Energy

Threshold Concept

Energy can't be created or destroyed, it can only be transferred from one store to another in a closed system

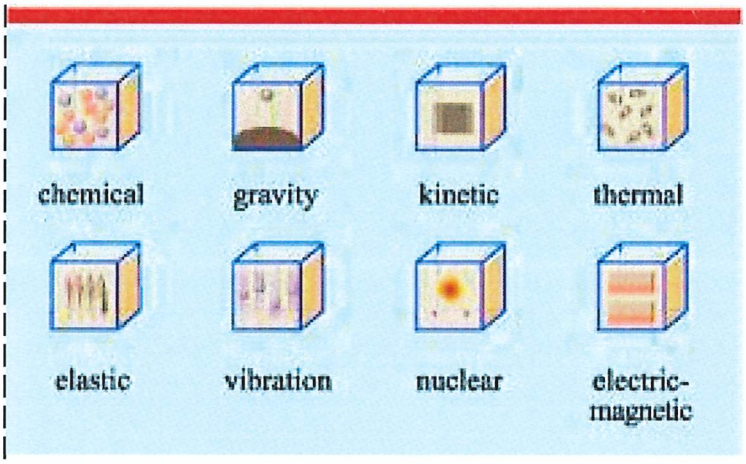
Keywords

Energy – moved between stores during transfers
Store – A temporary housing for energy
Transfer – The movement of energy between stores
Useful – The energy store that you wish for the energy to flow into
Dissipated – The store that energy flows into that is not useful or wasted

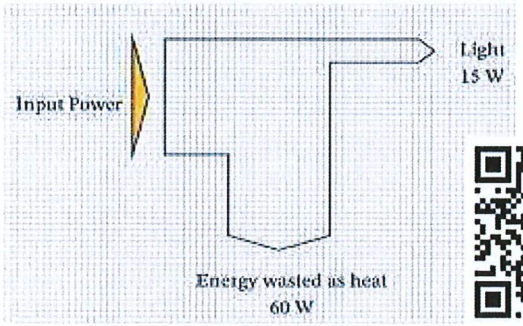
Movement between stores

Energy Transfer	Description
Mechanical	When a force acts on a body e.g. a collision
Electrical	Electricity can transfer energy from a power source, such as a cell, delivering it to components within a circuit
Heating	Thermal energy can be transferred by conduction, convection or radiation
Radiation	Light and sound carry energy and can transfer this between two points

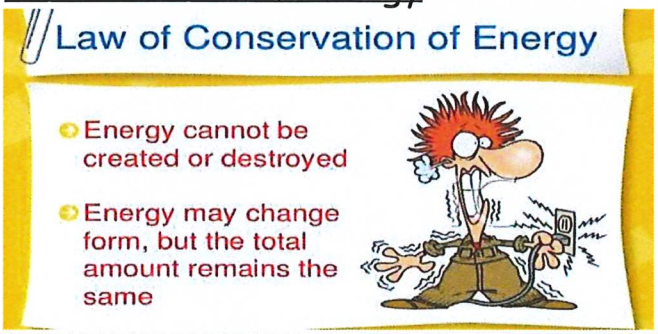
Energy Stores



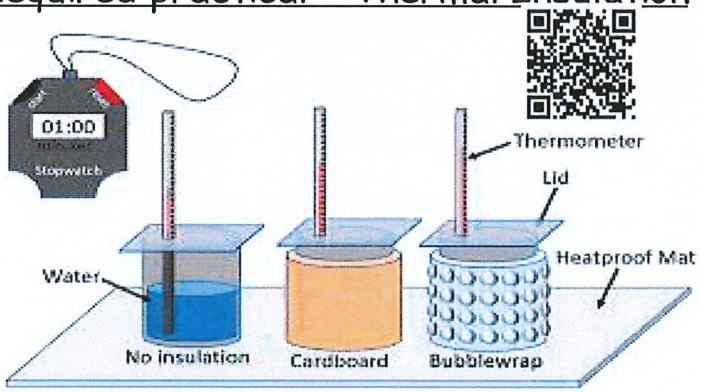
Sankey Diagrams



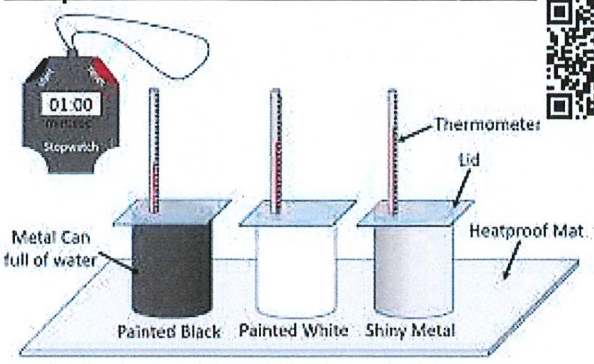
Conservation of energy



Required practical – Thermal Insulation



Required Practical – Radiation



Equations for this topic

Work = Force x Distance

Power = Work done/ time

Efficiency = useful energy output/total energy input

Forces

Threshold Concept

Every action has an equal and opposing action.

Keywords

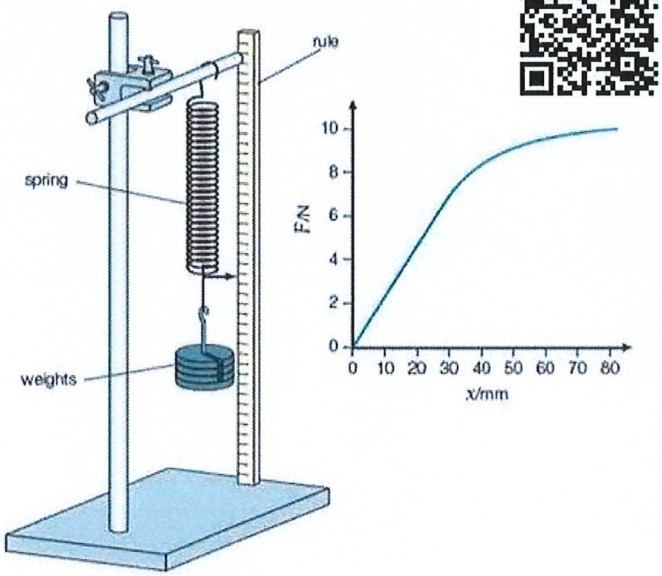
- **Contact:** Contact forces are forces that act between two objects that are physically touching each other.
- **Non contact:** Non-contact forces are forces that act between two objects that are not physically touching each other.
- **Balanced:** When the total force in opposite directions are equal in magnitude.
- **Unbalanced:** When the total force in opposite directions aren't equal in magnitude.
- **Force:** A push or a pull. The unit of force is the newton (N).

Contact and non contact forces

Contact Force	Non-Contact Force
A **contact force** involves a force between two objects in contact.	A **non-contact force** involves a force between objects not touching. You can't 'see' anything physically touching, but there is still an attraction or repulsion.
For example, **friction** between your feet and the ground can be present.	For example, **magnetic** forces between two magnets can happen when the magnets are near but not touching.

Required practical

When you apply a force to a material it can extend. The extension is the amount the length has increased by.



Scalar and vector quantities

A **scalar quantity** has only **magnitude**.
A **vector quantity** has both **magnitude** and **direction**.

Scalar Quantities

length, area, volume
speed
mass, density
pressure
temperature
energy, entropy
work, power

Vector Quantities

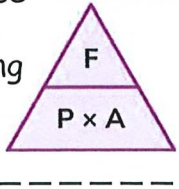
displacement
velocity
acceleration
momentum
force
lift, drag, thrust
weight

Free body diagrams

A free body diagram models the forces acting on an object.
The object or 'body' is usually shown as a box or a dot. The forces are shown as thin arrows pointing away from the centre of the box or dot.

Pressure:

Pressure is the amount of force applied to a specific area. It is caused when objects exert a force on another object. It can be on a visible level (pushing a door, rolling out cake icing) or at a molecular level (gas particles in a can)



Equations for this topic

weight = mass × gravitational field strength	$W = m\,g$
work done = force × distance (moved along the line of action of the force)	$W = Fs$
force = spring constant × extension	$F = ke$
moment of a force = force × distance (perpendicular to the direction of the force)	$M = Fd$
pressure = $\frac{\text{force normal to a surface}}{\text{area of that surface}}$	$p = \frac{F}{A}$
distance travelled = speed × time	$s = vt$
resultant force = mass × acceleration	$F = ma$

Space

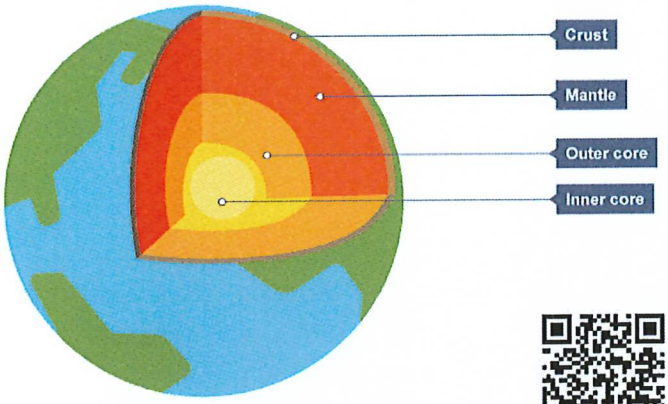
Threshold Concept

The Sun is the centre of the Solar system

Keywords

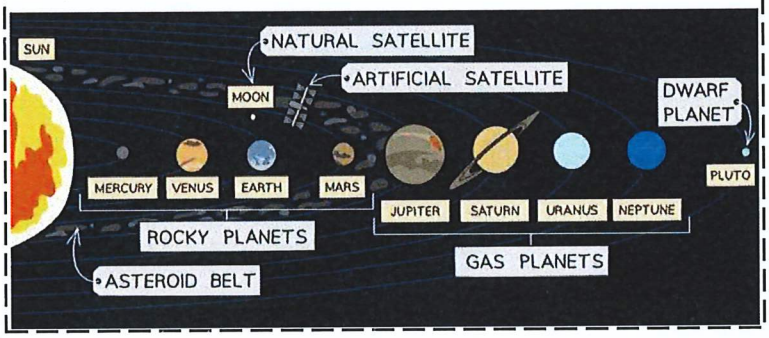
- **Earth**: The Earth is a planet and is roughly the shape of a sphere. There are three layers that make up the Earth's structure.
- **Planet**: A sphere of rock or gas orbiting a star.
- **Sun**: The Sun is our nearest star. It is a relatively small star when compared to other stars in the universe. Our Solar System contains the Sun and everything that orbits it.
- **Gravity**: Gravity is an attractive force that acts on all matter.

The earth:

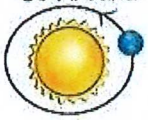


Solar system:

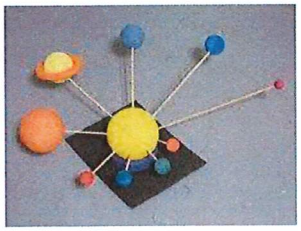
Our solar system consists of eight planets orbiting a star, our sun. Most planets have at least one moon orbiting it. In addition, there is an asteroid belt between Mars and Jupiter. Numerous comets also orbit the sun in elongated elliptical orbits



The earths rotation and revolution:

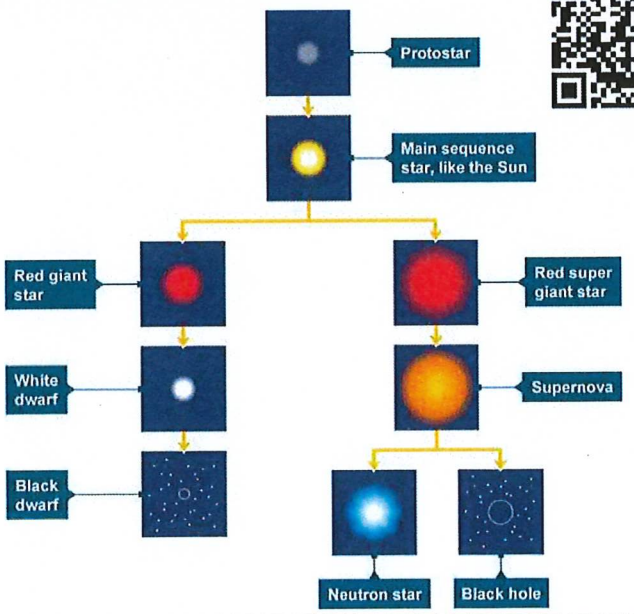
rotate	revolve
To Spin or Turn	Go Around
	
TAKES: 24 hours or 1 day	TAKES: 365 days or 1 year
CAUSES: Day & Night	CAUSES: The Seasons

Modelling the solar system:



A scale model is a copy of something that is much larger or smaller than the object itself but one which maintains the original's proportions.

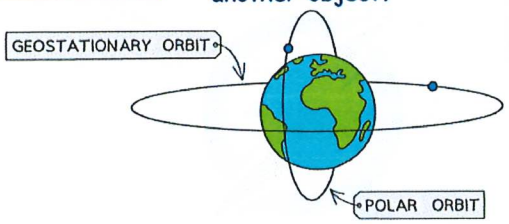
Stars and lifecycle:



The universe:

An orbit: a curved path that an object takes around another object.

A satellite: an object that orbits around another object.



Equations for this topic

Electricity (Part 1)

Threshold Concept

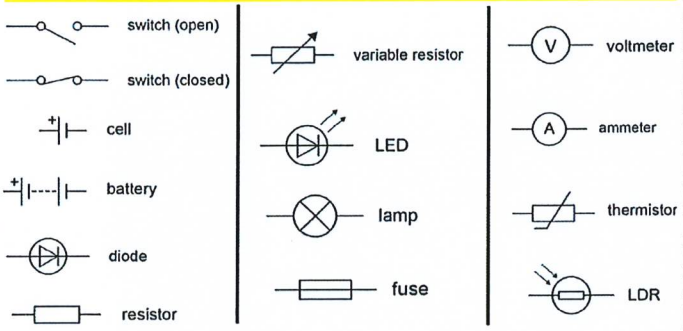
Electricity is the flow of electrons.

Keywords

- **Electron:** a stable subatomic particle with a charge of negative electricity, found in all atoms and acting as the primary carrier of electricity in solids.
- **Electricity:** is the presence or flow of charged particles.
- **Charge:** is a property of a body which experiences a force in an electric field. Charge is measured in coulombs (C).
- **Current:** Current is the rate of flow of electric charge around a circuit.

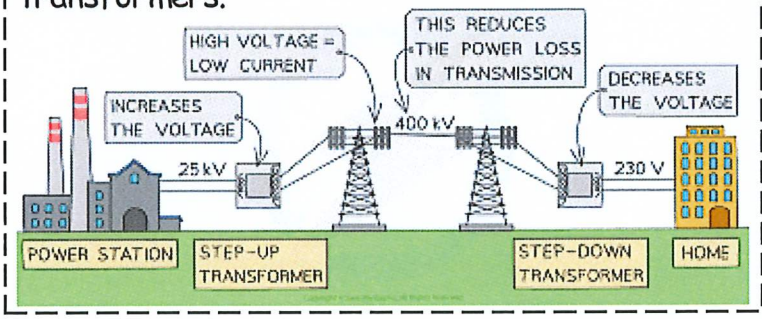
Circuit Symbols

An electronic circuit can include lots of different components. All of which can be represented with a symbol:

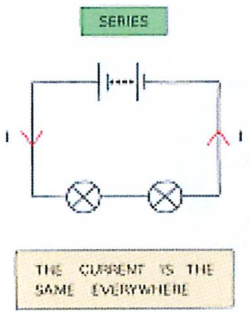


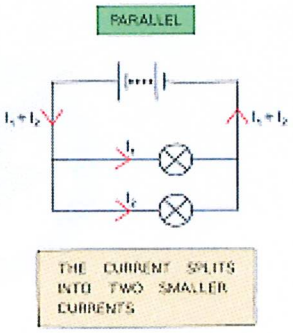
National Grid

The **National Grid** distributes electricity across the country. The National Grid connects power stations to homes, workplaces and public buildings all around the country through a system of cables and transformers.



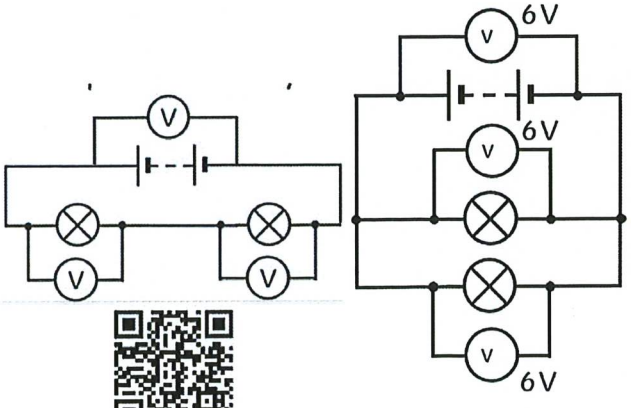
Series and Parallel circuits





In a series circuit, the potential difference/voltage supplied by the battery is **shared** by the components.

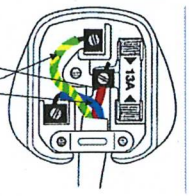
In a parallel circuit, the potential difference across each bulb is the **same** as the potential difference across the battery.



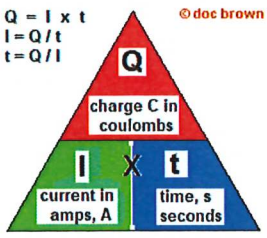
Practical

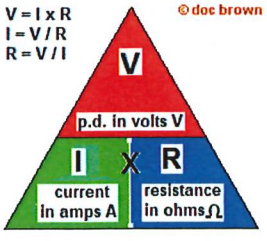
Wiring a plug

- The live wire.
- The neutral wire.
- The earth wire.



Equations for this topic





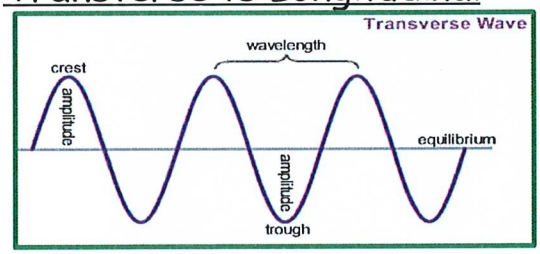
Waves

Threshold Concept

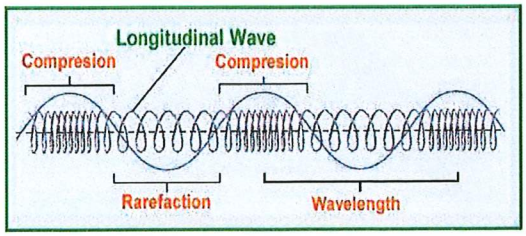
Waves transfer energy, **NOT** matter.

Link to information on the whole topic, consisting of slides, videos, and quizzes **Trilogy pupils ignore tasks 5,6 & 7.**

Transverse vs Longitudinal



Vibrations are **perpendicular** to the direction of energy transfer



Vibrations are **parallel** to the direction of energy transfer

Equations

Wave speed = distance / time
$v = s / t$

Wave speed = wavelength x frequency
$v = \lambda \times f$

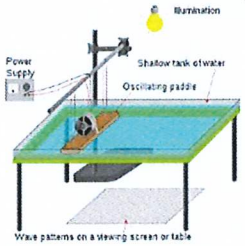
Time Period = 1 / frequency
$T = 1 / f$

Keywords

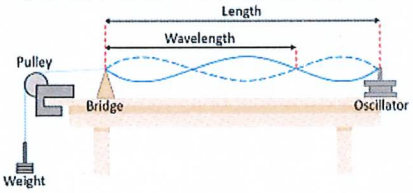
Wave - a disturbance/vibration in matter, which transfers the energy through the matter.
Energy - a property of a substance that is stored or transferred in order for things to be done.
Transverse - vibrations are perpendicular (at right angles) to the direction of energy transfer.
Longitudinal - vibrations are parallel (same direction) to the direction of energy transfer.

Required Practicals

Waves in a liquid



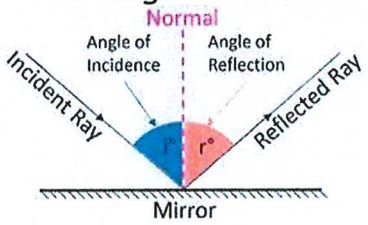
Waves in a solid



Reflection and refraction (HT only)

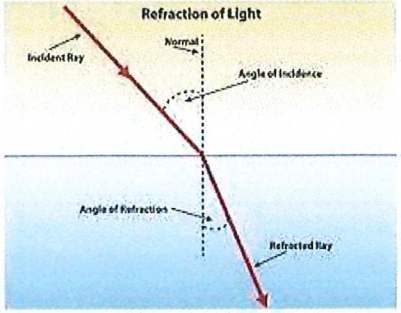
Law of reflection

The angle of incidence = the angle of reflection



Refraction

The change in direction and speed of light, due to passing from one medium into a different medium, of different densities



EM Spectrum

Threshold Concept

Electromagnetic waves are waves in different frequencies

Keywords

Frequency: The number of complete waves passing a certain point per second, or the number of waves produced by a source per second. Measured in Hertz, Hz

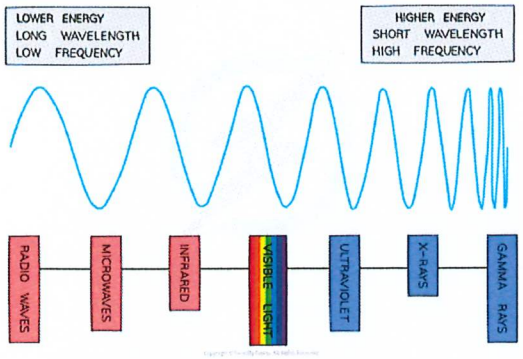
Wave: An oscillation that transfers energy without transferring any matter.

Spectrum: Used to classify something in terms of its position on a scale between two extreme points.

Energy: Is a key principle in physics, as it allows work to be done.

Speed: The maximum rate at which an individual is able to perform a movement or cover a distance in a period of time.

Types of electromagnetic waves:

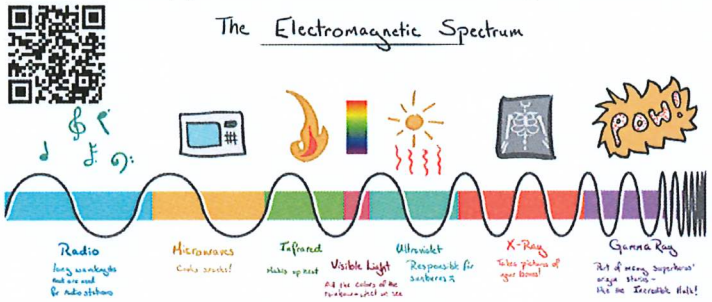


Properties of electromagnetic waves:

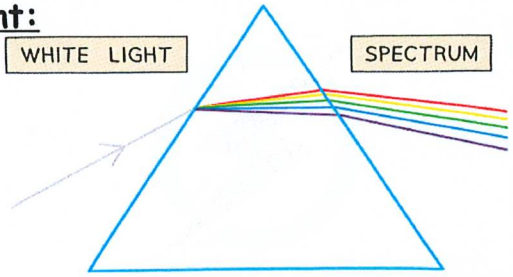
GAMMA RAYS | X RAYS | ULTRA VIOLET | VISIBLE | INFRA RED | MICROWAVES | TELEVISION | RADIO

GAMMA RAYS	Wavelength: around 1 pm Source: Nuclei Detector: Film, Geiger counter Properties/uses: Medical, sterilising food, checking metal castings, checking water flow
X RAYS	Wavelength: around 1 nm Source: Atoms Detector: Film Properties/uses: Medical X rays, defects in metals, checking paintings
ULTRA VIOLET	Wavelength: 0.001 – 0.4 μm Source: Atoms Detector: Skin, film Properties/uses: Sun tan, sun burn, theatre, checking documents, microscopes
VISIBLE	Wavelength: 0.4-0.7 μm Source: Atoms Detector: Eye, film Properties/uses: We use it to see the world around us
INFRA RED	Wavelength: 0.7-10 μm Source: Atoms Detector: Skin, thermometer, film Properties/uses: Physiotherapy, night sight, locating people trapped in smoke or ruins. Remote controls
MICROWAVES	Wavelength: 1 mm – 50 cm Source: Electronics Detector: Aerial Properties/uses: Microwave ovens, radio telescopes, radar
TELEVISION	Wavelength: around 50 cm Source: Electronics Detector: Aerial Properties/uses: Television
RADIO	Wavelength: 1 m – 1500 m Source: Electronics Detector: Aerial Properties/uses: Radio communication

Uses and applications of electromagnetic waves



Visible light:

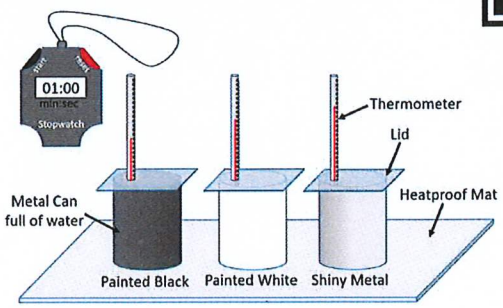


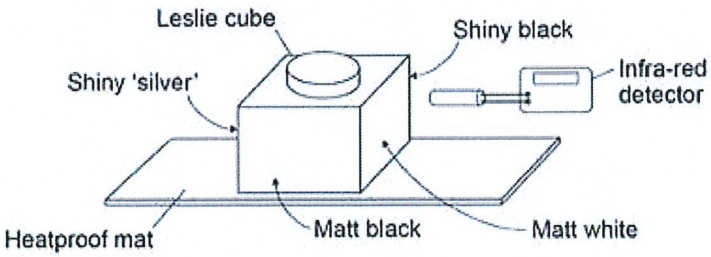
Communications:

Electromagnetic radiation is used for communications and transmission of information. The waves that are used in this way are radio waves, microwaves, infrared radiation and light.

Required practical:

EM infrared RP





Equations for this topic

wave speed = frequency × wavelength	$v = f\lambda$
time period = $\frac{1}{\text{frequency}}$	$T = \frac{1}{f}$

Electricity Part 2

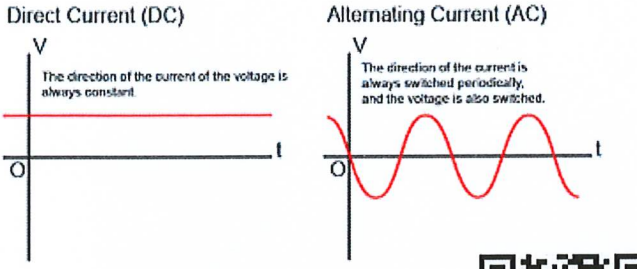
Threshold Concept

Potential Difference is the push that causes current to flow.

Keywords

- **Energy transfer:** the change of energy from one form to another.
- **Current:** Current is the rate of flow of electric charge around a circuit.
- **Resistance:** is a measure of the opposition to current flow in an electrical circuit.
- **Potential difference (voltage):** is the difference in the amount of energy that charge carriers have between two points in a circuit.

Alternating and Direct current (ACDC)

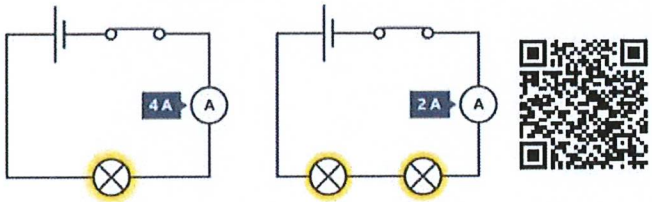


Electricity can flow either as direct or alternating current, and is used in homes to power electrical appliances.

Resistance

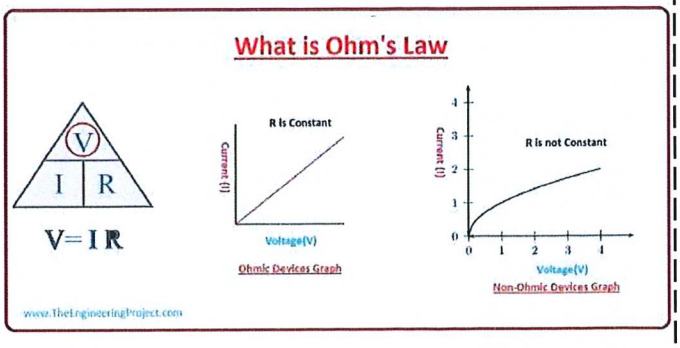
Resistance (R) is a measure of how difficult it is for current to flow. Resistance is measured in units called ohms (Ω).

The more resistance there is in a circuit, the less current will flow.



Ohm's Law

Ohm's law states that current is directly proportional to potential difference (providing the temperature remains constant).

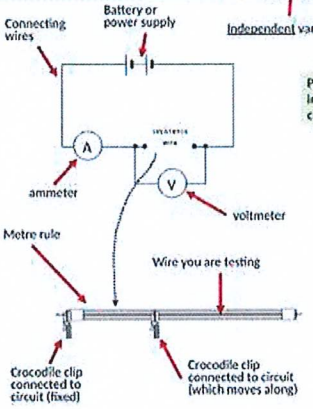


Required Practical's

Resistance

Required practical	Physics 3
Resistance in circuits	Combined Science 15

Use circuit diagrams to set up and check appropriate circuits to investigate the factors affecting the resistance of electrical circuits. This should include:
A - the length of a wire at constant temperature
B - combinations of resistors in series and parallel



Possible sources of significant error (which you can attempt to control): inaccurate attachment of crocodile clips; heating effect of electric current; misreading metre rule; misreading ammeter or voltmeter.

Method A steps:

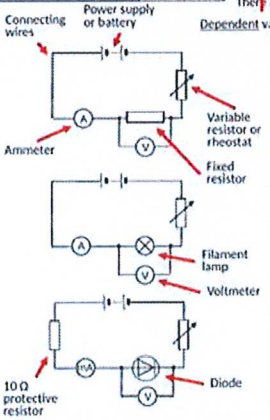
- Connect the circuit as shown
- Record in a table:
  - length of the wire between the crocodile clips
  - the readings on the ammeter
  - the readings on the voltmeter
- Move the crocodile clip and record the new ammeter and voltmeter readings. Note that the voltmeter reading may not change.
- Repeat this to obtain several pairs of meter readings for different lengths of wire
- Calculate and record the resistance for each length of wire using the equation $R = V/I$

I-V characteristics

Required practical	Physics 4
I-V characteristics	Combined Science 16

Use circuit diagrams to construct appropriate circuits to investigate the current - potential difference characteristics of a variety of circuit elements including a filament lamp, a diode and a resistor at constant temperature.

There are three investigations in this required practical.

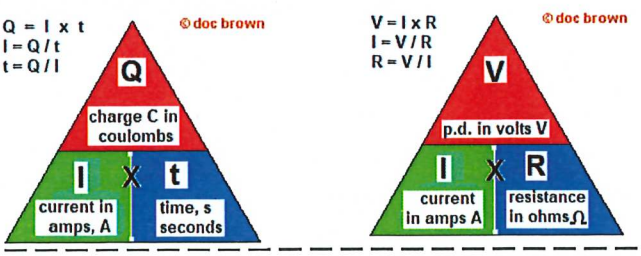


Possible sources of significant error (which you can attempt to control): misreading ammeter or voltmeter; inaccurate graphing

Method steps:

- Connect the circuit
- Record the readings on the ammeter and voltmeter in a suitable table.
- Adjust the variable resistor and record the new ammeter and voltmeter readings. Repeat this to obtain several pairs of readings
- Swap the connections on the battery. (the readings on the ammeter and voltmeter should now be negative)
- Continue to record pairs of readings of current and potential difference with the battery reversed
- Swap the leads on the battery back to their original positions
- Replace the resistor with the lamp.
- Repeat the steps above with the lamp in place of the resistor
- Swap the leads on the battery back to their original positions.
- If you can, reduce the battery potential difference to less than 5 V
- Replace the ammeter with a milliammeter (or change the setting on the multimeter)
- Replace the lamp with the diode. Connect the positive side of the diode to the milliameter.
- Repeat steps above to obtain pairs of readings of potential difference and current for the diode.

Equations for this topic



Motion

Threshold Concept

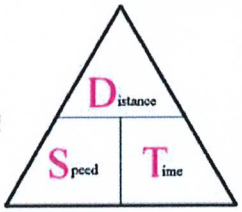
Speed equals distance travelled in a given time

Keywords

- **Speed:** Distance travelled in a certain time
- **Distance**: how far an object has travelled. It is a scalar quantity
- **Time**: how long something takes
- **Metres**: a unit measurement of distance (m)
- **Seconds**: a unit measurement of time (s)

Speed, distance, time

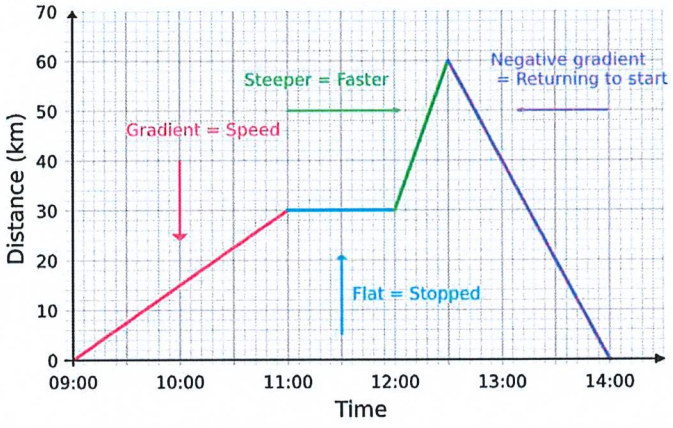
-Speed is measured in metres per second (m/s)
-Distance is measured in metres (m)
-Time is measured in seconds (s)



Scalar and vector quantities

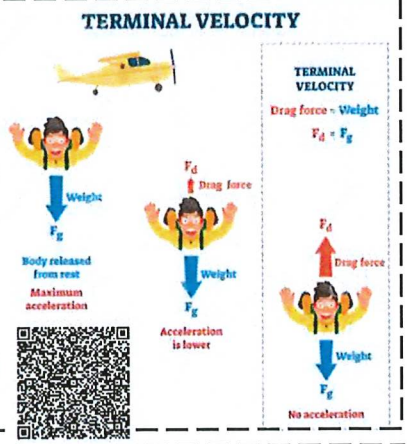
Scalar - a measurement of something. They only have MAGNITUDE (size)
Vector - a measurement of something. They have DIRECTION & MAGNITUDE (size)

Distance - Time Graphs

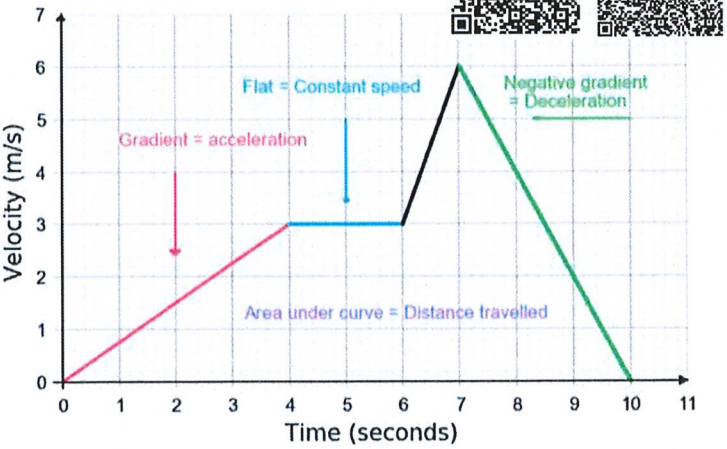


Terminal velocity

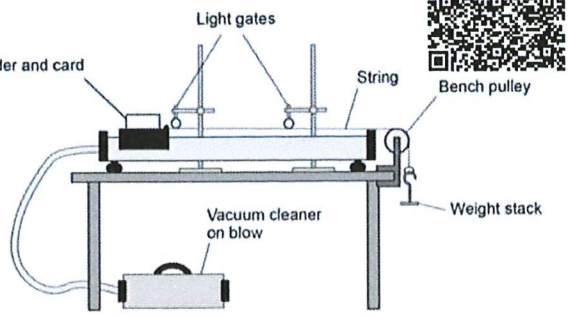
At terminal velocity, the object moves at a steady speed in a constant direction because the **resultant force** acting on it is zero



Velocity - Time graphs



Required practical - Acceleration



Equations for this topic

Speed = Distance ÷ Time
Change in Velocity = Acceleration x Time
Force = Mass X Acceleration

Atomic Structure

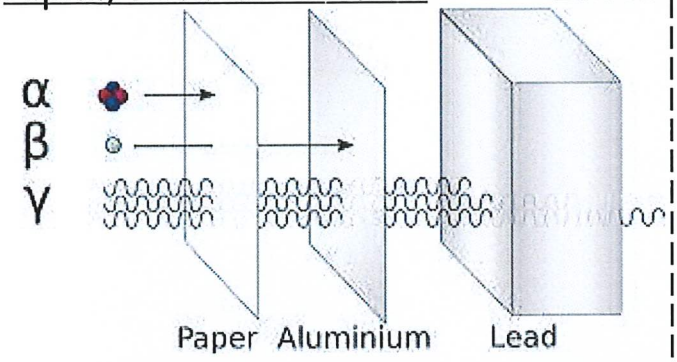
Threshold Concept

Identify that there are three types of radiation

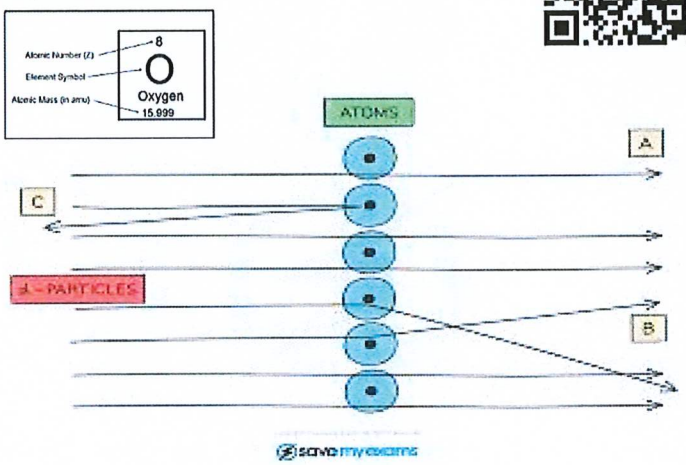
Keywords

Atom – the smallest particle of a chemical element that can exist
Proton – positively charged particle
Neutron – Particle with no charge
Electron – Negatively charged particle
Wave – Energy transfer method

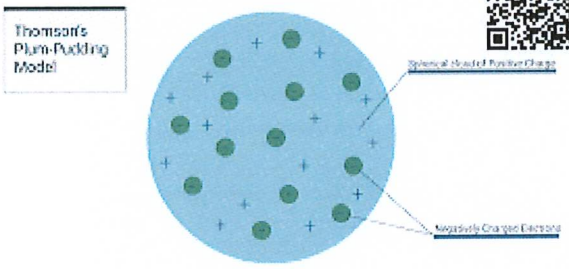
Alpha, Beta and Gamma



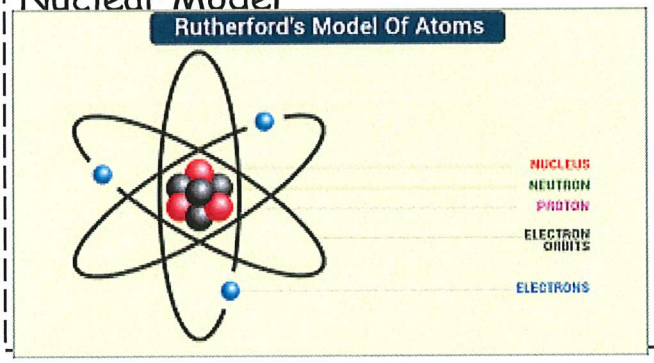
Rutherfords Scattering Experiment



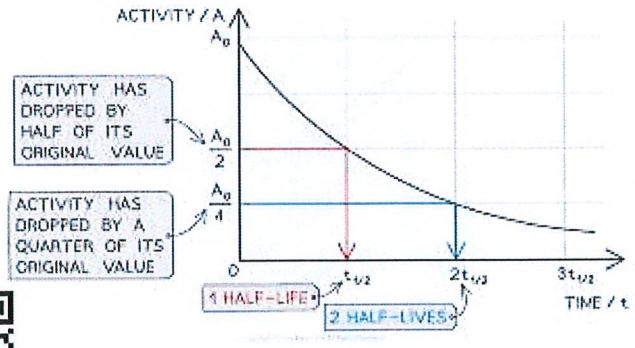
Plum Pudding Model



Nuclear Model



Half Life



Uses and Dangers of Radiation

	Irradiation	Contamination
Description	Object is exposed to radiation but does not become radioactive	Object becomes radioactive and emits radiation
Source	Danger is from radiation emitted outside the object	Danger from radiation emitted within the object
Prevention	Prevented by using shielding, such as lead clothing	Prevented by safe handling of sources and airtight safety clothing
Causes	Caused by the presence of radioactive sources outside the body	Caused by inhalation or ingestion of radioactive sources

uations for this topic

$^{235}_{92}U$ decay by releasing an alpha particle $\rightarrow$ $^{4}_{2}\alpha$ + $^{231}_{90}Th$

$^{14}_{6}C$ decay by releasing an beta particle $\rightarrow$ $^{0}_{-1}\beta$ + $^{14}_{7}N$

$^{235}_{92}U$ decay by releasing a gamma wave $\rightarrow$ $^{0}_{0}\gamma$ + $^{235}_{92}U$

Particle Models of Matter

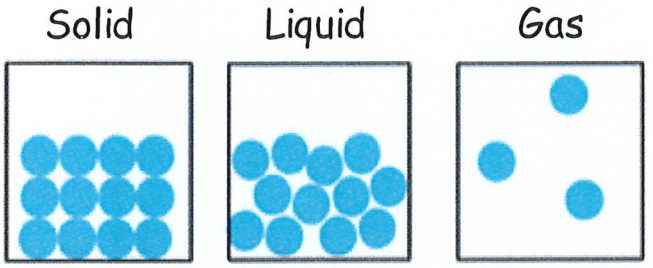
Threshold Concept

Changes of state are caused by energy changes

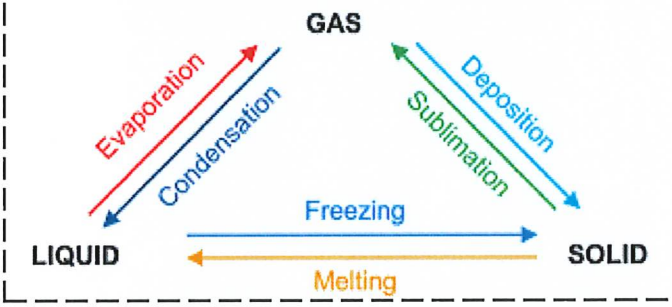
Keywords

States of matter - solid, liquid or gas.
Particles - the smallest part that a substance can be broken down into.
Energy - a property of a substance that is stored or transferred in order for things to be done.
Density - how compact a substance is.
Pressure - continuous force acted on or against an object.

States of matter



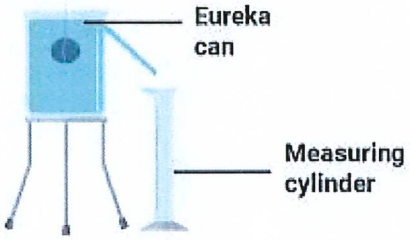
Changes of state



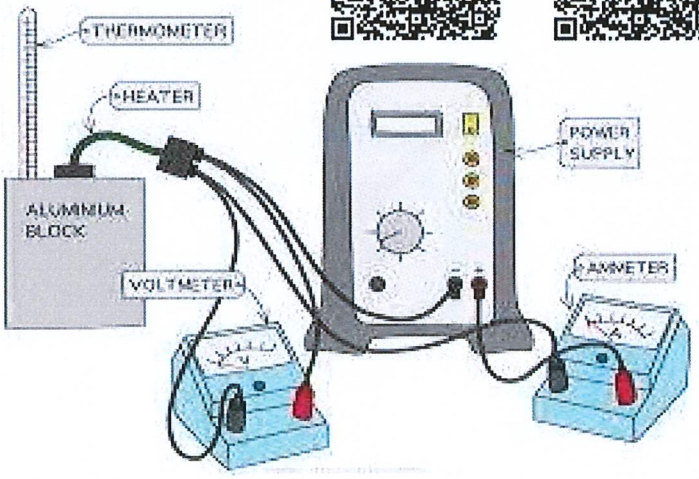
Links to information on the whole topic, consisting of slides, videos, and quizzes

Required Practical

Density



Specific Heat Capacity



Equations for this topic

$P=F/A$ Pressure = Force / Area

$P = m/V$ Density = mass / volume

$\Delta E = m \times c \times \Delta\theta$ Change in Energy = mass x specific heat capacity x change in temperature

$\Delta E = m \times L$ Change in Energy = mass x Specific Latent Heat

$P = \rho \times g \times h$ Pressure in a liquid column = density x gravity x height (TRIPLE ONLY)

For gases: $p \times v$ = constant For Gases: pressure x volume = constant (TRIPLE ONLY)

Electromagnetism

Threshold Concept

Magnets have two poles that attract or repel.

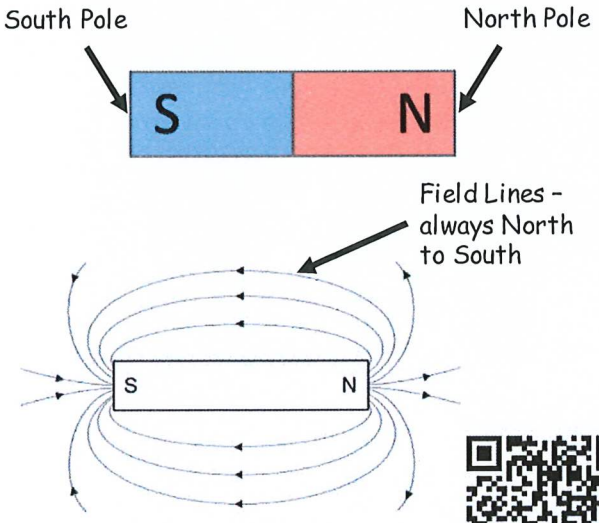
Keywords

Permanent Magnet - A material that has its own magnetic field without needing to be helped by another magnetic material.
Induced Magnet - a material that only becomes a magnet when placed in another magnetic field.
Magnetic Field - a region around a magnet where the force of magnetism acts.
Solenoid - a coil of wire that carries an electrical current.
Electromagnet - a soft, iron core placed inside a solenoid.

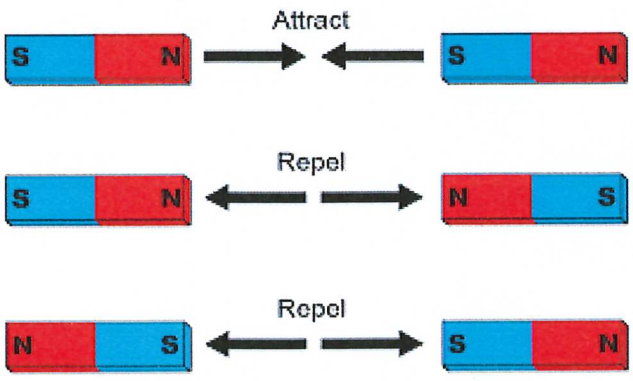
Common magnetic materials

- Iron
- Nickel
- Cobalt
- Steel

A bar magnet and its magnetic field



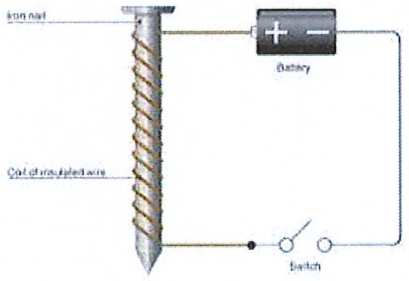
Attraction and repulsion



Electromagnets

Building an electromagnet

Electromagnets



Required Practical

Equations for this topic

Force = Magnetic Flux Density x Current x length of wire

$F = B \times I \times l$

Vehicle Safety

Threshold Concept

Cars have safety features to reduce impact forces

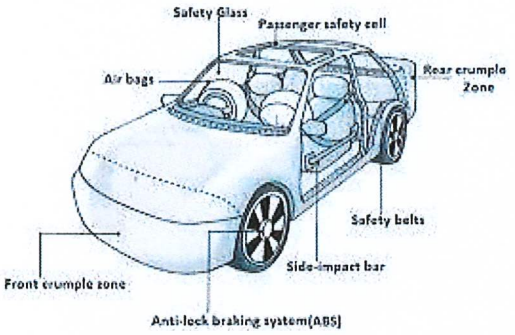
Keywords

Newtons Laws - Three guiding principles stating the movement and reactions of all things due to physics

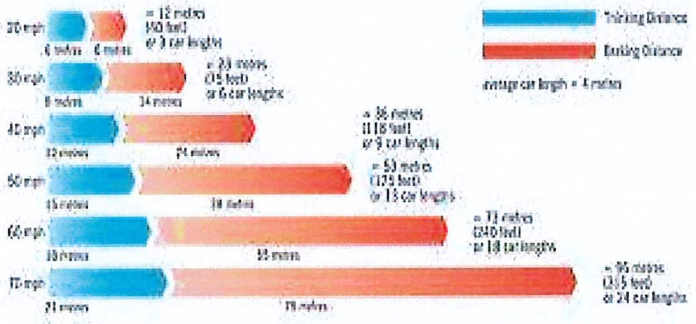
Impact forces - The forces occurring when two objects collide

Momentum - A measure of how difficult it is to stop a moving objects

Safety Features in Cars

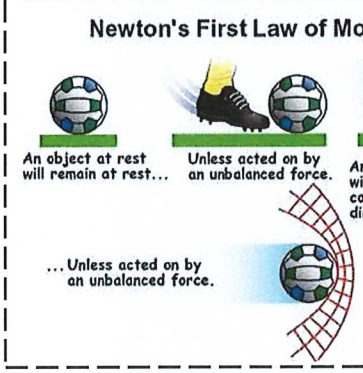


Stopping Distances

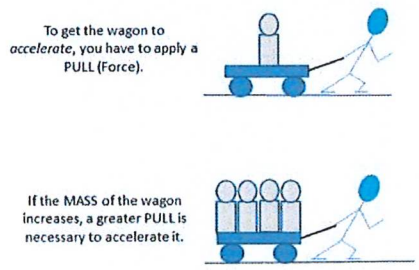


IT TAKES NEARLY TWICE AS FAR TO STOP at 70mph AS IT DOES TO STOP at 50mph

Newtons First Law



Newtons Second Law



Momentum

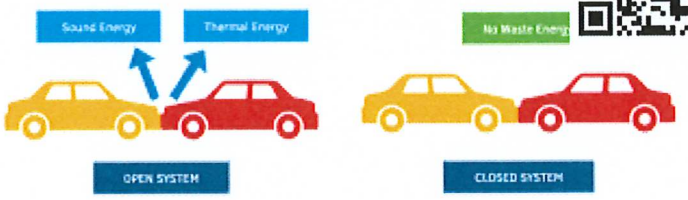
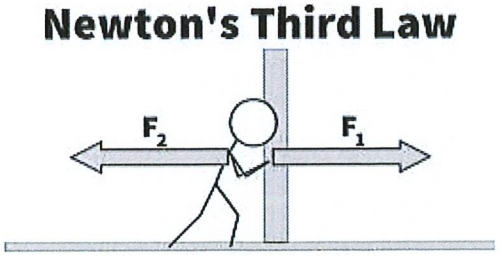


Fig 1. The Conservation of Momentum Applies to a Closed System Not an Open System.

Newtons Third Law



Equations for this topic

Force = Mass x Acceleration

Momentum = Mass x Velocity

Space (TRIPLE)

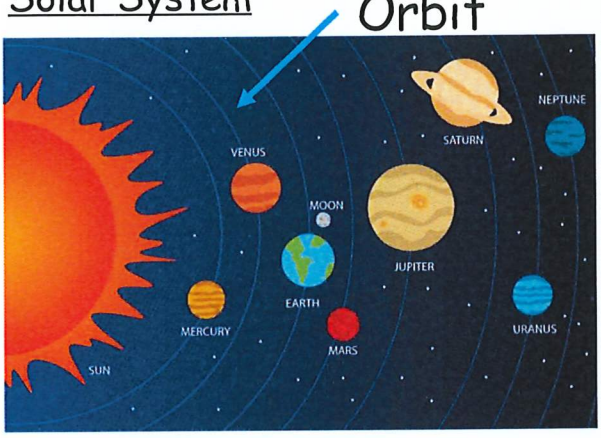
Threshold Concept

The Solar System is made up of many types of objects.

Keywords

Solar System - the collection of eight planets and their moons in orbit round the Sun, together with smaller bodies in the form of asteroids, meteoroids, and comets.
Orbit - the curved path of a celestial object or spacecraft round a star, planet, or moon
Sun - the star around which the 8 planets of the Solar System orbits.
Planet - a celestial body moving in an elliptical orbit round a star.
Moon - a celestial body moving in orbit around a planet. They are natural satellites.
Satellite - an object, either natural (e.g. The Moon), or artificial, that orbits a moon, planet or star. Artificial satellites are for information gathering.

Solar System



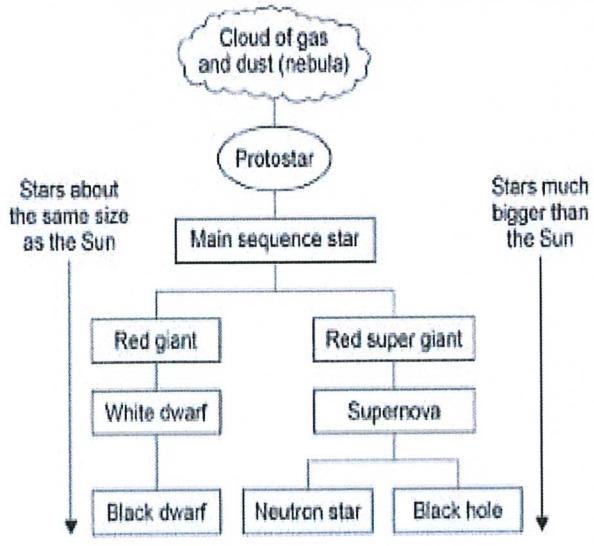
Link to information on the whole topic, consisting of slides, videos, and quizzes

Orbital Motion & Satellites

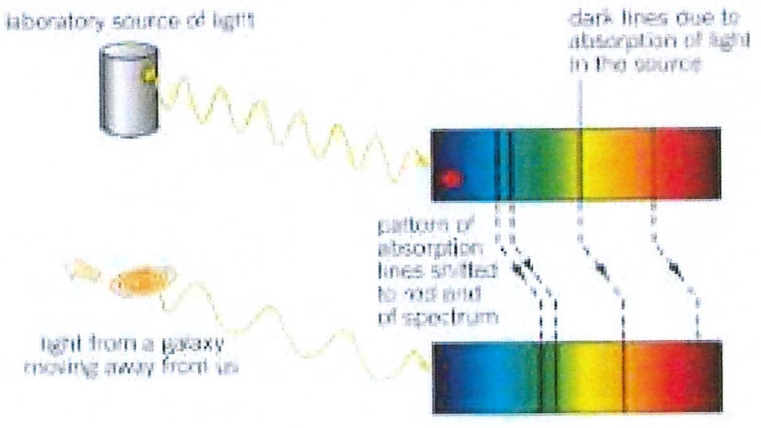
Planets orbit in near-circular orbits: they maintain a constant speed but are always changing direction. This means they have a constant speed but NOT a constant velocity

The Moon is a Natural Satellite. All other satellites of Earth are artificial, such as weather, military, ISS, GPS etc.
Geostationary satellites follow the same point above Earth, so have an orbital period of 24 hours.

Life Cycle of Stars



Red-shift and Big Bang



Equations for this topic

Required Practical