth depends on the height of its orbit. This is very important. Geo stationary orbits place a satellite over the same spot of the earth all the time. This is very important for communications satellites such as the Astra satellite net that broadcasts sky TV. It is also useful for global positioning system satellites used in the navigation of ships and aircraft.

Light

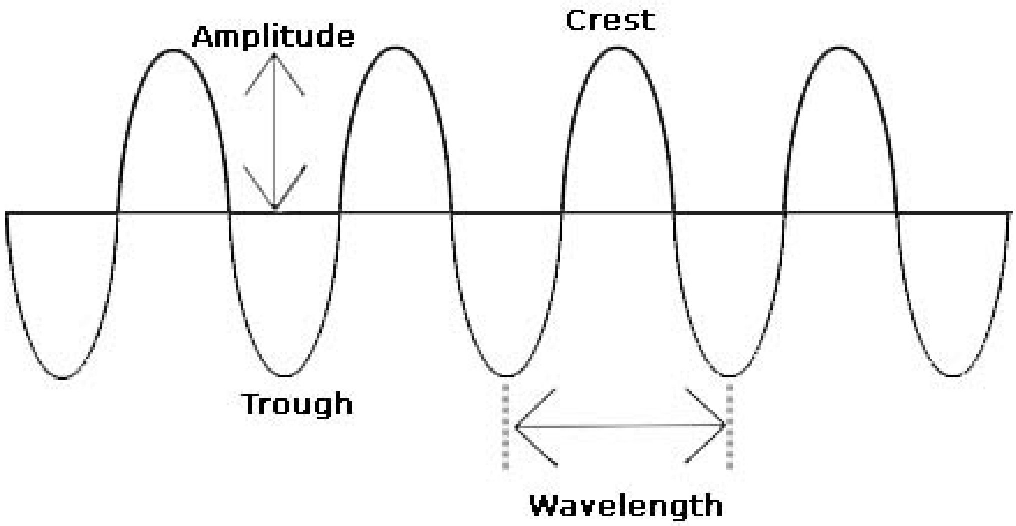
Why can you hear your friends if they are standing around the corner but you cannot see them? What form of energy enables you to read this booklet? Light enables us to see but you cannot see something unless light is shining on it.

Light is a form of energy. It enables us to see objects as our eyes are sensitive to it. Visible light is part of the electro magneic spectrum. Light travels very fast (300,000 km per second).

Sound is very slow compared to light travelling at only 0.33 km per second. If you are watching a race you see the smoke from the starting gun before you hear the bang. Thunder and lightning happen at the same time. But you see the lightning before you hear the thunder.

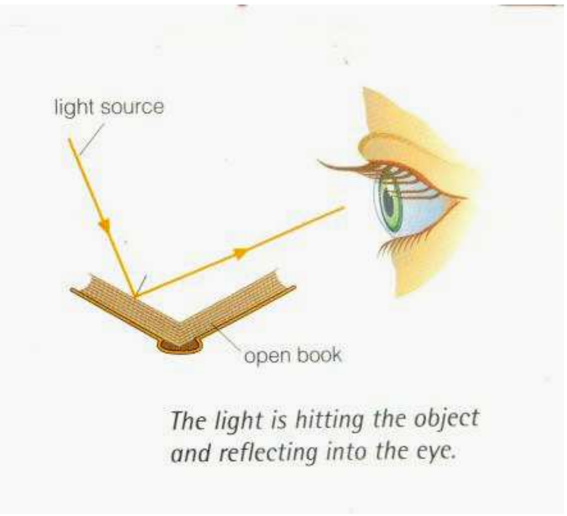
Light travels in energy waves. This type of wave is called a transverse wave as the deflection of the wave moves from side to side as it travels in a snake like manner.

A transverse wave



Scientific words associated with light

Word	**Meaning**	**Example**
Luminous	Objects that give off their own light	Sun
Illuminated	Objects which are lit up by light from luminous objects They DO NOT give off light themselves	moon
Transparent	A substance which allows light through it	Glass window
Translucent	An object which allows some light through it	Greaseproof paper
Opaque	A substance which does not allow light through it.	wood



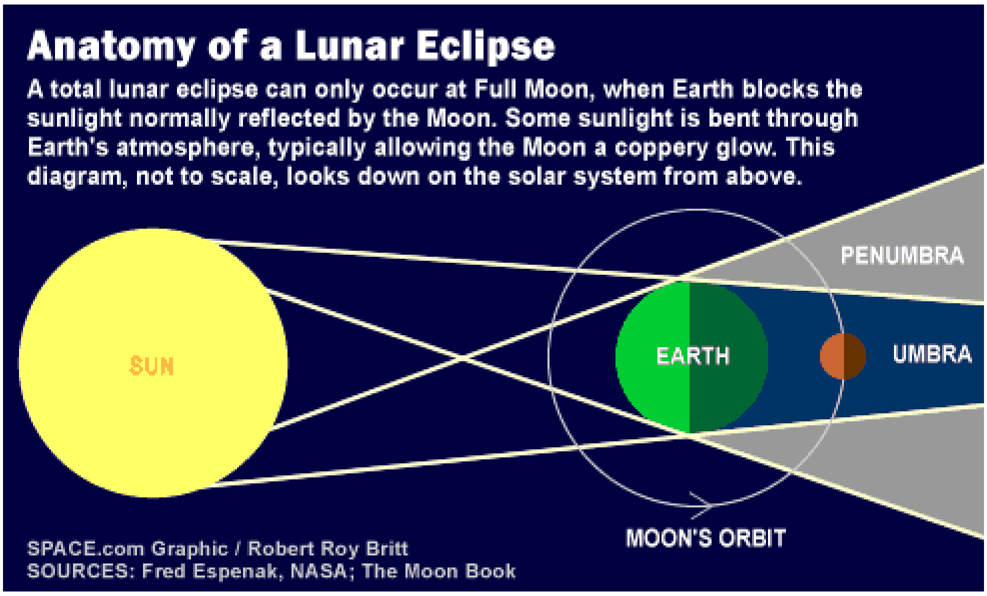
How we see a book

Light travels in straight lines – rectilinear propagation

A car headlight will not light the road around a corner. This is because light travels in straight lines. We call this **rectilinear propagation.**

Shadows

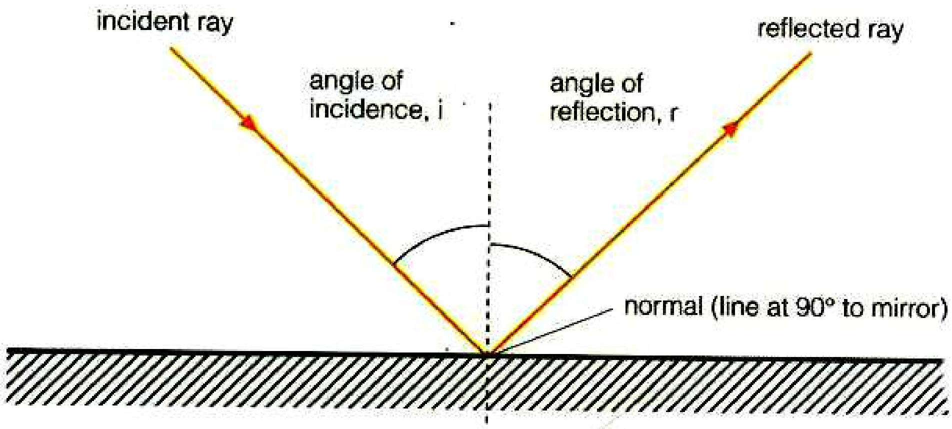
You cannot see through a brick wall as brick is opaque. Windows will allow light to go through it as glass is transparent. When the light to an object is blocked a shadow is formed.



Reflection of light

You can see both a mirror and this page. From what we have learnt earlier on this is because the light from the light bulb or sun is reflected off the page so it is illuminated. But why can you see your face in the mirror but not in the page. To answer this we need to look at how light is reflected.

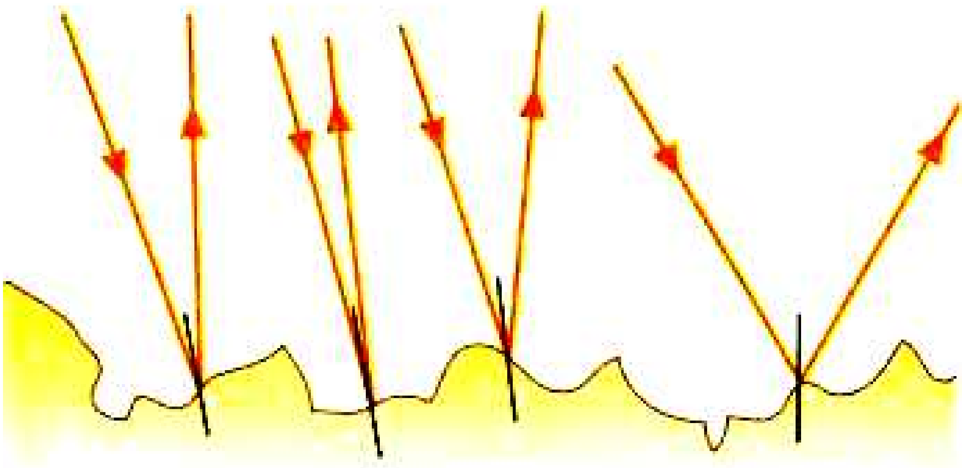
This is a diagram of a light ray being reflected off a mirror



Normal	An imaginary line drawn at 90° to the mirror where the incident ray strikes.
Incident ray	The ray coming towards the mirror
Angle of incidence	The angle made by the incident ray and the normal
Reflected ray	The ray moving away from the mirror
Angle of reflection	The angle between the normal and the reflected ray

Angle of incidence = angle of reflection

A mirror is shiny as it is very smooth. The light is reflected in a regular manner. This is called **regular reflection**. When you look into a mirror all the light is reflected and you get an image of your face. Rough surfaces scatter the light so not much is reflected into your eyes. This is called **diffuse reflection**.



The reflection of light from a rough surface.

The light is scattered in all directions.

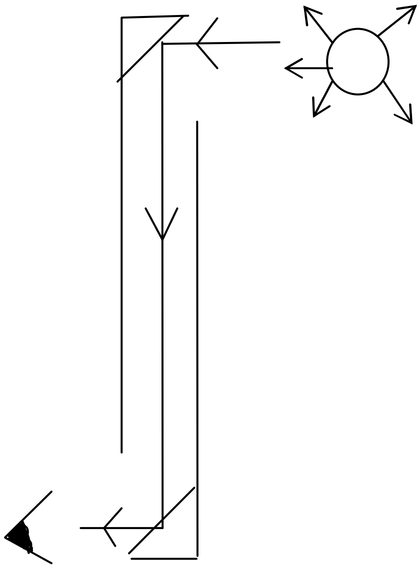
Mirrors

When you look in a plane (flat) mirror you see yourself in the correct size and colour. However your image is back to front or **laterally inverted**. This image only seems to be there. It is a **virtual** image. Images at the cinema are projected onto a screen. These are **real** images.

Seeing around corners

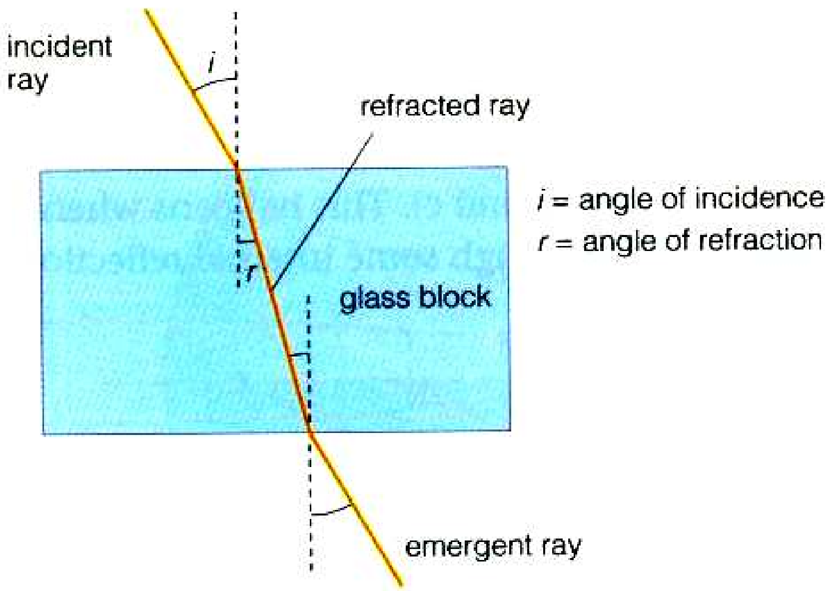
You cannot see around corners as light travels in straight lines. However with the use of mirrors you can. A good example of this is a periscope.

The light ray is drawn as it travels through the top opening, strikes the top mirror, down through the periscope and into the eye.



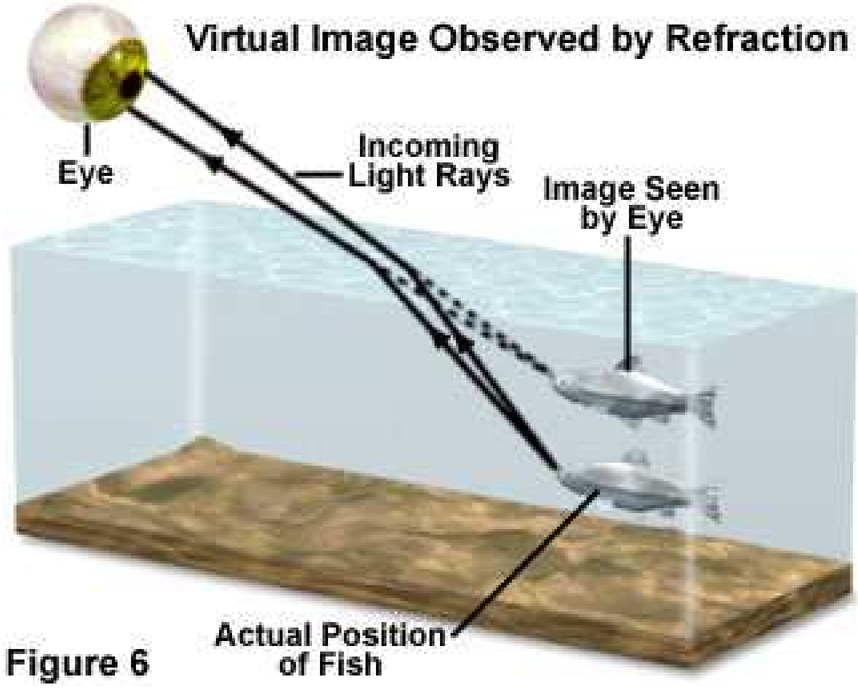
Refraction

Why does a swimming pool never look as deep as it is? Why does a straw in a glass of water look bent? What makes a diamond sparkle? When light goes from one substance to another (e.g. air → glass or air → water) it changes direction.



When the light enters the denser material it slows down slightly causing it to bend. This is called refraction.

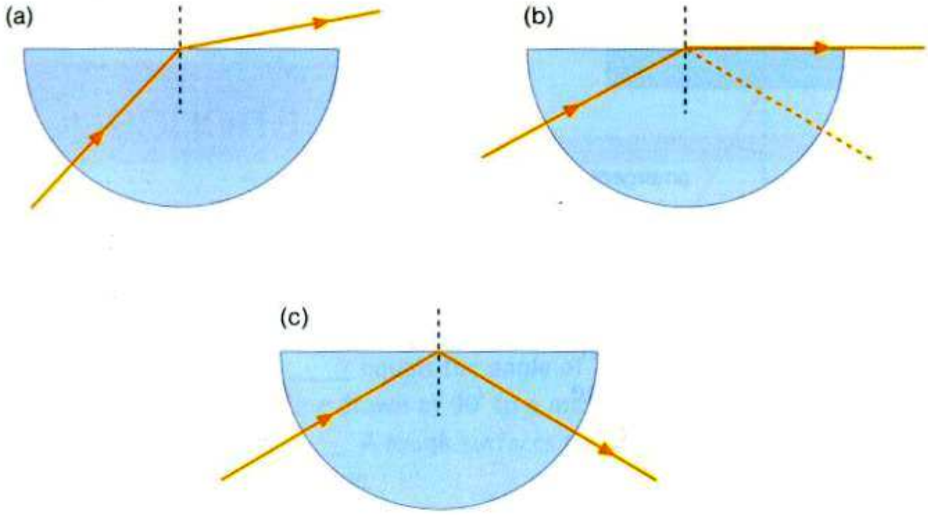
The light bends towards the normal as it enters the glass block from the air. This is because glass is a more optically dense material. The light ray actually slows down. It travels through the block in a straight line. When it meets the glass /air interface the ray bends away from the normal as it is going from a more dense material (glass) to a less dense one (air).



A fish in a river optical illusion.

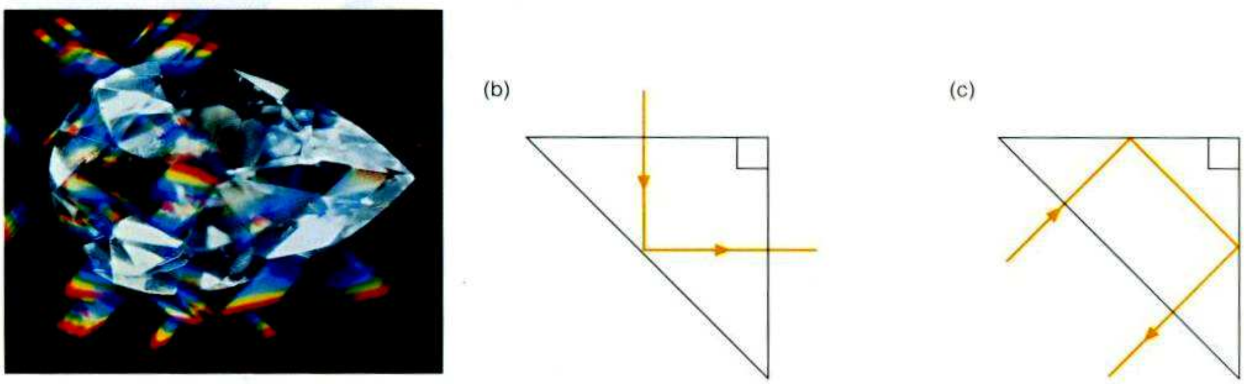
Total internal reflection

The diagram below shows a ray of light being refracted in a semi circular glass block. The angle of incidence is gradually increased. Eventually the light will have nowhere to refract to and **total internal reflection** takes place. This happens when the light reaches the **critical angle**.



Refraction in a semi-circular glass block: a) angle of incidence is below the critical angle; b) angle of incidence is at the critical angle; c) angle of incidence is greater than the critical angle – total internal reflection takes place.

The diagram below shows two 45° prisms. It shows how they can be used in periscopes and cats eyes in the road. Gems are cut so that they act as prisms and reflect light.



Prisms in use:
a) precious stone.

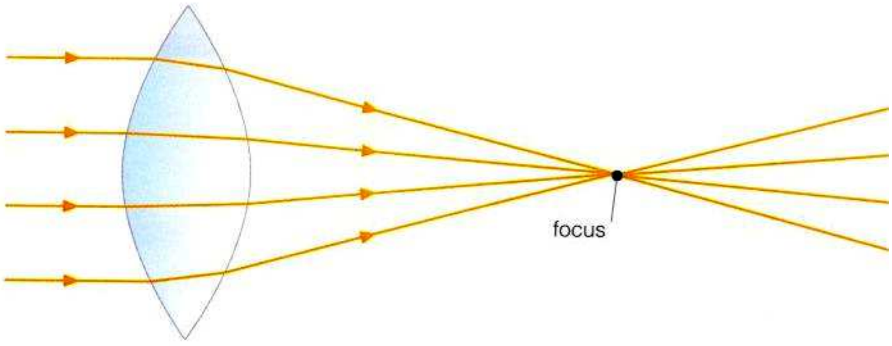
b) prism used in a periscope

c) prism used in cat's eyes

Lenses (information only will not be examined)

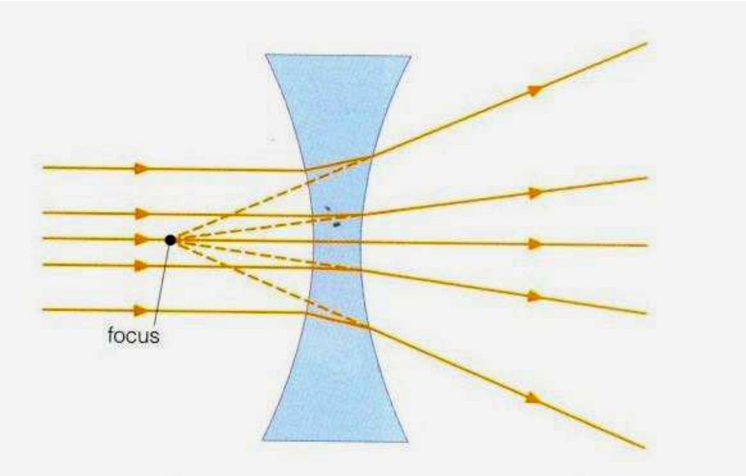
Lenses are transparent and can be used to change the direction of light depending on how they are cut. There are two types of lens convex lenses and concave lenses.

Convex lenses are fatter in the middle. They magnify an object but the image is inverted (upside down). When the image is sharp we say it is in focus. This is the shape of lens in your eye.



A convex lens.

Concave lenses are thinner in the middle, (like the entrance to a cave). The image is smaller but the right way up. If you are short sighted you have this sort of lens in your glasses.



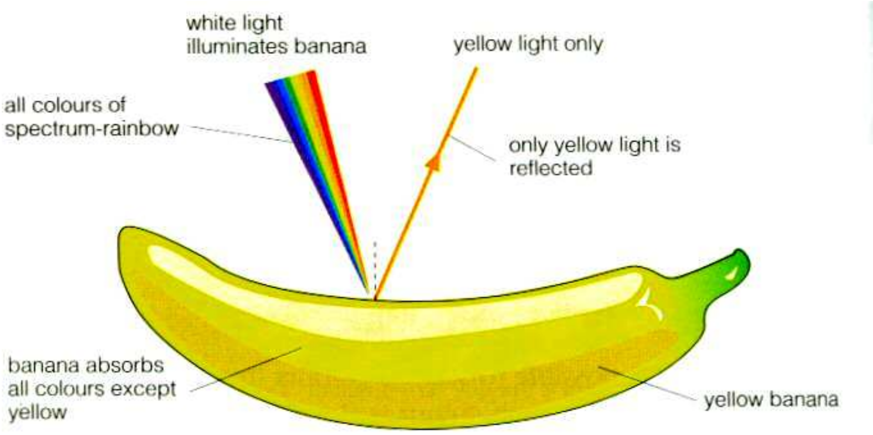
A concave lens.

Colour

White light is made up of the sever colours of the spectrum.

These are :-

red	**Richard**
orange	**Of**
yellow	**York**
green	**Gave**
blue	**Battle**
indigo	**In**
violet	**Vain**



White light is hitting the banana but only yellow is reflected.

We can only see these colours when light is split up using a prism. Each colour is slowed down by a slightly different amount as it passes through the air / glass interface so it is refracted by slightly different amounts and spread out so that we can see the colours. Red light travels slightly faster through glass than blue light so it is not refracted as much.

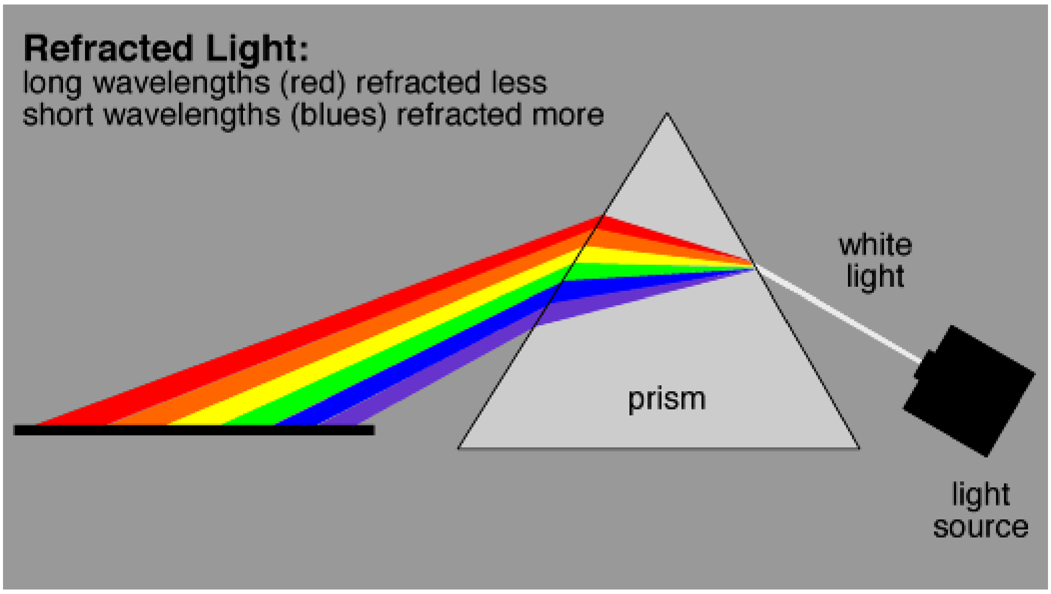


Diagram of how a prism splits up white light.

Coloured objects

A banana is coloured yellow because pigments in the skin will only reflect yellow light. A piece of coal is black because it absorbs all the colours and this white piece of paper reflects all the different colours.

Coloured filters

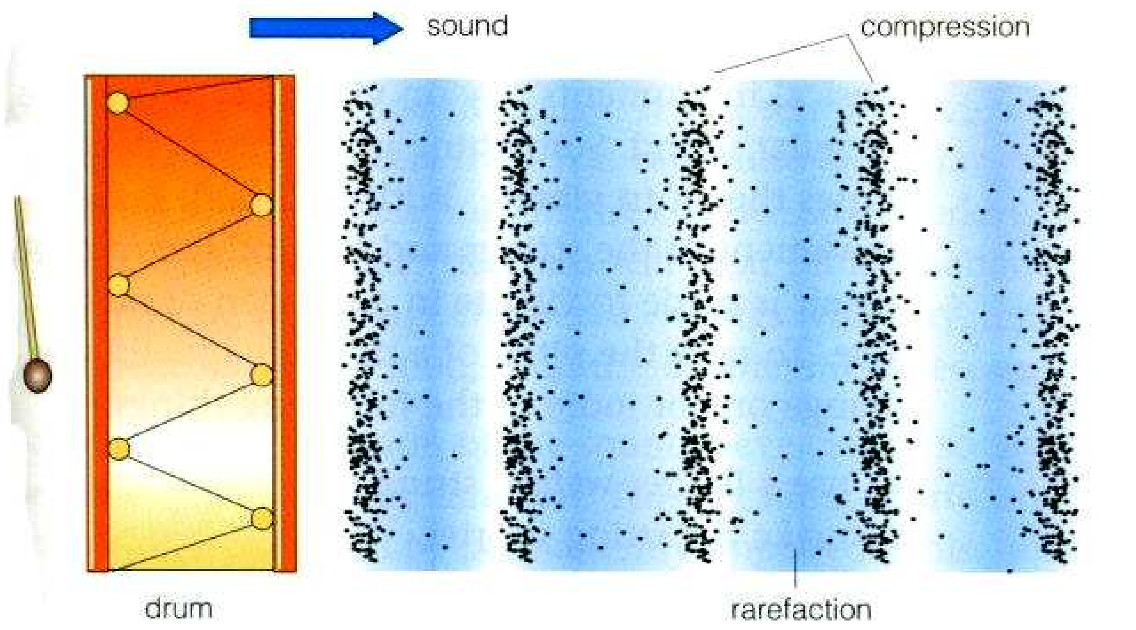
Traffic lights are coloured green, yellow and red. An ordinary light bulb is used behind coloured glass. The coloured glass filters out some colours. The red filter filters out all but red light. The other colours are absorbed. The same principal is used with other coloured filters on stage and in a disco to give different effects.

Sound

Sound energy is different from light energy. As we saw in the last unit light is an electromagnetic wave. This is transverse in nature this means that the deflection of the wave moves from side to side as it travels in a snake like manner. Light can travel through the vacuum of space.

Sound on the other hand is a longitudinal wave. This means that the pulses run in the same direction that the wave is moving. The waves are made up of compressions (particles bunched up close together) and rarefactions (particles spread out) as in the diagram below. The closer together the particles are the faster the sound will travel. Sound travels fastest in solids. The hearing range for humans is about 20 Hz to 20,000Hz As you get older you cannot hear sounds at the lower and upper end of the range. If the sounds are too loud then you can damage your ear drum. If you work in a loud environment you need to protect your ears. On a motorcycle at high speed the sound from the air passing your ear can damage your hearing in as little as ½ an hour.

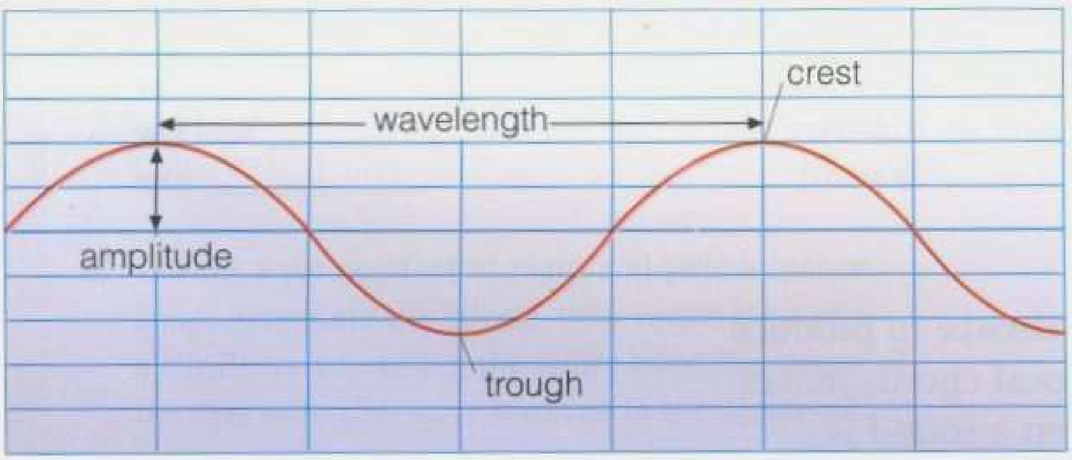
If you stand too near a loud speaker at a concert you can cause temporary deafness. This wears off after an hour or so. However if you continue to listen to loud music through headphones with the volume turned up the damage to the nerve endings becomes permanent as does the deafness. If the noise is too loud then the ear drum itself can tear causing a ruptured or burst eardrum. This is permanent and cannot be



Sound waves travel through the air from the drum in a series of compressions and rarefactions.

repaired.

Sound waves



A sound wave as shown on an oscilloscope.

This is what a sound wave looks like on an oscilloscope which is connected to a microphone. The troughs represent rarefactions and the crests compressions.

Crest	High points
Trough	Low points
Wavelength	The distance between two peaks or two troughs
Amplitude	The height of a crest or depth of a trough from a mid line
Frequency	How many wavelengths a second

If you increase the amplitude the sound gets louder. If you increase the frequency the pitch of the note gets higher. To raise the pitch of a note on a violin string you could

Use a lighter weight string
Make the string shorter
Put more tension on the string

The pitch or frequency of the note is measured in Hertz (Hz)
The volume or amplitude of the note is measured in decibels (dB)

Reflection of sound waves

Sound waves can be reflected as well as light waves. These take the form of echoes. Echoes behave differently depending on where they are. Sounds in an empty concert hall or tunnel are different from a furnished room or the same concert hall now filled with an audience. Hard objects reflect sound differently from soft ones. The differences in these echoes are utilised by animals such as bats who use echo location as a means of safely navigating in the dark.

We use echo location in the exploration of oil and in navigation of the worlds' seaways. It tells the captain how deep the water is under the hull and whether there are wrecks or shoals of fish

Ultrasound is a very useful tool. It can be used to clean small and delicate items of jewellery and glasses. In medicine it can be used for a variety of things. It can be used to create images to check on unborn foetuses in the womb. If the intensity is increased and the beam focused more it can be used to shatter gallstones.

Motion and speed

This is the final unit before the exams. It is probably the most mathematical unit we have done so far. However the maths is easy as long as you learn the processes thoroughly and follow the steps laid out FOR EVERY CALCULATION. If you do this then you WILL find it easy and you WILL get good marks.

How do we work out how fast an object is moving? How long will a journey take at a particular speed? Speed is a measure of how fast an object is moving. The speed of an object tells us the distance it travels each second.

Speed, distance and time are linked.
There are 3 equations you need to know how to use.

$$\text{Average speed} = \frac{\text{Distance}}{\text{Time Taken}}$$

$$\text{Time Taken} = \frac{\text{Distance}}{\text{Speed}}$$

$$\text{Distance} = \text{Speed} \times \text{Time Taken}$$

Units

The units of speed are:- metres per second ($\frac{m}{s}$) or m/s

Kilometres per hour ($\frac{km}{h}$) or km/h

Miles per hour (mph)

Units of distance are:-		Units of time are:-	
Metres	(m)	Seconds	(s),
Kilometres	(km)	Minute	(min)
Miles (miles)		Minutes	(mins.)
		Hour	(hr)
		Hours	(hrs)

UNLIKE MATHS UNITS ARE TO BE USED IN ALL STAGES OF THE CALCULATIONS

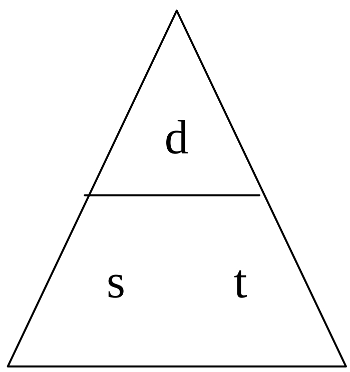
Several facts that are common knowledge but people forget

60 seconds = 1 minute
60 minutes = 1 hour
1000 metres = 1 km

This might be obvious but you must remember that time does not work on the decimal system!

To help you remember the equations above the triangle below will help you remember them. You may draw the triangle to help you remember the equation you need. HOWEVER a triangle is a triangle and NOT an equation. If you draw a triangle but fail to write down the equation -

YOU WILL GET NO MARKS FOR THE TRIANGLE.



To use the triangle you put your finger over the part you want to find then see what the other two leave you.

Examples

1. To find the time taken you put your finger over the t then you are left with $\frac{d}{s}$.

   Therefore time taken (s) = $\frac{\text{distance (m)}}{\text{Speed } (\frac{m}{s})}$

2. To find the distance you put your finger over the d then you are left with s t (from maths 2 letters next to each other means s *multiplied by* t)
3. Therefore distance (m) = speed ($\frac{m}{s}$) multiplied by time (s)

Other units of speed

It is not always a good idea to measure speeds in metres per second. A snail making its way along a garden path will be moving very slowly and it would be better to measure its speed in millimetres per second.

For a car travelling along a motorway at high speed it would be better to measure the speed in miles per hour or kilometres per hour.

The same equation is used to calculate the speed, but the appropriate units for distance and time must be used. To find the speed of the snail (mm/s) the distance should be measured in millimetres and the time in seconds. To find the speed of a car in kilometres per hour, the distance travelled should be measured in kilometres and the time taken measured in hours.

Example

A horse takes 12 s to trot a distance of 96 m. Calculate the average speed of the horse during this part of its journey.

- **information:**
  distance travelled = 96 m
  time taken = 12 s.
- **calculation:**
  average speed = distance travelled ÷ time taken
  = 96 m ÷ 12 s
  = 8 m/s.

Example
A girl walks at an average speed of 2 m/s for 80 s. Calculate how far she walked in that time.

- **information:**
  average speed = 2 m/s
  time taken = 80 s.

- **calculation:**
  distance travelled = average speed × time taken
  = 2 m/s × 80 s
  = 160 m.

Time taken

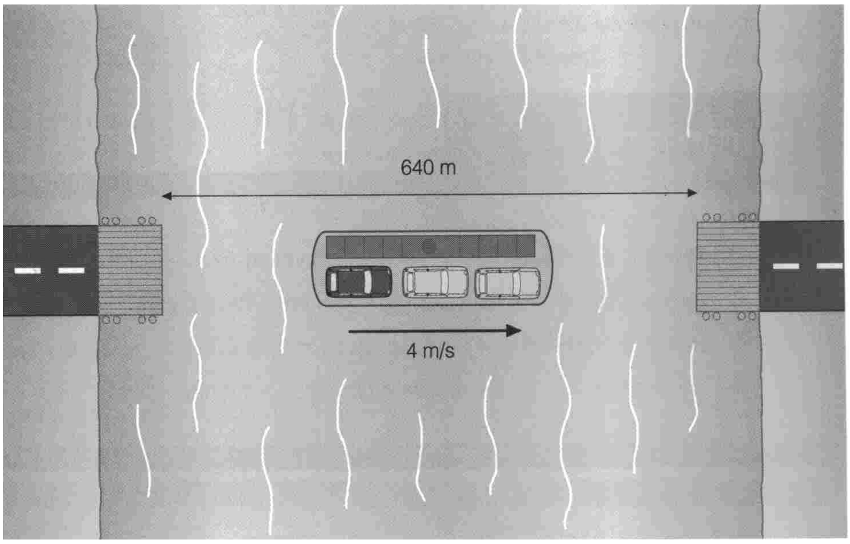
To calculate the time taken to travel a given distance when the average speed is known, use the following equation (see equation triangle in Figure 1.2):

time taken = distance travelled ÷ average speed

Example
A ferry transports cars across a river at an average speed of 4 m/s. The river is 640 m wide. Calculate the time that it takes for the ferry to cross the river.

- information:
  distance travelled = 640 m
  average speed = 4 m/s.

- calculation:
  time taken = distance travelled ÷ average speed
  = 640 m ÷ 4 s
  = 160 s.



Motion graphs

Can we use graphs to show how something is moving? There is more than one way of using graphs to show the motion of an object.

Farshad's journey

Farshad walked to the shops to buy some batteries for his personal stereo. His journey can be described like this:

A The shop was 600 m from his home and it took 300 s for Farshad to walk there.

B He spent 240 s in the shop buying the batteries and fitting them into his personal stereo.

C He then walked back home listening to some music. This took Farshad 400 s.

Another way to describe this journey is to use a **distance–time graph**.

- Section A is a straight line that shows Farshad is travelling at a steady speed.
- Section B is a horizontal line showing that he is not moving.
- Section C is a straight line but it is not quite as steep as section A. This shows that Farshad is travelling at a steady speed but slightly slower than during section A.

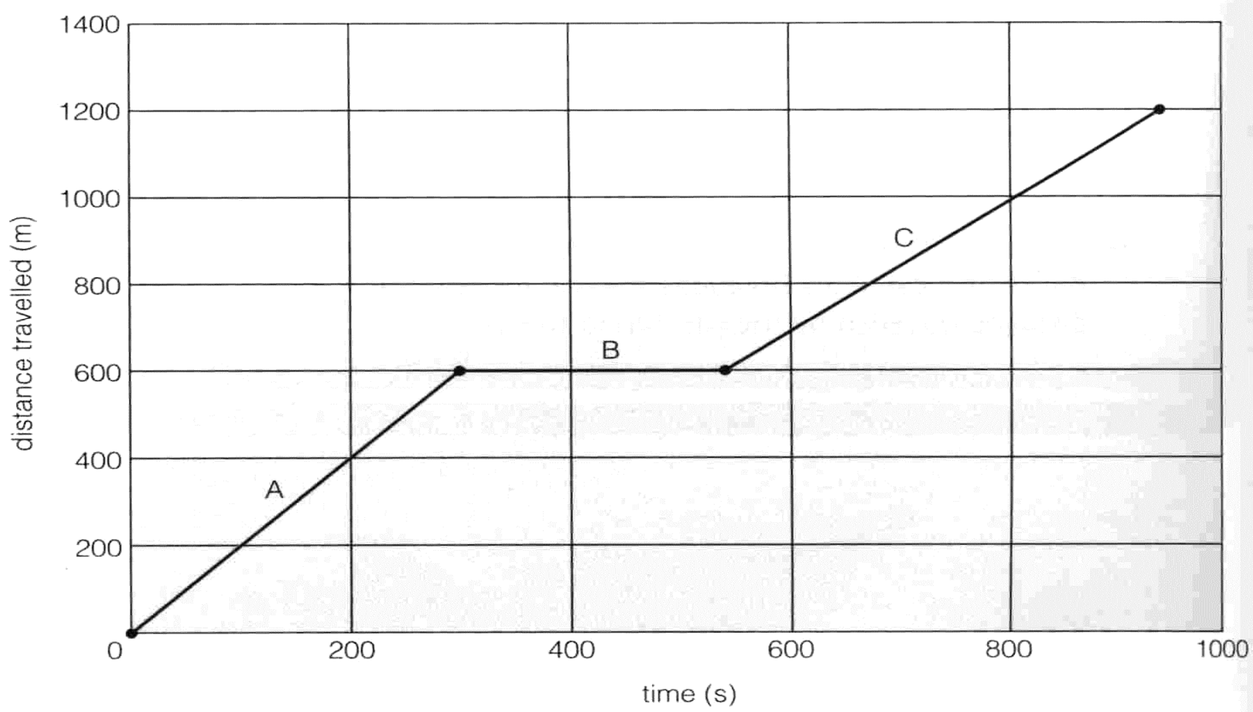


Figure 2.1 *Farshad's journey.*

The graph also gives the information that is needed to calculate Farshad's speed during each part of his journey. This is shown in Table 2.1.

Table 2.1 *Farshad's speed during his journey.*

	A	B	C
Distance travelled (m)	600	0	600
Time taken (s)	300	240	400
Speed (m/s)	= 600 ÷ 300 = 2	= 0 ÷ 240 = 0	= 600 ÷ 400 = 1.5

Examples of distance–time graphs

Figure 2.2 shows three examples of distance–time graphs. Figure 2.2a shows an object that is stationary; Figure 2.2b shows an object that is moving at a steady speed and Figure 2.2c shows an object that is moving faster and faster, or accelerating.

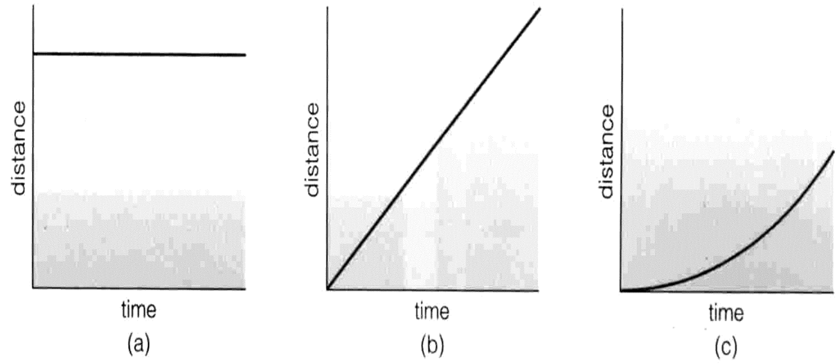


Figure 2.2 *Three distance-time graphs: a) stationary object; b) object moving at a steady speed; c) object getting faster (or accelerating).*

Speed–time graphs

Figure 2.3 shows the speed of a tractor travelling at a steady speed of 6 m/s. When an object is travelling at a steady speed, plotting a speed–time graph produces a horizontal straight line.

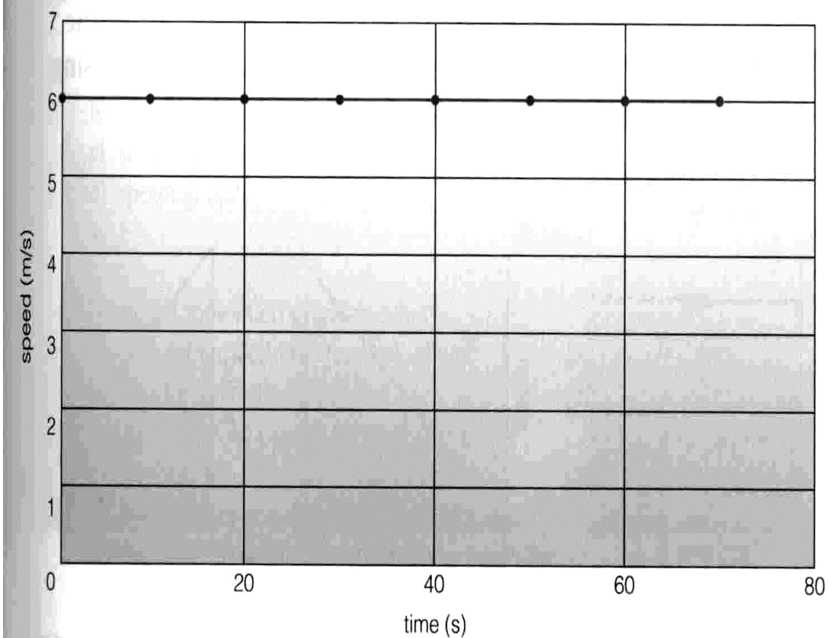


Figure 2.3 *Speed-time graph for tractor going at a steady speed of 6 m/s.*

! The crew of Apollo 10 reached a speed of 39 897 km/hr on the craft's return flight to Earth in May 1969.

Summary Sheets

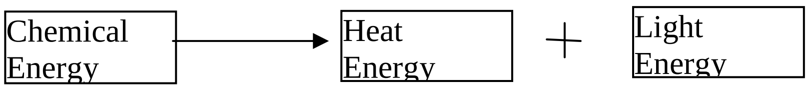
Energy Summary

- Energy is the ability to do work units Joules (J) or kilojoules (kJ)

- Energy CANNOT be made or destroyed, only transferred from one form to another.

- Several different types of energy
    - Thermal (heat)
    - Kinetic (movement) (KE
    - Gravitational potential energy (GPE)
    - Elastic (potential energy) (EPE)
    - Chemical
    - Electrical
    - Sound
    - Light

- Energy transfers can be drawn using block diagrams or Sankey diagrams



- Energy efficiency is the amount of useful energy out compared to the total amount of energy put in (usually expressed as a percentage.)

Thermal Energy Summary

- Temperature is a measure of how hot an object is and is measured in °C.
- Heat is a form of energy and is measured in Joules (J).
- Thermal energy is transferred by 4 ways - Conduction, convection, radiation and evaporation.
- Conduction is the main method of heat transfer in solids.
- Convection is the main method of heat transfer in fluids (liquids and gases).
- Thermal energy can be transferred through a vacuum by radiation only.
- Evaporation takes place on the surface of a liquid.
- Boiling occurs throughout a liquid.
- Insulators are used to reduce the rate of thermal energy transfer.

Energy Resources Summary

- Energy resources can be put into 2 main groups, renewable and non renewable.
- Renewable resources are continuously available and will not run out.
- Non Renewable resources are running out and cannot be replaced.

Space Summary

- Gravity is the attraction between masses.
- Weight = mass x gravitational field strength.
- The Earth's gravitational field strength is 10 N/kg.
- On Earth weight (N) = mass (kg) x 10 (N/kg).
- Larger masses have stronger gravitational fields.
- A planet's gravitational field strength decreases with distance from a planet.
- A force acting on a mass due to the Earth's gravitational field is called weight.
- Satellites are kept in orbit by the Earth's gravitational field.
- The Moon is a natural satellite.

- The sun is just one star out of millions in the Milky Way galaxy
- The sun is the centre of the solar system.
- Nuclear fusion produces the sun's energy
- The solar system is made up of the sun, nine planets, comets and asteroids.
- Only the earth has an atmosphere that will support our life form.

- The earth spins on its axis once every 24 hours
- The earth orbits the sun every 365¼ days.
- The Moon is the only natural satellite of the Earth.
- The same side of the Moon always faces the earth.
- A lunar eclipse is when the moon goes into the Earth's shadow.
- A solar eclipse is when the Moon casts a shadow over part of the Earth.

Light Summary

- Light is part of the electromagnetic spectrum
- A luminous object gives off its own light
- An object that reflects light is visible when illuminated
- Light travels in straight lines
- Light travels a fixed speed and is much faster than sound
- Light is reflected off objects into our eyes
- Opaque objects block light and cast shadows

- Angle of incidence = angle of reflection
- The image in a mirror is back to front (laterally inverted)
- Smooth surfaces reflect more regularly than rough ones

- Light slows down when travelling in more optically dense materials.
- The bending of light is called refraction.
- Total internal reflection occurs when the angle of incidence reaches the critical angle for the boundary between substances

- White light is made up of seven colours
- Light can be split into its colours using a prism

Sound Summary

- Vibrating molecules carry sound energy
- Sound needs a substance to carry it
- Sound travels faster if the particles in the medium it is travelling through are closer together
- The larger the amplitude of a sound the louder it is
- Pitch depends on frequency. High frequency gives high pitch.
-
- The reflection of sound is an echo
- A sound too high to hear with the human ear is called ultrasound
- Ultrasound can be used to detect objects under the sea and used in medicine as an imaging technique. It is also used to clean things.

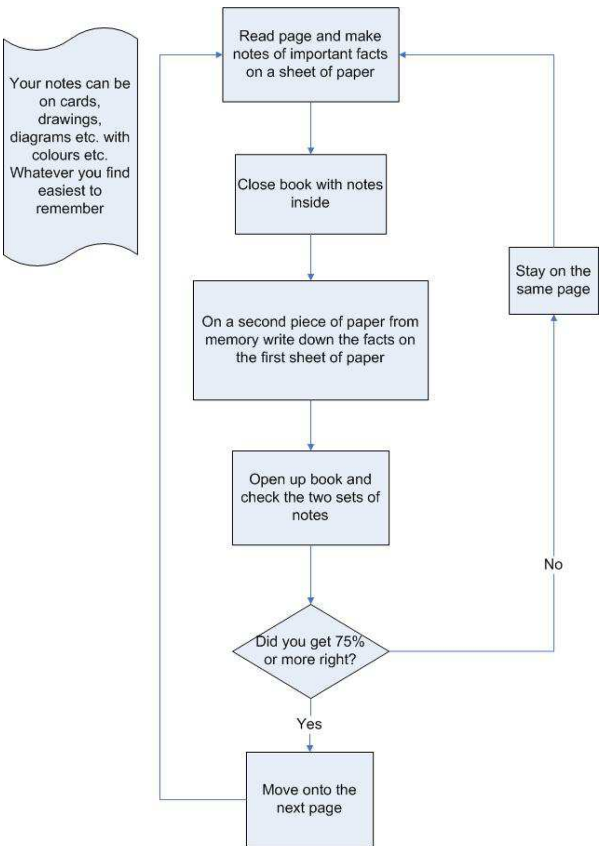
Speed and Motion

Speed = Distance / time

Density Summary

- Density is a measure of how concentrated a mass is.
- It is measured in $\frac{g}{cm^3}$ or $\frac{kg}{m^3}$

How to revise



Physics Exam Technique

You should have with you the following equipment.

1. Short ruler
2. Long ruler
3. 2 sharp pencils
4. Rubber
5. Pencil sharpener
6. Pen
7. Spare cartridges
8. Highlighter pen
9. Protractor
10. Calculator

The physics exam is 25 minutes long in year 7

The first thing you should do is see how many questions are in the paper.

The first few minutes should be spent reading the paper and highlighting important words and phrases.

Pace yourself so that you attempt all the questions. Remember do not spend loads of time on a question worth only 1 mark.

The last couple of minutes are spent checking through the paper.

If you are struggling on a question move on. You can come back to it later.

Important points to remember

- Use a sharp pencil to draw and label all diagrams.
- A ruler must be used to draw straight lines.
- Light ray diagrams must include arrows to show the direction of the light.
    - (ONLY SUPERMAN CAN FIRE LASERS FROM HIS EYES!!!)
- Show all working and lay it out neatly as in maths.
- Include units throughout the calculations.