Combined Science Knowledge Organiser

Science

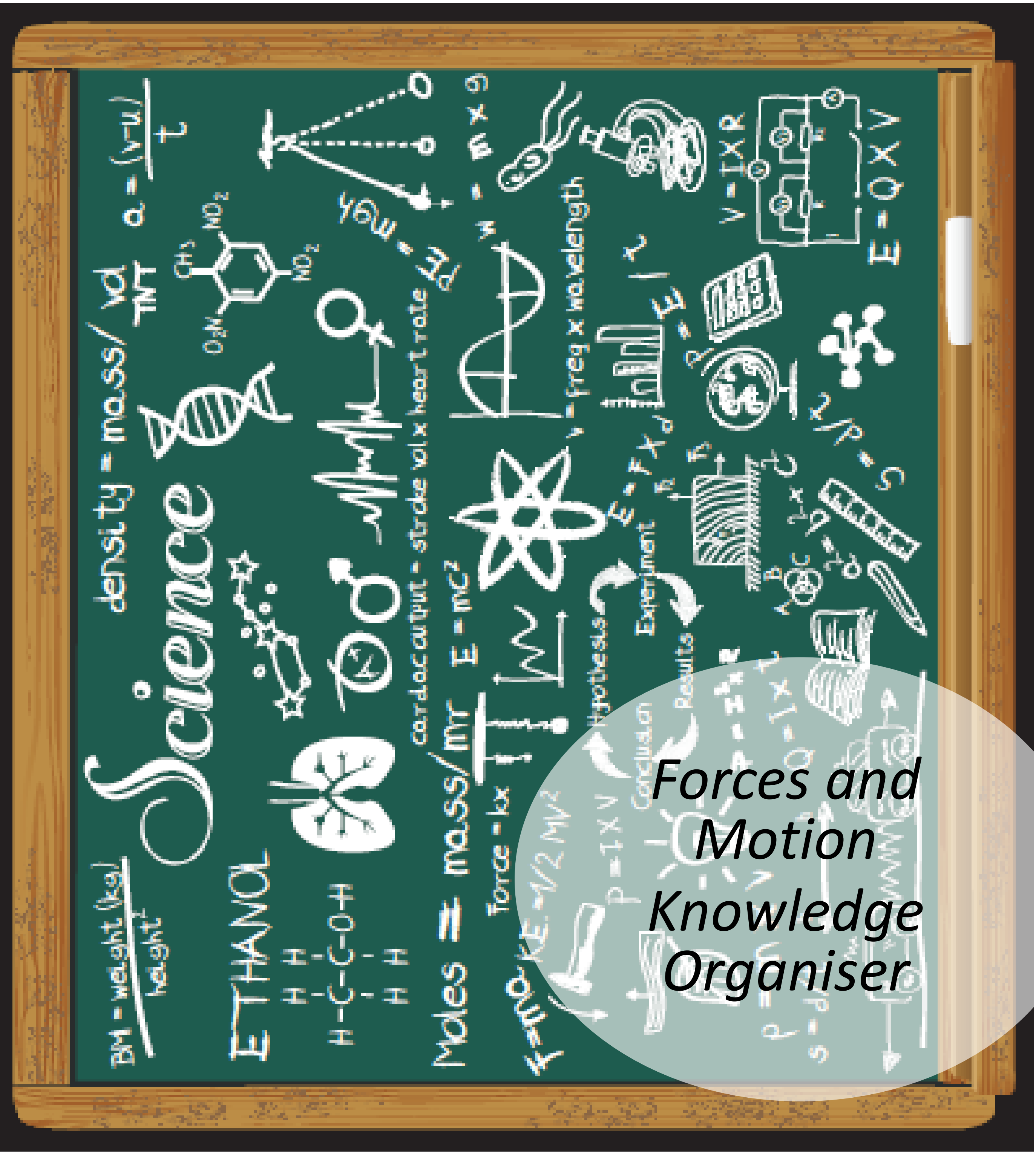
Team Science

End of Year 11 Target Grade

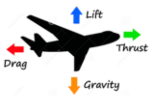
Name

Teacher Code

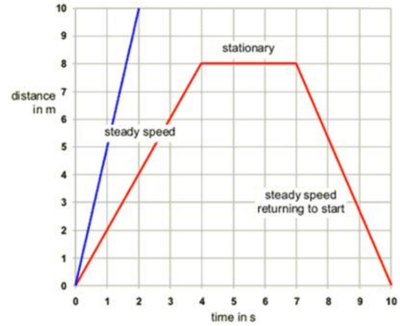
Class



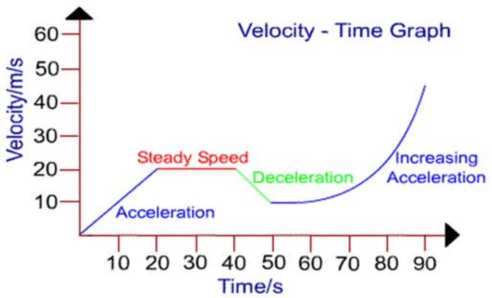
Forces and Motion Knowledge Organiser



- **Scalar** quantities only have **magnitude** (anything that you can put a number on) and no direction: 30m/s or 30m.s^{-1} for example.
- **Vector** quantities have **magnitude** (anything that you can put a number on) and a fixed **direction**: 30m/s North or 30m.s^{-1} Left for example.
- Common **Scalar** Quantities: **speed**, **temperature**, **time**, **density**, **mass**, **energy**, **volume**
- Common **Vector** Quantities: **velocity**, **pressure**, **forces**, **weight**, **momentum**, **acceleration**

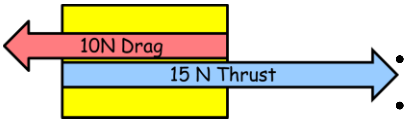


- **Speed** is calculated by dividing the distance travelled by time taken.
- **Distance-Time Graphs** can be used to **represent** this **motion**. Different **gradients** (how **steep** a line is) show **different rates** of motion.
- We can use distance time graphs to: **interpret** the **motion** of an object; **calculate** the **velocity** of an object.

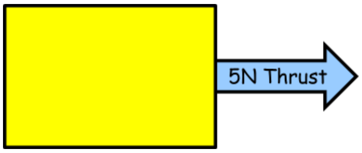


- From a **velocity-time graph** can show you the **velocity**, the **acceleration** and the **distance travelled** of an object.
- The **velocity**: From reading off the **Y axis** on the graph.
- The **acceleration**: Found from the **gradient** of the line on the velocity-time graph (**Difference in Y / Difference in X**).
- The **distance travelled**: The **area under the line** on a velocity-time graph (**width x height OR ½ width x height**).

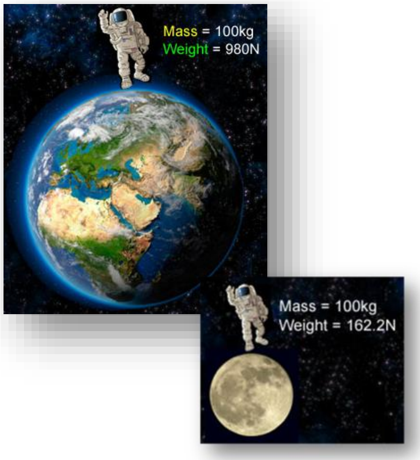
Contact Forces	Description	Non-Contact Forces	Description
Tension	A force in **stretched** objects	**Gravity**	**Attraction** between **objects** with **mass**
Compression	A force in **compressed** objects	**Magnetic**	**Attraction** and **repulsion** of **magnetic fields**
Contact	The force acting on **objects touching**	**Electric**	**Attraction** and **repulsion** of **electric fields**
Buoyancy	**Fluids pushing** up on objects	The list here is **not exhaustive**. All **forces** are **vector quantities** as they always **act in a direction**.	
Friction	When **surfaces slide over** each other		
Drag	Objects **moving** through **fluid particles**		



- A number of **forces acting** on an **object** may be **replaced** by a **single force** that has the **same effect** as all the original forces **acting together**.
- This single force is called the **resultant force**.
- When **two forces** act in a line the **resultant force** is the **vector addition of the two vectors**. Remember the **direction is important**.

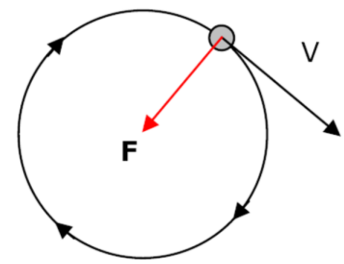


- The **direction** of the **force** is shown by the **direction** of the **arrow**
- The **strength** of the **force** is shown by the **length** of **arrow**)
- The **position** of the **arrow** shows **where** the **force acts**
- They always act on something so the **tail** of the **arrow** must always be **anchored** on something



- **Gravity** is a **non-contact force**.
- **Weight** (**W**) measured in **Newtons** (**N**) is the **force** due to **gravity** acting on an **object** of any **mass** (**m**) measured in **Kilograms** (**Kg**).
- The force of gravity close to the Earth is due to the **gravitational field** (**g**) measured in **Newtons per Kilogram** (**N/Kg**) around the Earth.
- The **weight** of an object **depends** on the **gravitational field strength** at the point **where the object** is.
- The **strength** of the gravitational field on **Earth** is **10N/Kg**. You must **remember this number**.
- **Gravity accelerates objects downwards** at **10m/s** on **Earth**. You must **remember this number**.

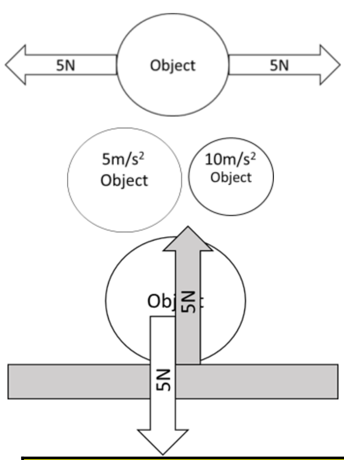
- An **object** moving in a **circular orbit** at **constant speed** has a **changing velocity** therefore it is also **accelerating**.
- For **motion** in a **circle** there must be a **resultant force** known as a **centripetal force** that acts **towards** the **centre** of the circle
- The **resultant force** that causes the **change** in **direction** is a **centripetal** force (**gravity**, **friction** and **tension**).



Method of travel	Typical speed (m/s)
Walking	1.5
Running	3
Cycling	6
Car	13 - 30
Train	50
Aeroplane	250

- The **speed of sound** in air is about **330m/s** but this can change **depending** on the **temperature** and **air pressure**.
- The **speed** of **wind** can range from **2m/s** (light breeze) to **20m/s** in a gale

Equipment	Distance measurement	Time measurement
Ruler and stopwatch	Ruler measures distance travelled	Stopwatch measures time taken
Light gates	Size of object, measured with a ruler	Light gate connects to a timer, which gives the reading
Video analysis	Distance moved from frame to frame observed on a ruler in the pictures	The time between frames is known



- **Newton's 1st Law**: An **object** at **rest** will **stay** at **rest unless** an **outside force acts** upon it.
- An **object** in **motion** will stay at **constant motion** and **direction** unless an **outside force acts** upon it.
- **Newton's 2nd Law**: With a **constant force**, the **acceleration** of an **object** is **proportional** to the **mass**. The **Force (F)** measured in **Newtons (N)** when applied to a **mass (m)** measured in **kilograms (kg)** causes **acceleration (a)** measured in (**m/s^2**)
- **Newton's 3rd Law**: To any **action** there is always an **equal** and **opposite reaction**; or the **actions** of **two bodies** upon each other are at all times **equal** and **always opposite** in direction

Factor Affecting Braking Distance	How this factor affects braking distance
Speed	Increasing speed increases braking distance
Weight of Vehicle	Increasing weight of vehicle increases braking distance
Icy Roads	Braking distance increases due to reduced friction between tyre and road
Wet Roads	Braking distance increases due to reduced friction between tyre and road
Poor Brake Condition	Braking distance increases
Bald Tyres	Braking distance increases when wet.

Factor affecting thinking distance	Affect on Reaction Time
Alcohol	Increases
Caffeine	Decreases
Tiredness	Increases
Distractions	Increases

- The **stopping distance** of a vehicle is made up of the **sum** of the **thinking distance** and the **braking distance**
- When **braking** there is a **force applied** to the **brakes**. This **reduces** the **kinetic energy** of the vehicle and causes the **brakes** to **heat up**. The **faster** a vehicle travels, the **greater** the **braking force** needed to stop it in a certain distance.
- **Large decelerations** may cause the **brakes** to **overheat**, and the **driver** may also **lose control** of the vehicle

Name	Equation symbol	Unit	Unit Symbol
$d = s\ x\ t$			
Distance	d	metre	m
Speed	s	Metre / second	m/s
Time	t	Second	s
$a = \frac{\Delta V}{t}$			
Acceleration	a	Meter / second2	m/s^2
Velocity	v	Metre / second	m/s
Time	t	Second	s
$F = m\ x\ a$			
Acceleration	a	Meter / $second^2$	m/s^2
Force	F	Newton	N
Mass	m	Kilograms	kg
$W = m\ x\ g$			
Weight	W	Newton	N
Gravitational Field Strength	g	Newton / Kilogram	N/kg
Mass	m	Kilogram	Kg
$\rho = m\ x\ v$			
Momentum	ρ	Kilogram meters / second	Kg.m/s
Velocity	v	Metres per second	m/s
Mass	m	Kilograms	kg

Core practical 1: Investigating force, mass and acceleration

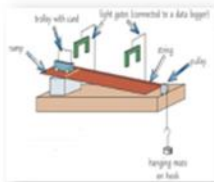
Set up the experiment so the slope of the ramp allows the cart to roll slightly. This controls for the force of gravity and friction.

Ensure your hanging masses have room to avoid hitting the floor. To keep the mass of the system constant, take masses from the trolley and add to the hanger.

Ensure the interrupt card on top of the cart can pass easily through the light gate. Using a light gate controls for human reaction time errors.

Use a stopwatch to time between the gates if you are using them to calculate speed. This will introduce human reaction time errors

Make sure you use the equation $a = \frac{\Delta V}{t}$ to calculate the answer. Remember to include this in your answers.



Ensure that when you are asked to improve this experiment that you review sources of error and how to use more accurate equipment.

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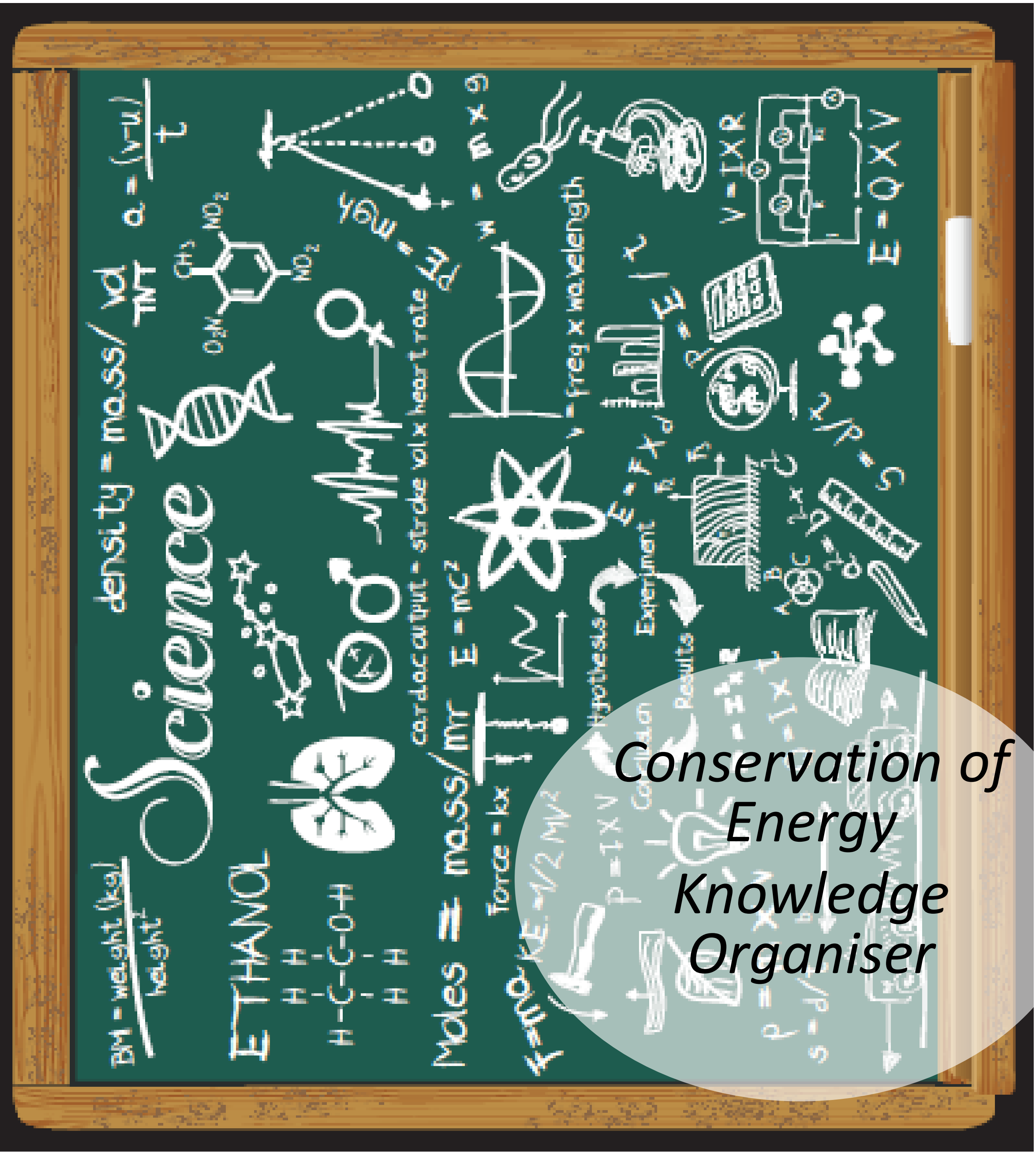


Conservation of Energy Knowledge Organiser

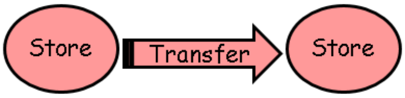
- **Energy** is the ability to do **work**
- **Energy** can be **stored** or **transferred,** but it **cannot be created or destroyed.** This means that the **total energy** of a **system** remains the **same.** This is called the **conservation of energy**

6 main energy **stores** are

- **Kinetic** (energy stored in **moving** objects)
- **Gravitational potential** (energy stored in **raised** objects)
- **Chemical** (energy stored in **bonds**, main sources **food, fuel & batteries**)
- **Thermal** (energy associated with **temperature**)
- **Elastic potential** (energy stored in stretched or deformed objects)
- **Nuclear** (energy from nuclei of atoms)

Energy can be **transferred** from stores in four main ways using **'pathways'**

- **Mechanically/Forces** (A force acts on it e.g. pushing, pulling, stretching squashing)
- **Electrically** (A charge flows around a circuit)
- **Heating**(Energy moves for hot areas to colder ones)
- **Radiation**(Transferred by waves e.g. light from the Sun)



When an **object is raised** above ground level it **gains gravitational potential energy** (GPE). This stored energy can be released if the object is allowed to fall.

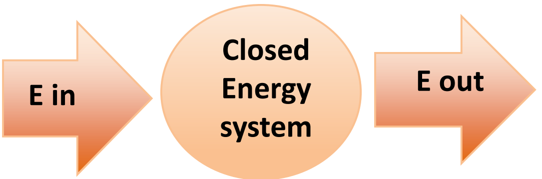
$$\Delta GPE = m \times g \times \Delta h$$

Gravitational field strength on Earth is 9.8N/kg OR 10N/kg

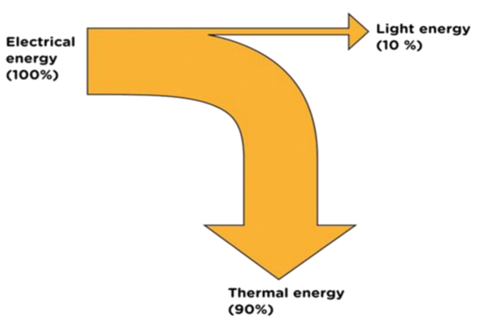
Moving objects have **kinetic energy**. The long-jumper is using her kinetic energy to carry her body as far as possible. The more kinetic energy she has, the longer her jump will be. Her **kinetic energy depends on** her **mass** (which she can not change) and her **velocity** (she can run faster!). **KE = ½ x m x v^2**

In a **closed energy system** there can be **transfer of energy** but **not mass**. There is **no change to the total energy** in the system.

No mass change



In a **closed energy system** all the energy can be accounted for even when energy stores change.



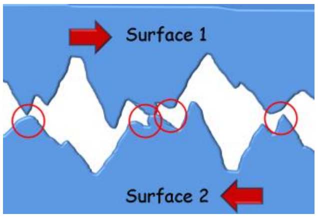
The diagram shows the energy transfer for a light bulb. **All** the electrical **energy** store **can be accounted for** as light energy and thermal energy.
The **thermal energy is not useful** in this case and can be considered to be **dissipated or "waste" energy.**

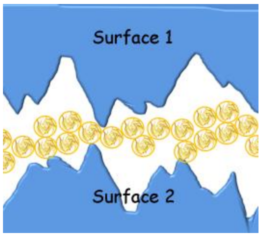
Unwanted energy transfers result in energy stores that **are not useful.**
In **mechanical systems** this is usually due to **internal combustion** or **friction.**
The waste energy that is **dissipated** is usually **heat.**

- **Efficiency** is a measure of **how much** energy is **used usefully**.
- Different devices have different efficiency values. **No device** can be **more 100% efficient**. As **energy cannot be created or destroyed**

Efficiency = (useful energy transferred by the device) / (total energy supplied to the device)

- **Unwanted energy transfers** result in energy **stores that are not useful**.
- In **mechanical systems** this is usually due to internal combustion or **friction**.
- The **waste energy** that is **dissipated** is usually heat.
- This **wasted energy** can be **reduced** by **lubricants** which **reduce friction**
- We can reduce friction using **lubricants** which **prevent** "**interlocking**"



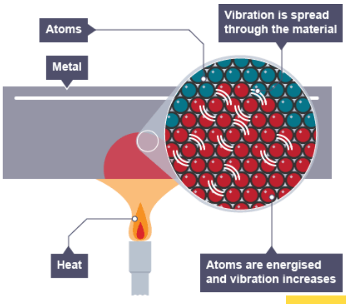


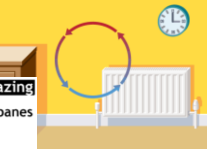
Mechanical devices can be made **more efficient** by **lubrication** this **reduces** energy transferred by **friction**
e.g. engine oil

Having good **insulation reduces** the rate of thermal energy **transfers**
e.g. loft insulation

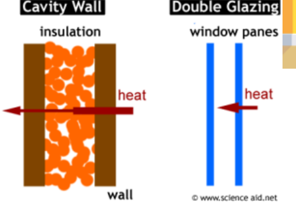
Heat transfer

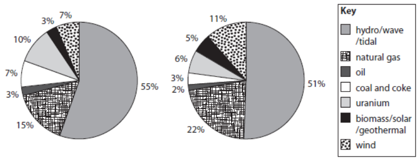
- **Conduction** heat transfer in **solids** (the transfer of KE throu the vibration of atoms or electrons)
- **Convection** heat transfer in **fluids** (hot fluids become less dense rising them falling transferring energy via convection currents
- **Radiation** heat can be transferred by infrared radiation. (Unlike conduction and convection - which need particles - infrared radiation is a type of electromagnetic radiation that involves waves.)





The **particles** in a **gas** are very **spread out**. This means that it takes a long time for heat to move between particles. This is why **insulation materials** like **cavity walls** and **double glazing** have **trapped air pockets**





Non-renewable resources are **increasing global warming** and lead to much air pollution.
The non-renewable resources are also **running out**.
Alternative energy resources are being developed and are replacing traditional resources.
This is causing an **increase in the percentage of renewable resources** and **decreasing the percentage of non-renewable resources.**

Nuclear energy resources are technically non-renewable but they can be produced on an almost **indefinite basis**

Renewable

- Will not run out
- Is generally unreliable (apart from biofuels and hydroelectricity)
- Does not produce CO_2 and SO_2 (apart from biofuel)
- Not suitable in all locations

Non-renewable

- Will run out
- Is very reliable
- Produces CO_2 and SO_2 (apart from nuclear)
- Fuel is cheap

Some more specifics

- **Wind:** Produces noise and visual pollution. Turbines spin a generator to produce electricity
- **Fossil fuels**: Very easy to transport
- **Geothermal**: Very expensive to drill into the earths core
- **Hydroelectric Dams** and **Tidal Power** stations: Damage habitats. Water spins a turbine to produce electricity
- **Gas**: Has a very short start up time
- **Nuclear**: produces waste that can cause cancer as is radioactive. Plentiful but difficult to extract / purify
- **Biofuel:** almost carbon neutral, takes up space to grow food, Plant matter usually used as a fuel

Name	Equation symbol	Unit	Unit Symbol
$\Delta GPE = m \times g \times \Delta h$			
Gravitation PE	GPE or E_p	Joule	J
Mass	m	Kilogram	Kg
Grav. Field	g	Newton/Kilogram	N/Kg
Height	h	Metre	m
$KE = 0.5 \times m \times v^2$			
Kinetic Energy	KE or E_k	Joule	J
Mass	m	Kilogram	Kg
Velocity	v	Metres / second	m/s
$\text{efficiency} = \frac{\text{useful energy transferred}}{\text{total energy transferred}}$			
efficiency			
Useful energy transferred		Joules OR Watts	J OR W
Total energy transferred		Joules OR Watts	J OR W
$E = F \times d$			
Work Done / Energy transfered	E	Joules	J
Force	F	Newtons	N
Distance	d	Metres	m

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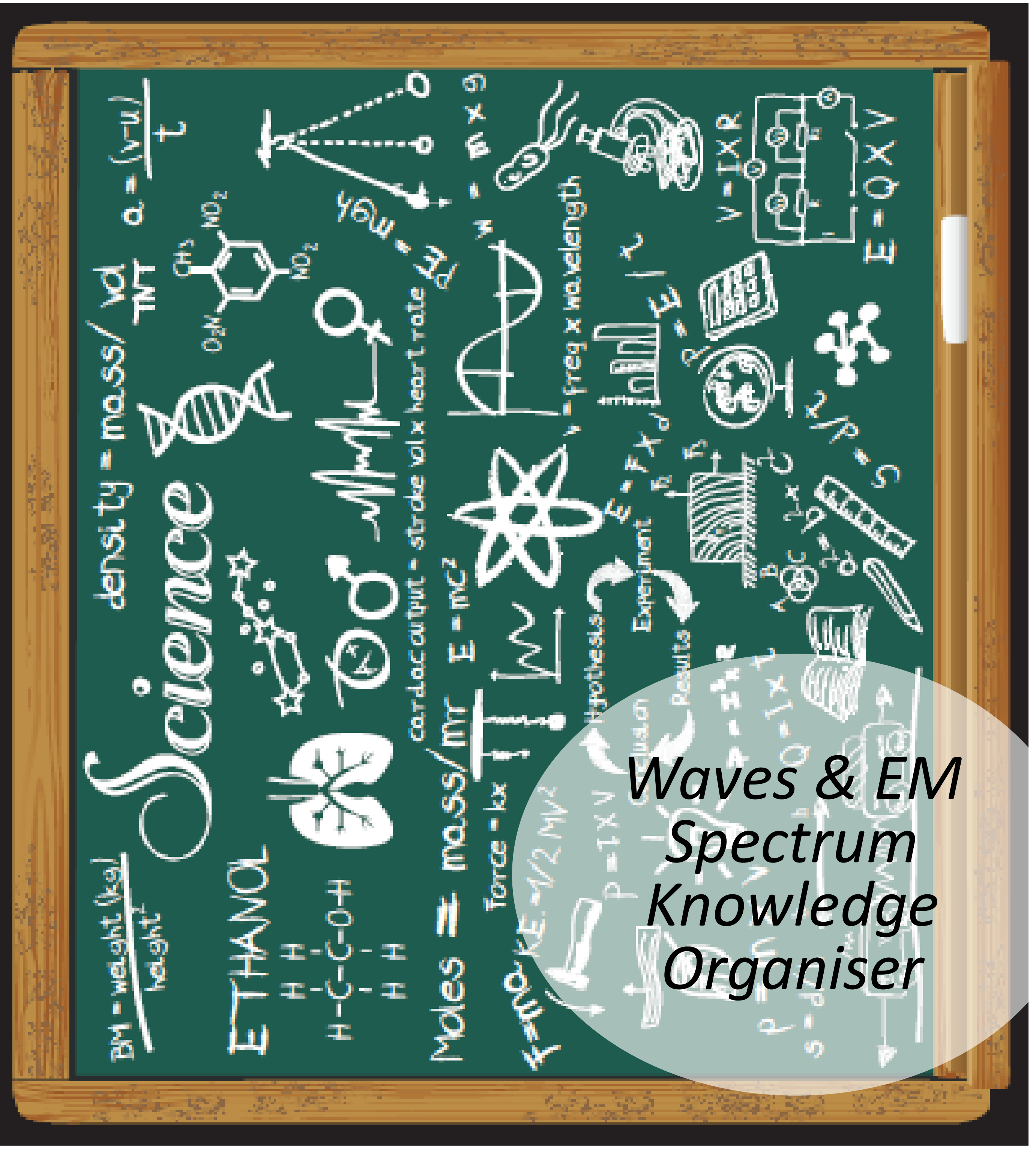
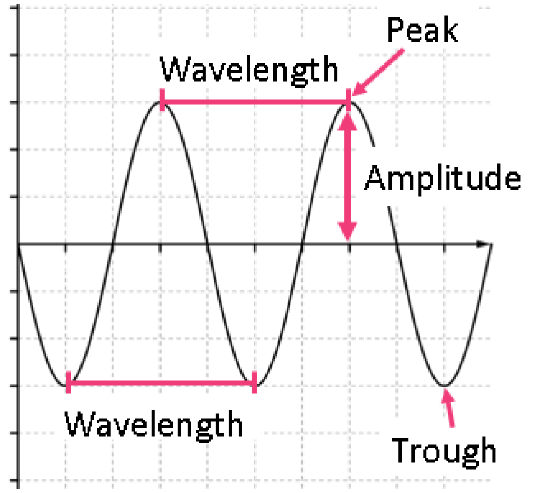
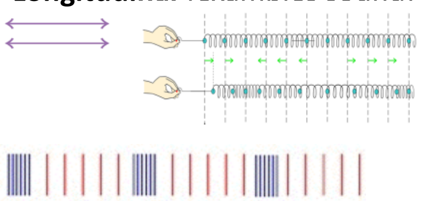


Waves & EM Spectrum Knowledge Organiser

- **Waves transmit energy** and i**nformation**, but they do **not transmit matter.**
- **Frequency**: the **number** of **waves** that **pass a point in a second** (Hertz, Hz)
- **Period**: how long it takes **one wave to pass** a given **point** (seconds, s)
- **Wavelength**: the **distance between two points** on a wave (Meters, m)
- **Amplitude**: the **maximum distance** that a particle **moves** away **from resting** (Meters, m)
- **Wave velocity**: **speed** of the **wave** in a given direction (m/s)



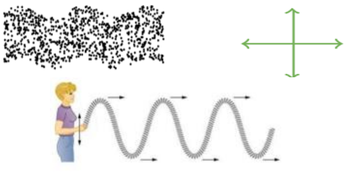
Longitudinal (examples sound)



Longitudinal waves **oscillate PARALLEL** to **direction of energy**
Or
Longitudinal waves **oscillate PARALLEL** to the **direction of travel**

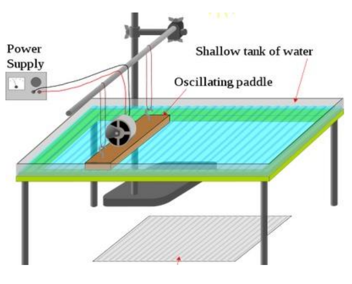
- Waves can oscillate up and down or side to side.
- **Up and down** waves **oscillate perpendicular** to the direction of the wave
- **Side to side** waves **oscillate parallel** to the direction of the wave.

Transverse (examples light, water, EM waves)



Transverse waves **oscillate PERPENDICULAR** to **direction of energy**
Or
Transverse waves **oscillate PERPENDICULAR** to the **direction of travel**

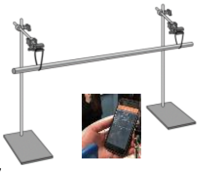
- Waves velocity can be calculated in two ways
- If the **distance (m)** the wave has travelled and the **time taken (s)** is known. **Velocity (m/s)** can be calculated using **v = x / t**
- If the **wavelength (m)** and **frequency (Hz)** are known about the wave. **Velocity (m/s)** can be calculated using **v = f x λ**



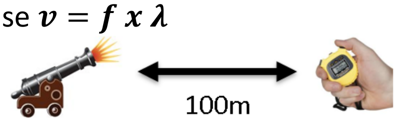
Finding Speed of water waves

- A **ripple tank** is used to make waves which are seen under the glass tank.
- **To find the frequency**. A **strobe** light has its frequency of flashes **adjusted** until the **wave appears stationary** – this is the frequency of the water wave**. Or** A **point is picked** the **number of waves** that **passes** that point in 20s is **counted**, then this total is **divided** by 20
- Then, the **wavelength** of the water wave is measured by using a **ruler** to measure the **distance from one peak to the next peak** (white line to white line). This is converted to **metres**. This can be **improved** by **measuring several waves** to find the length of one. Or by **placing the ruler** near the screen then **taking a photograph** if the waves are moving so they become stationary
- **Wave speed (m/s) = Frequency (Hz) x Wavelength (m)**

Finding speed of sound in solid

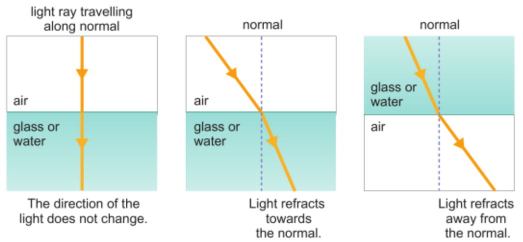


- **Hang metal bar** on rubber bands
- Find **wavelength** by **measuring length of bar** and **doubling it**
- **Hit bar** with hammer
- Use an mobile **app** like "Phyphox" to **measure the frequency** of the wave.
- Use $v = f \times \lambda$



Finding speed of sound in air

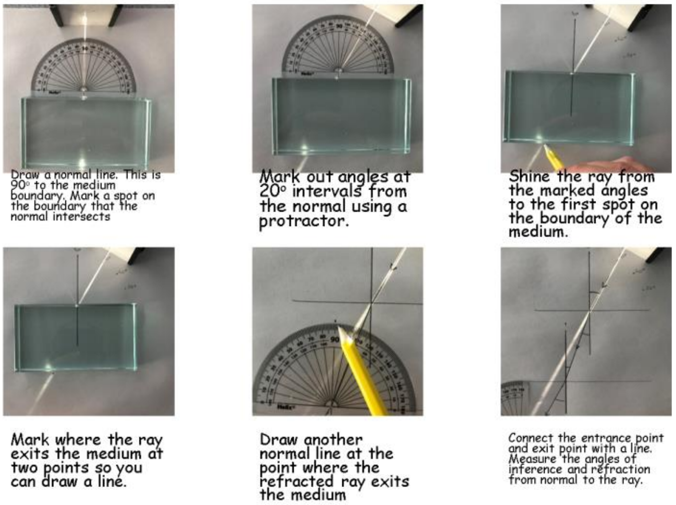
Use something that **makes a loud noise** eg a cannon. It **fires** and the **stopwatch is started** (you can see a flash of light which takes almost zero time to travel 100m). When the **sound reaches** the **observer** the **stopwatch** is **stopped**. This will give the time for sound to travel 100m. **Speed (m/s) = Distance (m) / Time (s)**



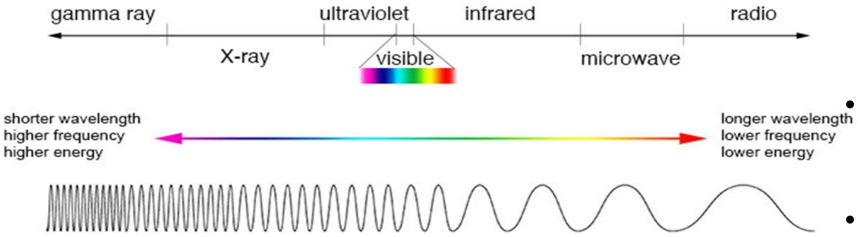
Refraction

- When **waves** travel through different mediums with **different densities** their **velocity changes**. (eg sound travels faster in solids than air, light travels slower through glass than air)
- If a wave enters a new medium at an **angle** its **direction** also **changes** as the **two sides** of the wave are travelling at **different speeds**

Core practical 3: Investigating refraction



- If it **slows down** it bends **towards the normal line** (an imaginary line at 90° to the interface between the mediums at he point the wave enters) If the wave **speeds up** it **bends away** from the **normal**



- **Electromagnetic waves** are **transverse** waves that **transfer energy** from the wave source to an absorber.
- All electromagnetic waves travel at the **same velocity** in a **vacuum**: 300 000 000m/s.
- The only part we detect with **our eyes** is **visible light**
- As the **length** of **EM waves decreases** (from radio waves to gamma rays) the **frequency increases** so the **transfer more energy**

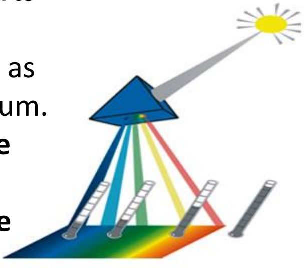
Health risks of high energy EM radiations:

High frequency radiations have **high energy**. They can have a **hazardous** effect on **human tissue**.

- **microwaves**: can cause internal heating of body cells
- **infrared**: can cause skin burns
- **ultraviolet**: can damage the surface cells and eyes, leading to skin cancer and eye conditions
- **x-rays** and **gamma rays**: can cause mutation or damage to cells in the body

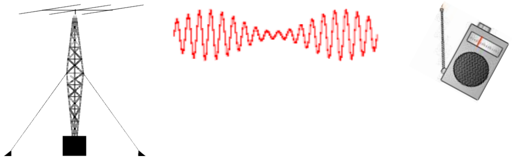
Infrared discovery

- Herschel placed **thermometers** in different **parts** of the **colour spectrum and beyond the red**.
- He found that the **temperature rise increased** as you moved **towards the red** end of the spectrum.
- The temperature rise was **greatest beyond the red.**
- This showed the **presence** of an **invisible wave** named **infrared**



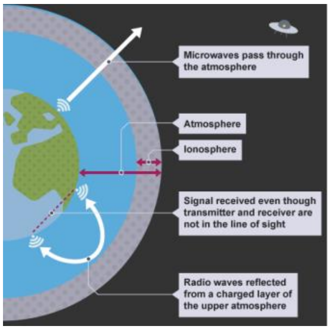
Type	Application
Radio	Television, radio broadcasting and satellite transmissions
Microwave	Cooking, communications and satellite transmissions
Infrared	Cooking, thermal imaging, short range communications, optical fibres, T V controls and security systems
Visible	Vision, photography and illumination
Ultraviolet	Security marking, fluorescent lamps, detecting forged bank notes and disinfecting water
X-rays	Observing the internal structure of objects, airport security scanners and medical x-rays
Gamma rays	Sterilising food and medical equipment, and the detection of cancer and its treatment

Radio signals are produced when an **alternating current** is passed through a wire in a radio transmitter. The **oscillating (vibrating) particles** in the wire produce a **radio wave** which is modulated and boosted so it can carry the signal over a great distance.



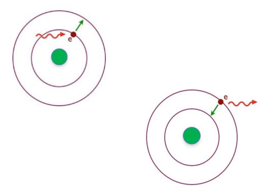
A radio wave is **transmitted** at the **same frequency** as the a**.c. current** which produced it.

When this radio signal reaches another antenna (e.g. aerial on a radio) the **radio waves cause oscillations in the wire**. This produces an alternating current of the **same frequency as the radio signal.**



Radio waves can be received **halfway around** the **world** because they are **reflected** by the **Earths atmosphere**
Microwaves are used for mobile communication as they can bass through the atmosphere to satellites but sometimes high frequency radio waves are used.

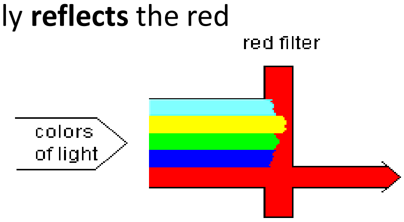
- **Atoms** can **receive energy (EM waves)** from external sources. To cause **electrons to jump** to a higher energy level.
- When **the electron falls back** energy is **given out** as a photon of **EM radiation**.
- **Changes** within the **nucleus** of an atom can result in the **emission of gamma** waves



Most materials absorb some of the light falling on it. A **white or shiny surface reflects** most of the incident light whereas a **black surface absorbs** most wavelengths of light.
Absorbed light is changed into a **heat** energy store so is not re-radiated as light.

- **White light/sunlight** is made from **all the wavelengths** of **light** in the spectrum.
- A red object appears red in white light because it only **reflects** the red wavelengths of light, all other colours are absorbed.

- If light **transmits** through a coloured object, the colour passing through is the colour we see. As with reflected light, all other wavelengths of light are absorbed by the transparent or translucent material.



Name	Equation symbol	Unit	Unit Symbol
$v = \frac{x}{t}$			
Velocity	v	Metres / second	m/s
Displacement	x	Metre	m
Time	t	Seconds	s
$v = f \ x \ \lambda$			
Velocity	v	Metres / second	m/s
Frequency	f	Hertz	Hz
Wavelength	λ	Metre	m
$T = \frac{1}{f}$			
Period	T	Seconds	s
frequency	f	Hertz	Hz

Team Science

Science

End of Year 11 Target Grade

Name

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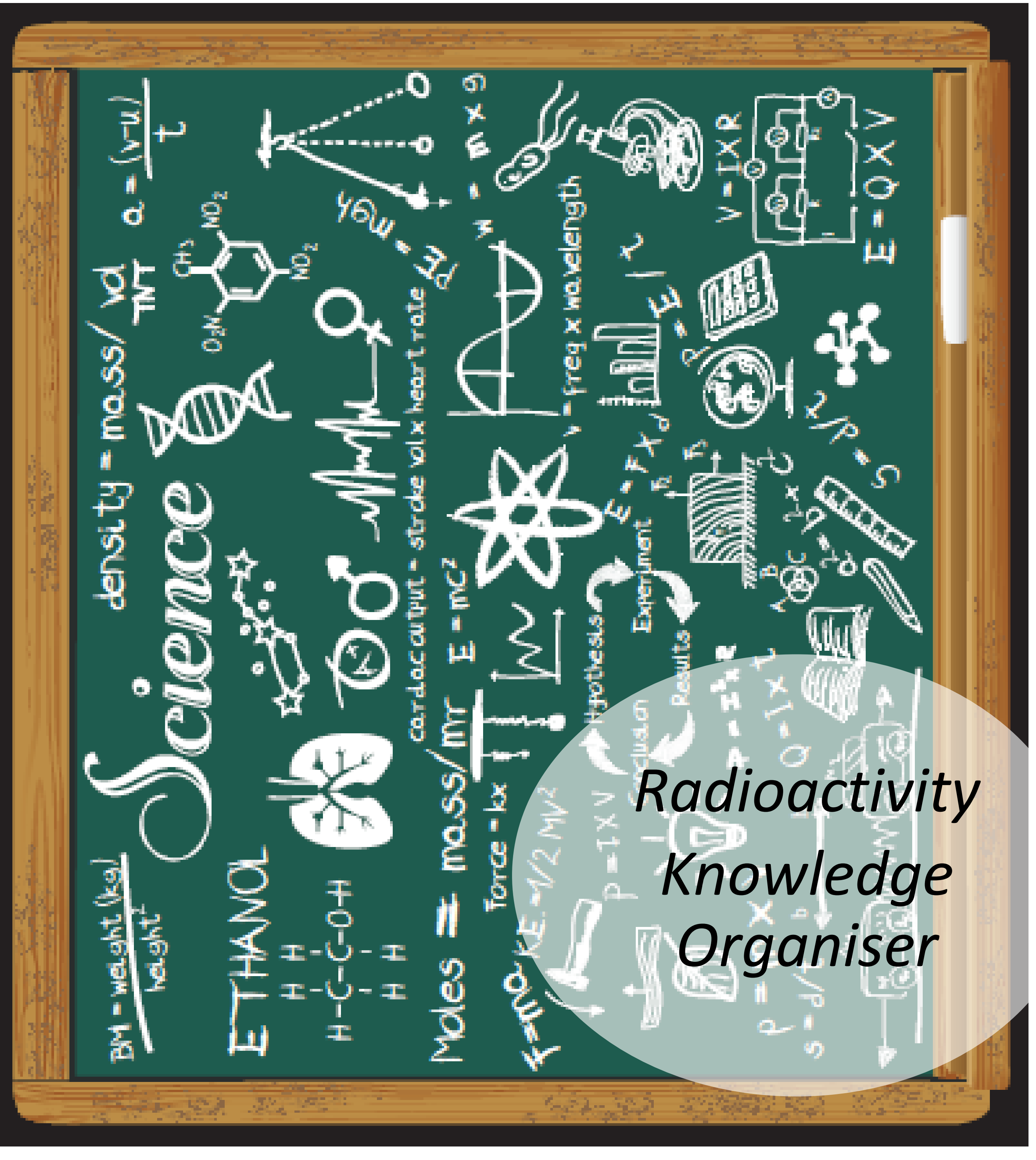
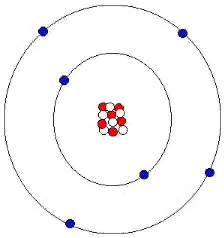


Radioactivity Knowledge Organiser

Radius of an atom **1 x 10 $^{-10}$m**



	Mass	Charge	Location
Proton	1	+ (positive)	nucleus
Neutron	1	no charge	nucleus
Electron	1/1835 negligible	- (negative)	shells

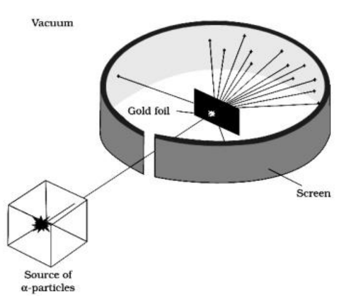
Pre 1900

Pre 1911

1911 to present

Sphere	Plum pudding model	Nuclear model
Before the **discovery of the electron**, atoms were thought to be **tiny spheres that could not be divided**.	The **discovery of the electron** led to the **plum pudding model** of the atom. The **plum pudding model** suggested the **atom is a ball of positive charge with negative electrons embedded in it**.	• **Alpha scattering experiment** – mass of the atom is concentrated in the **nucleus, which is charged**. • **Niels Bohr – electrons orbit nucleus** at **different distances**. • **Later experiments – positive charge in nucleus** divided into whole number of **smaller particles with positive charge**. • **James Chadwick** – 20 years after nucleus accepted – provided evidence for existence of **neutrons in nucleus**.

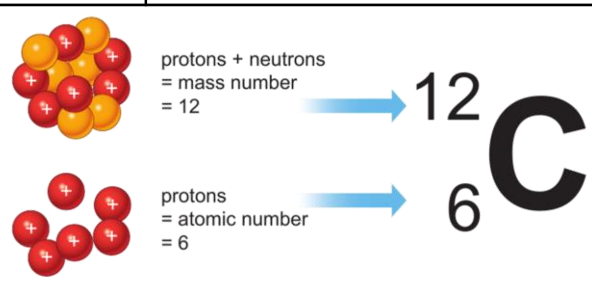
Rutherford's alpha scattering experiment. A beam of **alpha particles** are directed at a very thin **gold foil** screen.



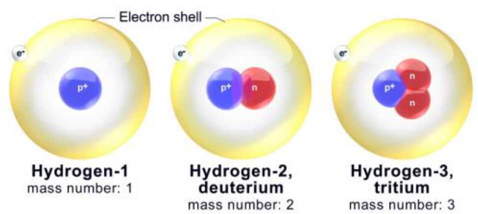
A **few** (+) alpha particles are **deflecte**d by a **positive nucleus** within the gold atoms.

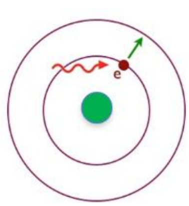
Most (99.99%) of the alpha particles pass **straight through** the gold foil unaffected by its presence.
A **tiny number** of alpha particles are **reflected** because they **collide with the nucleus** of the gold atoms.
Rutherford concluded that the gold atoms are **mostly empty space** with a **positively charged nucleus** that **contains nearly all the mass** of the atom.

Ions are **charged atoms**. Ions are formed through the process of ionisation, **where atoms lose or gain electrons**. Due to **gaining so much energy** that an electron escapes



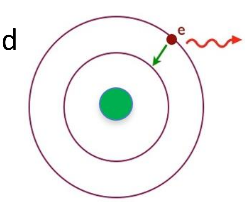
The isotopes have the **same number of protons** and the **same number of electrons**. Only the number of **neutrons changes** in an isotope.



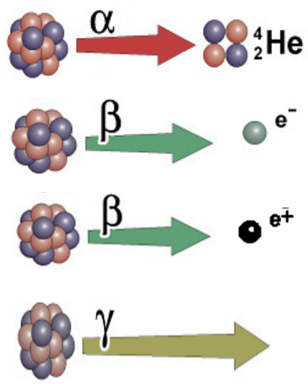


Electromagnetic radiation absorbed by the electron causes it to **move to a higher energy level.**

The electron can **emit** this stored energy as **electromagnetic radiation.**
As it loses energy the electron **returns to its original energy level.**



- The **nuclei** of some atoms are **unstable**.
- To become **more stable** these nuclei **give out radiation**.
- This process is called **radioactive decay**.



Alpha (symbol α or ^4_2He) consist of **2 protons and 2 neutrons** emitted from the nucleus. They have a **positive** charge as they contain 2 (+) protons.

Beta Minus (symbol β^- or $^0_{-1}e$) consist of an **electron** emitted from the nucleus. This results from a neutron splitting into a proton and an electron. Beta particles are **negatively** charged.

Positron/Beta Positive (symbol β^+ or $^0_{+1}e$.) are released when a proton becomes a neutron and a positron. Positron particles are **positively** charged.

Gamma rays (symbol γ) are **electromagnetic radiation** emitted from the nucleus. Gamma radiation has **no mass** and **no electrical charge.**

Name	Symbol	Particles	Mass	Charge	Stopped by	Penetration	Ionisation
Alpha	α or ^4_2He.	Helium nucleus	4	+2	6cm of air / paper	Low	High
Beta	β^- or $^0_{-1}e$.	Fast moving electron	1/1835	-1	Aluminium	Medium	Medium
Positron	β^+ or $^0_{+1}e$.	Fast moving positron	1/1835	+1	Aluminium	Medium	Medium
Gamma	γ	EM wave	0	0	Thick lead	High	Low

Alpha emission

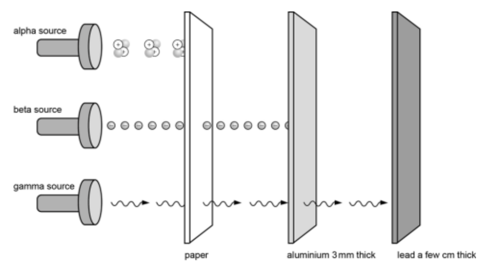
$$^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}^4_2He$$

Nucleus **loses 2 protons** and **2 neutrons**.
Atomic number will reduce by 2 and atomic mass by 4.

Beta emission

$$^{14}_{6}C \longrightarrow {}^{14}_{7}N + {}^{0}_{-1}e$$

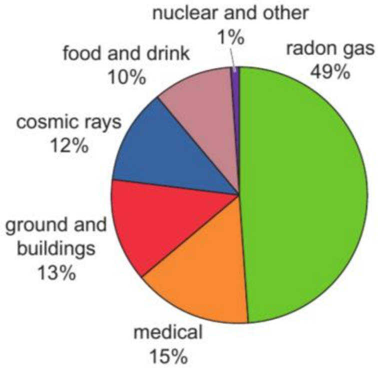
Nucleus **loses an electron** which is produced when a neutron turns into a proton. So **mass stays the same** but **atomic number of the product increases by one**.



Gamma emission

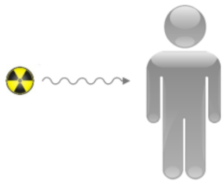
$$^{99}_{43}Tc \longrightarrow {}^{99}_{43}Tc + \gamma$$

No particles are emitted so there is **no change to the nucleus**. Atomic mass and atomic number stay the same.



- **Background radiation** is the constant , low level radiation in the environment.
- This can be natural radiation from rocks, building materials, cosmic rays etc.
- **Radioactive pollution** from nuclear testing, nuclear power and industrial/medical waste also contributes to background radiation.
- Everyone receives background radiation but people who **work or live** in locations with high levels of radiation **receive additional doses of radiation**.
- Some nuclear workers, medical staff, military and industrial workers may have higher doses due to working with radioactive sources.

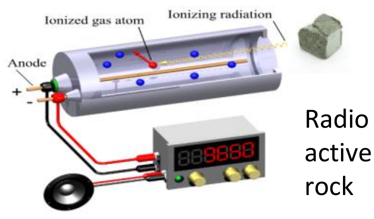
Irradiation is when an object or person is **exposed** to radiation. Protection from irradiation means stopping the radiation from reaching you.



Medical dressings are often irradiated but present no danger to the user.

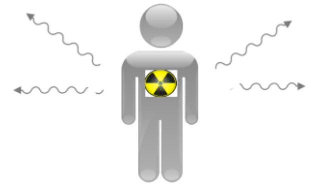
Radioactive materials are **hazardous** to **life**. **Nuclear radiation** can **ionise** (add or remove electrons) substances **within** the human body. This can **change** the way cells behave, **damage** DNA or **destroy** human cells.

Activity = **rate at which a source of unstable nuclei decays**, measured in **becquerels (Bq).**



Radio active rock

Contamination is when a radioactive source is in **contact** with an object or person. The radioactive substance rather than the emissions are present.



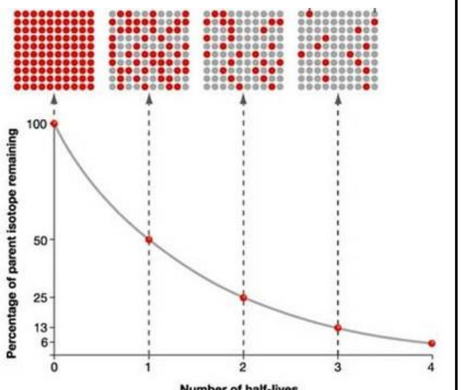
The object remains radioactive until the contamination is removed or decays naturally.

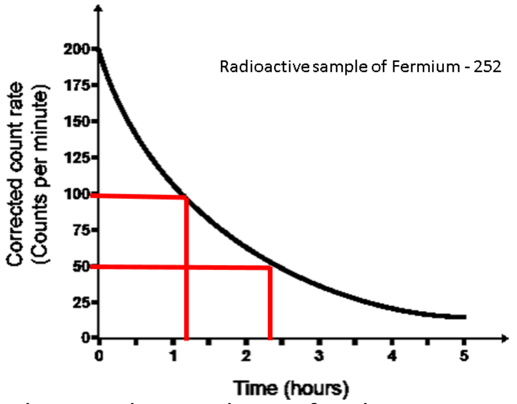
Radioactive materials are hazardous, so certain **precautions** can be taken to reduce the risk when using radioactive sources. These include:

- wear **protective clothing** to prevent the body becoming contaminated should radioactive isotopes leak out
- Using l**ead lined containers/shielding**
- Keep sources at a distance eg using **tongs**
- limit the **dose** and monitor **exposure** using detector badges, etc

- **Count-rate** = **number of decays recorded each second by a detector** (e.g. Geiger-Muller tube)
- Exposure can also be measures using a **dosimeter**. **Photographic film** that **changes colour** when exposed to nuclear radiation

- Radioactive decay is a random process so the likelihood of a decay taking place is a probability problem. For this reason, the **half-life** of an isotope is given rather than saying how long it will take to fully decay
- The **half-life** of a radioactive isotope is the time it takes for the **number of nuclei** of the isotope in the sample to **halve**, or the time it takes for the **count rate** from a sample containing the isotope to **fall to half its initial level**.





It always takes 1.2 hours for the count rate to halve.

Half life of Fermium - 252 = 1.2 hours

If you know the start and finish count rate and the time taken, you can calculate the half life.

Example:

The count rate of an isotope is 1008 Bq.

This falls to a count rate of 126 over a period of 21 days.

1008 → (1) 504 → (2) 252 → (3) 126

3 half lives for count rate to fall to 126.

These 3 half lives took 21 days so each half life took 7 days.

Half life if this isotope = 7 days

Science

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Energy & Force Knowledge Organiser

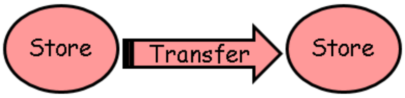
- **Energy** is the ability to do **work**
- **Energy** can be **stored** or **transferred,** but it **cannot be created or destroyed.** This means that the **total energy** of a **system** remains the **same.** This is called the **conservation of energy**

6 main energy **stores** are

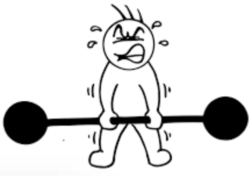
- **Kinetic** (energy stored in **moving** objects)
- **Gravitational potential** (energy stored in **raised** objects)
- **Chemical** (energy stored in **bonds**, main sources **food, fuel & batteries**)
- **Thermal** (energy associated with **temperature**)
- **Elastic potential** (energy stored in stretched or deformed objects)
- **Nuclear** (energy from nuclei of atoms)

Energy can be **transferred** from stores in four main ways using **'pathways'**

- **Mechanically/Forces** (A force acts on it e.g. pushing, pulling, stretching squashing)
- **Electrically** (A charge flows around a circuit)
- **Heating**(Energy moves for hot areas to colder ones)
- **Radiation**(Transferred by waves e.g. light from the Sun)



- When a **force** causes an object to move through a **distance**, **WORK IS DONE** (**energy transferred**) on the object. So a force does work on an object when the force causes a displacement of the object. **E = F x d**



- **Power** is the **rate** at which **energy is transferred** OR the **rate** at which **work is done** (rate means "how quickly") **P = E / t**
- **Power** is measured in **joules per second**. So **1 J/s = 1 Watt**

When an **object is raised** above ground level it **gains gravitational potential energy** (GPE). This stored energy can be released if the object is allowed to fall.

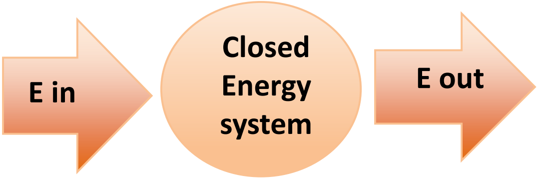
$\Delta GPE = m \times g \times \Delta h$

Gravitational field strength on Earth is 9.8N/kg OR 10N/kg

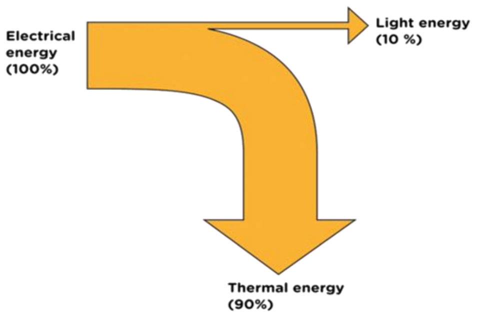
Moving objects have **kinetic energy**. The long-jumper is using her kinetic energy to carry her body as far as possible. The more kinetic energy she has, the longer her jump will be. Her **kinetic energy depends on** her **mass** (which she can not change) and her **velocity** (she can run faster!). **KE = ½ x m x** v^2

In a **closed energy system** there can be **transfer of energy** but **not mass**. There is **no change to the total energy** in the system.

No mass change



In a **closed energy system** all the energy can be accounted for even when energy stores change.



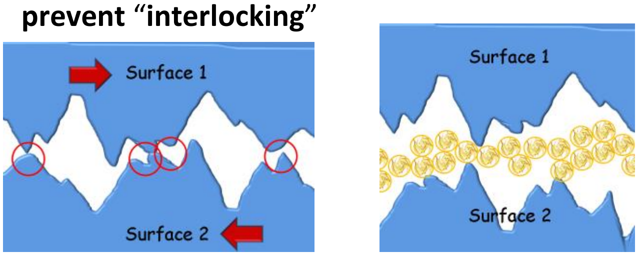
The diagram shows the energy transfer for a light bulb. **All** the electrical **energy** store **can be accounted for** as light energy and thermal energy.
The **thermal energy is not useful** in this case and can be considered to be **dissipated or "waste" energy.**

- **Efficiency** is a measure of **how much** energy is **used usefully**.
- Different devices have different efficiency values. **No device** can be **more 100% efficient**. As **energy cannot be created or destroyed**

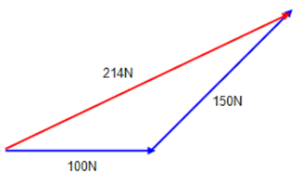
Efficiency = (useful energy transferred by the device) / (total energy supplied to the device)

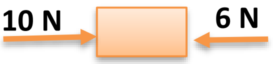
When **work is done** against **frictional forces** on an object there is a **temperature increase** of the object.
A bicycle pump gets hot in use as work is done in compressing the gas, causing the pump to get hotter.

- **Unwanted energy transfers** result in energy **stores that are not useful**.
- In **mechanical systems** this is usually due to internal combustion or **friction**.
- The **waste energy** that is **dissipated** is usually heat.
- This **wasted energy** can be **reduced** by **lubricants** which **reduce friction**
- We can reduce friction using **lubricants** which **prevent "interlocking"**



- **Scalar quantities** have a **magnitude** only, eg time, speed, mass, area
- **Vector quantities** have a **magnitude** and a **direction**, eg forces, acceleration, velocity
- **Velocity is speed in a direction**
- **Vectors** can be shown by **arrows**.
- The **length** of the arrow **shows the size**, or **magnitude**, of the **force**
- The **direction** of the arrow **shows the direction** of the **force**.
- The **vector arrows** can be **added together** to show the **resultant** of two of more vectors





RF = 4 N to the right

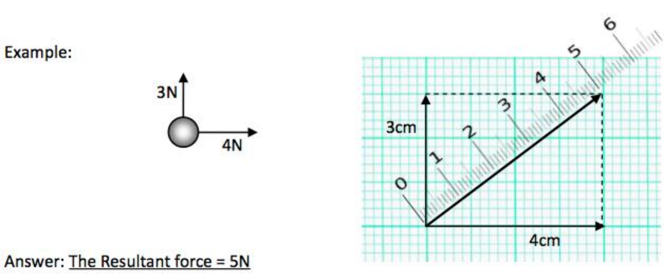
RF = 16 N to the right

- Forces can be placed into two groups. There are forces that act on contact and there are forces that act at a distance.

Contact Forces	Non-Contact Forces
Air Resistance	Gravity
Friction	Magnetism
Tension	Electrical Force
Normal Force	Nuclear Force

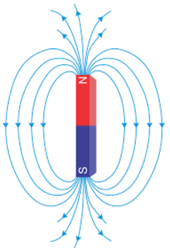
- A **single force** can be **resolved** into **two components** acting at **right angles** to each other. The two component forces together have the same effect as the single force. **Scale drawings** can be used to find the size of the component forces

- Reversely scale drawings can be made of multiple forces acting on an object, to find the resultant force

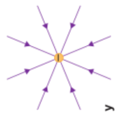


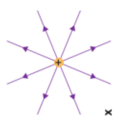
- The **space around an object** that can **affect other objects** is called a **force field**.
- **Object with mass** have a **gravitational field**. Eg the earth and moon both affect each other as they are both inside the others gravitational field.

- The **space around a magnet** is known as the **magnetic field** and can affect attract/repel objects made from magnetic materials (iron, nickel and cobalt) when they enter its magnetic field. This is how compasses work.



- Any **charged object** (positive or negative) has an **electric/electrostatic field** and these can attract/repel other charged object that enter the field.





Name	Equation symbol	Unit	Unit Symbol
$\Delta GPE = m \times g \times \Delta h$			
Gravitation PE	GPE or E_p	Joule	J
Mass	m	Kilogram	Kg
Grav. Field	g	Newton/Kilogram	N/Kg
Height	h	Metre	m
$KE = 0.5 \times m \times v^2$			
Kinetic Energy	KE or E_k	Joule	J
Mass	m	Kilogram	Kg
Velocity	v	Metres / second	m/s
$\text{efficiency} = \dfrac{\text{useful energy transferred}}{\text{total energy transferred}}$			
efficiency			
Useful energy transferred		Joules OR Watts	J OR W
Total energy transferred		Joules OR Watts	J OR W
$E = F \times d$			
Work Done	E	Joules	J
Force	F	Newtons	N
Distance	d	Metres	m
$E = F \times d$			
Energy transferred	E	Joules	J
Force	F	Newtons	N
Distance	d	Metres	m
$P = E / t$			
Work Done OR Energy transferred	E	Joules	J
Power	P	Watt	W
Time	t	Seconds	s

Team Science

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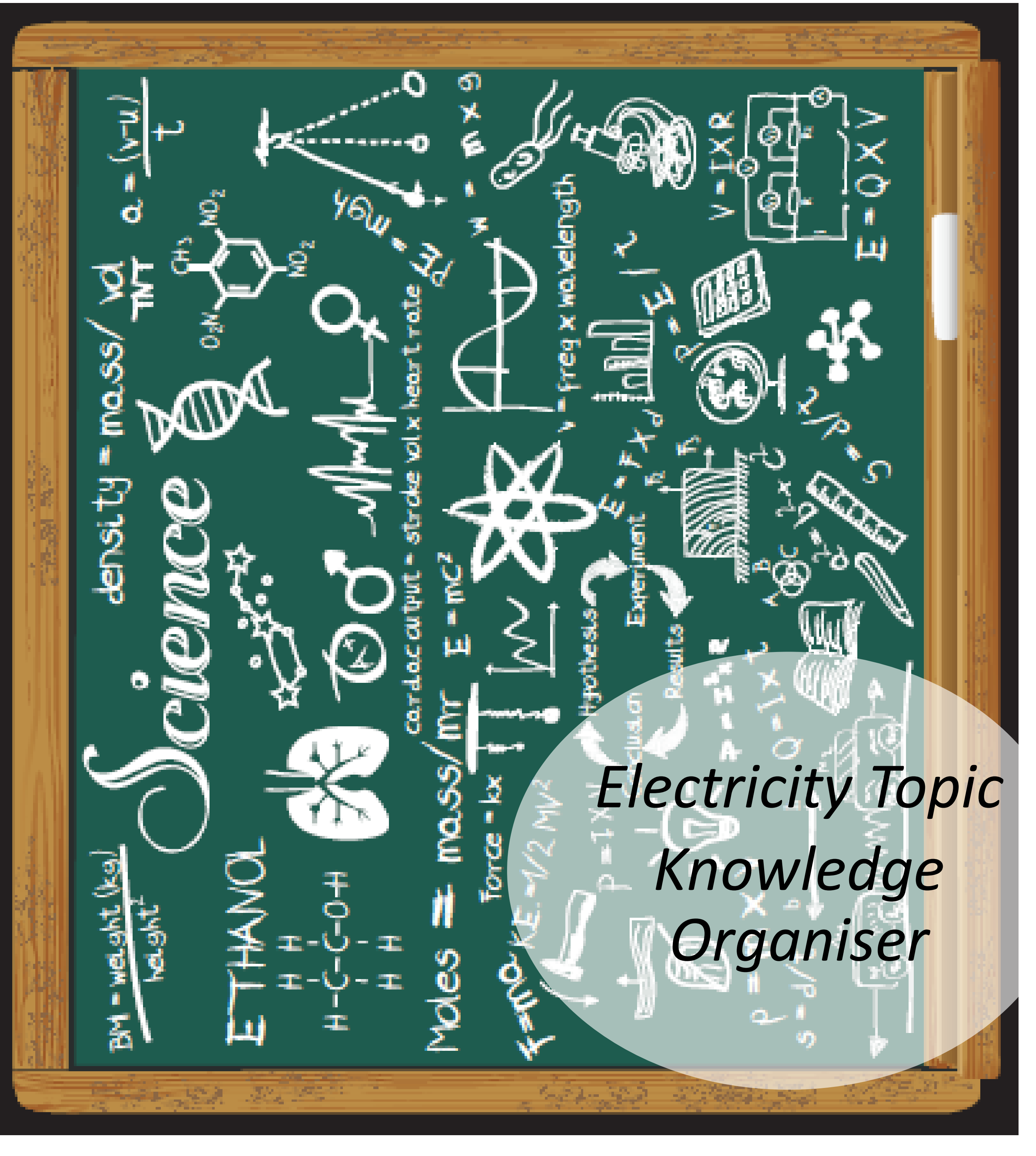
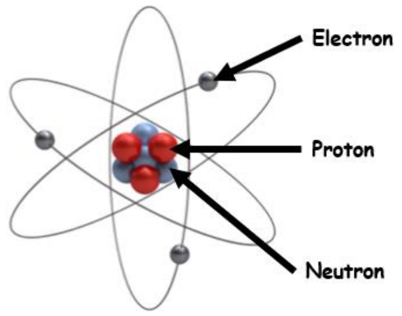
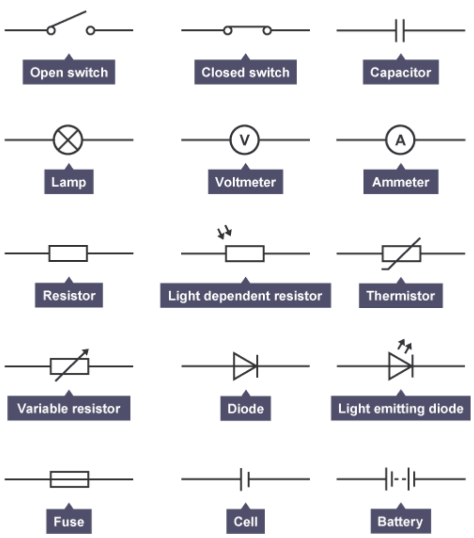


Electricity Topic Knowledge Organiser

Circuit Annotations



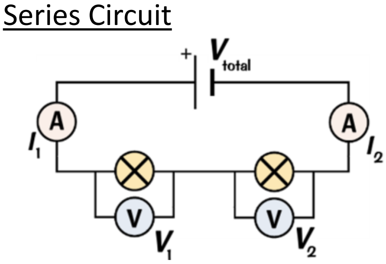
Particle	Mass	Charge	Location
Proton	1	+ (positive)	nucleus
Neutron	1	no charge	nucleus
Electron	1/1835	- (negative)	shells



- **Voltmeters** measure the **voltage** across components and must be connected in **parallel**. **Ammeters** measure the **current** across components and must be connected in **series**.
- **Potential difference** (or **voltage, V**), is a measure of the **energy (E)** that is carried around the circuit by **charge (Q)**. **Potential difference** is measured in **volts (V)** This can be written as: the **volt** is the **joule (J)** per **coulomb (C)**.
- **Current (I)**, is the rate that **charge** flows around a circuit. **Current** is measured in **amps (A)**. It is defined as the amount of **charge** passing a point per **second (s)**.
- **Charge** is carried by electrons. Each electron carries only a small amount of **charge**. A **large packet** of electrons will carry a **large amount** of **charge**. **Charge** is measured in **coulombs**. 1 **coulomb** is the amount of **charge** that flows when there is a **current** of 1 **amp** for one **second**.
- **Resistance (R)** is caused by **electrons** colliding with the **positive nuclei** in the wire. **Resistance** is measured in **ohms (Ω).** The **electrons** transfer **kinetic energy** to the **positive nuclei** causing them to **oscillate more**. This causes the **nuclei** to increase their **thermal stores**. This also reduces the **current** in the wire.

- When components are wired in **series** they are joined by wires and there are no **branches**. It can also be called a cascade, or end to end connection.
- When components are joined by wires and there are **branches**, it is a **parallel** circuit. This can also be called a side by side connection. Or a connection across each component.
- In circuits, we use **notation**. The **symbol** for the quantity is used in conjunction with **subscript** numbers to differentiate the reading at different components.
- $\mathbf{I_1}$ would correspond to the **current** through component 1. $\mathbf{I_{tot}}$ would correspond to the total **current** in a circuit.
- $\mathbf{V_1}$ would correspond to the **voltage** across component 1. $\mathbf{V_{tot}}$ would correspond to the total **voltage** in a circuit.
- $\mathbf{R_1}$ would correspond to the **resistance** of component 1. $\mathbf{R_{tot}}$ would correspond to the total **resistance** in a circuit.
- In **series** components the **current** is **equal**. In **parallel** circuits the total current **splits at junctions**, but the total **current** doesn't change. Because of that we say current is **conserved at junctions**.
- In **series** components, **voltage** is **shared** among components but **not always equally.** In circuits with **parallel** components, the **voltage** down **each branch** is **equal**.
- When components are connected in **series** the **resistance adds together.** When components are added in **parallel**, the total **resistance decreases**. The total **resistance** will always be **less than the smallest resistor** in a **parallel** circuit.

Series Circuit

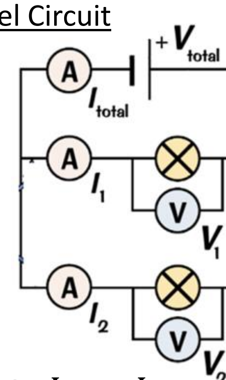


$$I_1 = I_2 = I_{tot}$$

$$V_1 + V_2 = V_{tot}$$

$$R_1 + R_2 = R_{tot}$$

Parallel Circuit

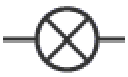


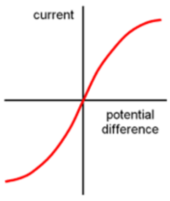
$$I_1 + I_2 = I_{tot}$$

$$V_1 = V_2 = V_{tot}$$

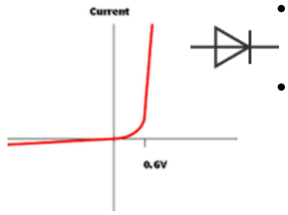
$$\frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{R_{tot}}$$

- **Ohmic conductors** have a fixed resistance at a **constant temperature.**
- **Current** is **directly proportional** to the **potential difference.**
- **Ohmic conductors** produce a **straight-line** graph.

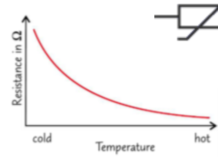




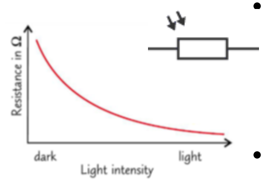
- The **resistance** of some components changes as **current** or **voltage** increase.
- As **current increases**, the **temperature** of the **filament lamp increases**. This **increases resistance.**
- As **resistance** increases the **current cannot increase proportionally**



- **Diodes** only allow **current** to **flow** in **one direction**.
- **Diodes** have **low resistance forward**, but a **high resistance** in the **reverse** direction.



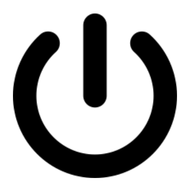
- **Thermistors** are types of **resistors** where the **resistance** varies with **temperature**.
- The **resistance** of a **thermistor decreases** as **temperature increases**.

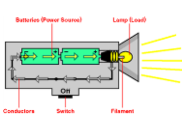


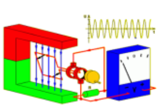
- **Light Dependent Resistors - LDRs** are types of **resistors** where the **resistance** varies with **light intensity.**
- The **resistance** of **LDRs decrease** as **light intensity increases**.

- The **greater** the **resistance** of wires, the greater the amount of **energy** that is **lost** to the surroundings.
- To **reduce resistance**, thick copper wires can be used, this **reduces the energy wasted**, **increasing** the **efficiency**.
- The **heating effect** can be **useful** when **regulated**, but it can lead to **dangerous overheating** if wired **incorrectly**.

- **Power (P)** is the amount of **energy transferred** in a **second**, it is measured in **Watts (W)**. **Electrons** are the "**carriers**" of **energy**.
- **Power** is therefore the amount of **electrons** passing **energy** to the component every **second**. **Current** is the amount of **electrons** passing a point in a given amount of time.
- The **current** in a circuit depends on the amount of **resistance** in the circuit and the **energy** carried for each **coulomb** of **charge**.
- We can **derive equations** for **power** using these facts.



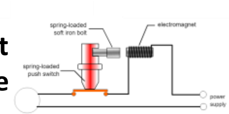




- **D.C** is short for **Direct Current** (**Battery** Powered)
- Electrons are simply pushed by the cell so there is only **one direction**.
- **A.C** is short for **Alternating Current** (**Mains** in UK)
- Caused by a **rotating copper wire** in a **magnetic field**. Electric **current** is only formed in wires when there is this **alternation**. This happens because **electric field lines** and **magnetic field lines interact.**
- Because it is rotating, the **current** in the system also **changes direction**. The change is **50 times a second** (or **50Hz**) and in the mains it is **230V**. You need to **remember this for use in exams.**

- In a **conventional UK plug**. Different wires have different **names**, **functions** and **colours**.
- The **neutral (Blue)** wire **completes the circuit**. It is the **return path** to the power station. This is where the circuit is closed. If the circuit is connected properly the **voltage is 0V**.
- The **live (Brown)** wire **carries alternating potential difference** from the **supply**. The **live wire connects** the **component** or appliance to the **generator**. The **voltage** on this wire is **230V**.
- The **earth** (Green) wire is a **safety feature**. The **live wire** may be **dangerous** when a switch in the **mains circuit** is open as a **person** could **complete** the **circuit** to the ground **themselves** and therefore get **electrocuted** as the **current** will **flow through them**.
- The **earth wire connects** the **casing** to the **earth**. It has a **lower resistance** than people so **current flows through it**.

- **Fuses** have **small thin wires** in them – they are designed to **stop an overflow** of **current** from reaching the **appliance** by **disintegrating** if too much **current** flows through the **wire**.
- **Circuit Breakers** are **soft iron plugs** that are **attracted** to an **electromagnet**. As the **current increases** the **electromagnet** becomes **more powerful**. If the **current** reaches an **unsafe** level, the **plug** is **removed** and the **circuit stops.**



Name	Equation symbol	Unit	Unit Symbol
$Q = I \times t$			
Charge flow	Q	Coulombs	C
Current	I	Amp	A
Time	t	Seconds	s
$E = Q \times V$			
Energy transferred	E	Joules	J
Charge flow	Q	Coulombs	C
Potential difference	V	Volts	V
$V = I \times R$			
Potential difference	V	Volts	V
Current	I	Amp	A
Resistance	R	Ohms	Ω
$E = V \times I \times t$			
Energy transferred	E	Joules	J
Potential difference	V	Volts	V
Current	I	Amp	A
Time	t	Seconds	s
$P = E \div t$			
Energy transferred	E	Joules	J
Power	P	Watts	W
Time	t	Seconds	s
$P = I \times V$			
Power	P	Watts	W
Potential difference	V	Volts	V
Current	I	Amp	A
$P = I^2 \times R$			
Power	P	Watts	W
Current	I	Amp	A
Resisitance	R	Ohms	Ω

Team Science

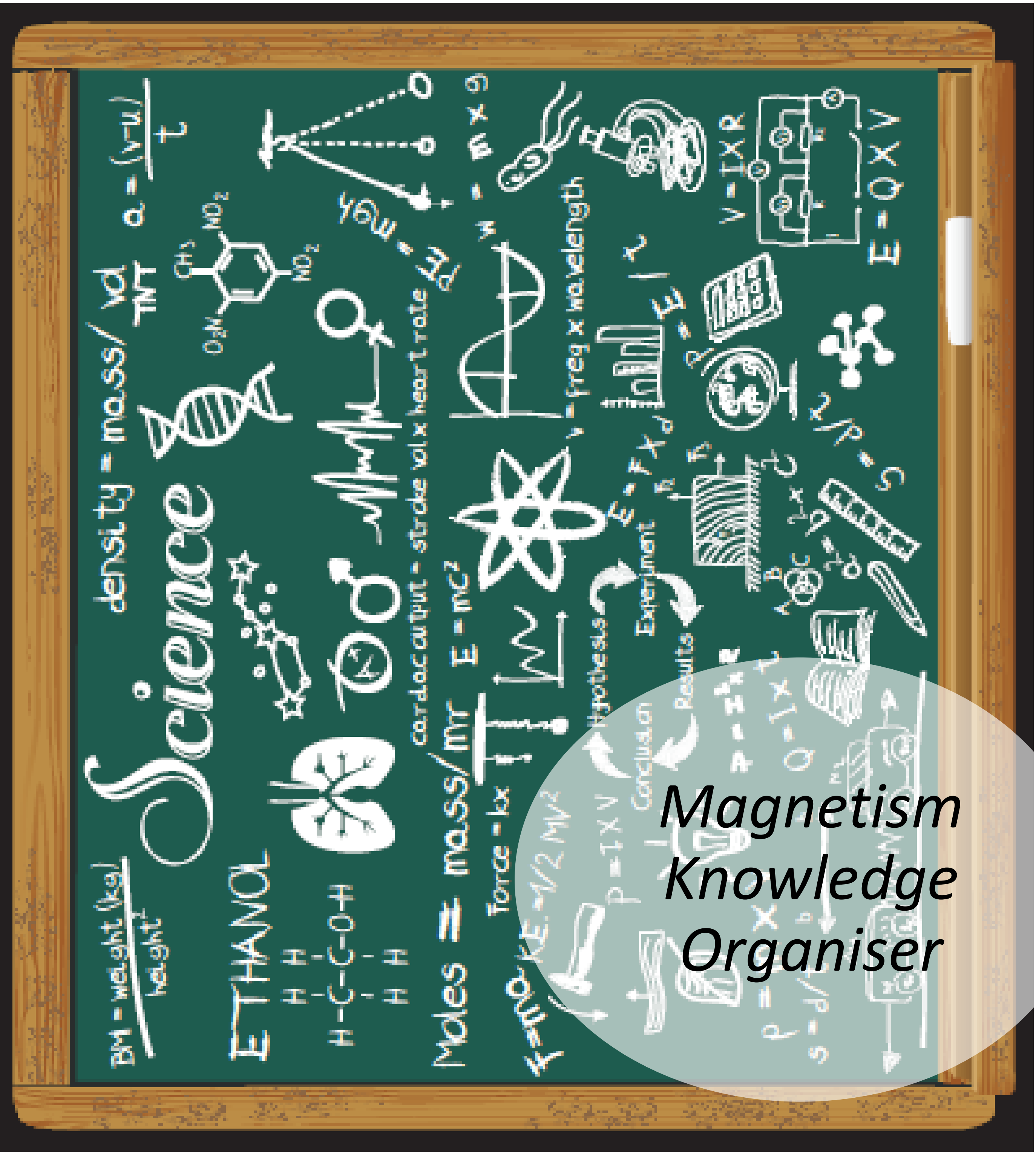
Science

End of Year 11 Target Grade

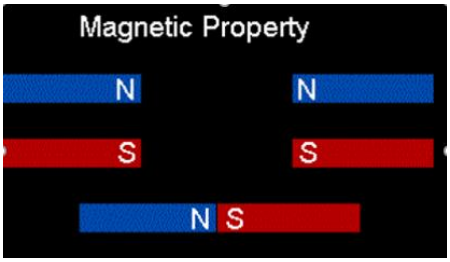
Name

Teacher Code

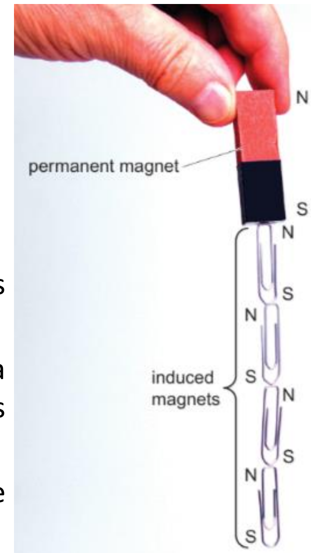
Class



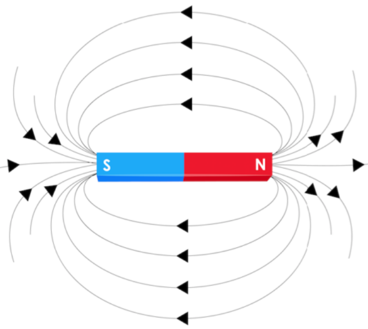
Magnetism Knowledge Organiser



- **Magnets** have a **North** and **South pole**
- **Like poles repel** from each other (**North & North**) & (**South & South**)
- **Opposite poles** are **attracted** to each other (**North & South**)
- Magnetic materials are always attracted to the poles of a magnet



- Magnets have **fields of magnetism** (the **space** around a magnet that can **affect magnetic materials**). Any magnetic material in the field is effected by it.
- The **more field lines** the **greater the strength** of the magnet.
- Magnetic field always go from **North to South**



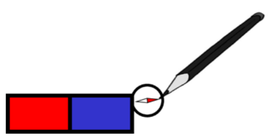
- A bar magnet is a **permeant magnet** because it is **always magnetic.**
- When a piece of **magnetic material** is in a **magnetic field** it becomes a magnet itself. This is called an **induced magnet.**
- It **stops** being magnetic when it is **taken out** of the **magnetic field.**

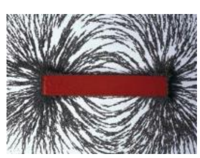
- **Cobalt** makes magnets that can operate at really high temperature. 
- **Steel** magnets can keep their magnetism for a long, long time. They can make permanent magnets 
- **Iron** loses it's magnetism very quickly, this could be used for electromagnets that have to be switchable 
- **Nickel** is inexpensive and quite hard. It can be used to cover more expensive magnets for protection 

Finding Magnetic field

Use **iron filings**

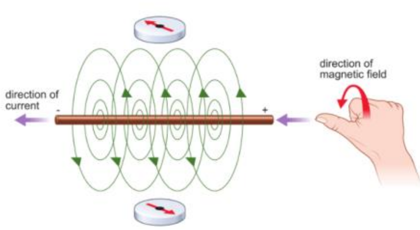
- Place a bar magnet under a sheet of paper
- **Sprinkle iron filings** on top of the paper
- **Tap** the **paper**
- The **pattern** the iron filings make is the **shape of the magnetic field**



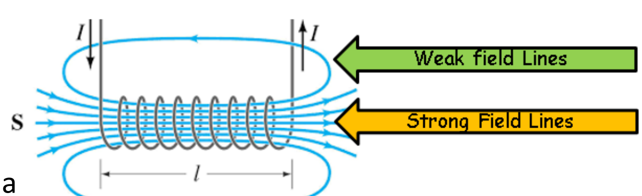


Use **plotting compasses**

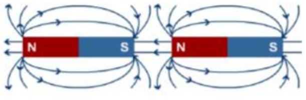
- **Place** the plotting **compasses around** the bar **magnet**
- The **direction the compass** points is the **direction of the magnetic field** at that point
- Use a **pencil to mark** the **direction** of the field and use the compass to trace the field around the bar magnet.



- When **current** flows through a long thin **conductor** – a **magnetic field** is **formed.**
- The **field is circular perpendicular** to the wire.
- **Changing the direction** of the **current changes the direction** of the **magnetic field.**
- The **larger the current** or the **closer to the wire** – the **stronger** the magnetic **field** is.

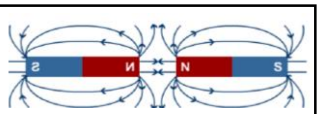


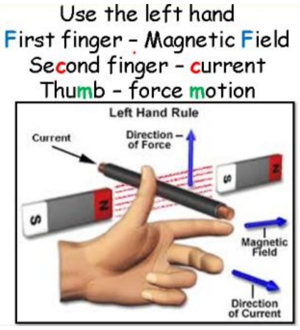
- **Solenoids** are coils of wire, with a current running through them.
- Inside a solenoid (an example of an **electromagnet**) the fields from individual coils add together to form a very **strong** almost **uniform** field along the centre of the solenoid and cancel to give a **weaker** field outside the solenoid
- **Increase strength** of **electromagnets field** by **increasing current, adding coils** or by **adding iron core**



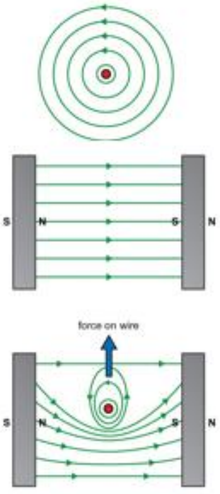
Attraction is due to the **force fields lining up** in the **same direction**

Repulsion is due to the **force fields lining up** in **different directions**



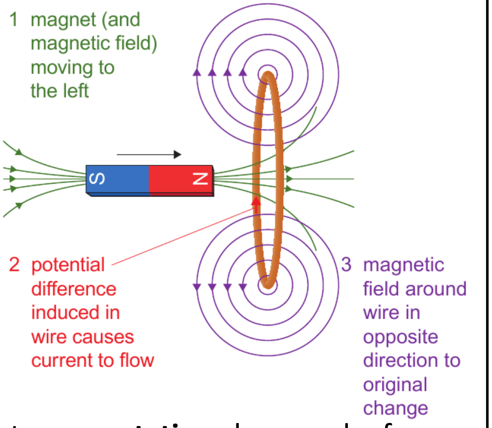


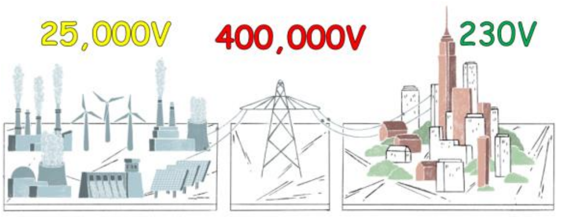
To determine the direction of force Fleming's left hand rule is used



- A **wire carrying** a **current** has a **magnetic field** around it.
- **Two flat magnets** produce a **uniform magnetic field** between them
- If the **wire** is put **in** the **magnetic field**, it **experiences a force**.
- The force occurs because of the way the **magnetic fields interact**.
- The **force** is **greatest** when the **wire is at right angles** to the direction of the magnetic field
- When a **force** is **exerted** on the **wire** an **equal and opposite force** is **exerted** on the **magnet**. (the wire moves as has less mass)

- When the **magnetic field** in a **conductor changes**, you get an **induced potential difference** and **current**.
- This is because the **magnetic field** and the **electrical field lines interact.**
- If you keep the **magnet moving forwards and backwards**, you get an **alternating current**.
- You can **increase the p.d**. by **increasing the strength** of the **magnetic field**, the **speed** of the movement and **more turns** in the coil.
- The **current** that is **induced acts against the change**, trying to return things to the way it was.

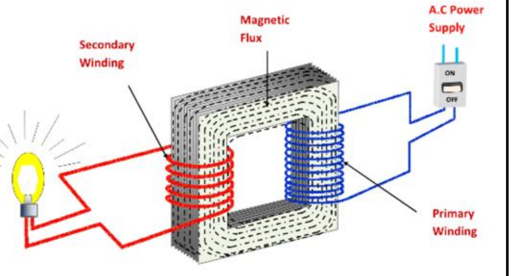




- Electricity generated at **power stations** has a p.d. of **25,000V**. Its is **transmitted** around the country through the **national grid** with a p.d. of **400kV**. It used in **domestic dwellings** with a p.d. of **230V**
- **Step up transformers** are used to **increase the p.d**.
- **Step down transformers** are used to **lower the p.d**.

Transformers work

- Using an **alternating current** in the **primary coil**
- **Induces an alternating magnetic field** in the laminated **iron core.**
- As the **alternating magnetic field** is **induced** inside the **secondary coil**
- A **potential difference** is **induced** in the **secondary coil**
- By the generator effect (as the magnetic field is moving relative to the coil of wire)
- **Alternating potential difference** in secondary coil induces **alternating current** in secondary coil



Transformers are **assumed** to be **100% efficient** to use equations. But some energy is lost in the real world

Step up transformers so transmission at high potential difference

- **Increasing** the **potential difference** through the powerlines **decreases the current**
- As the total power stays the same.
- The **greater the current** the more the **wires heat up**
- So a **lower current** means that the **wires heat up less**
- Making **transmission more efficient**.

Step down transformers so domestic use at low potential difference. **Low (230V) potential difference is safer for domestic use**

Name	Equation symbol	Unit	Unit Symbol
$F = BIl$			
Force	F	Newton	N
Magnetic Flux Density	B	Tesla	T
Current	I	Amps	A
Length	L	Metres	m
$P = IV$			
Power	P	Watts	W
Current	I	Amps	A
Voltage	V	Volts	V
$V_P \times I_P = V_S \times I_S$			
Primary Voltage	Vp	Volts	V
Secondary voltage	Vs	Volts	V
Primary current	Ip	Amps	A
Secondary current	Is	Amps	A
$P = I^2 \times R$			
Power	P	Watts	W
Current	I	Amps	A
Resistance	R	Ohms	Ω

Team Science

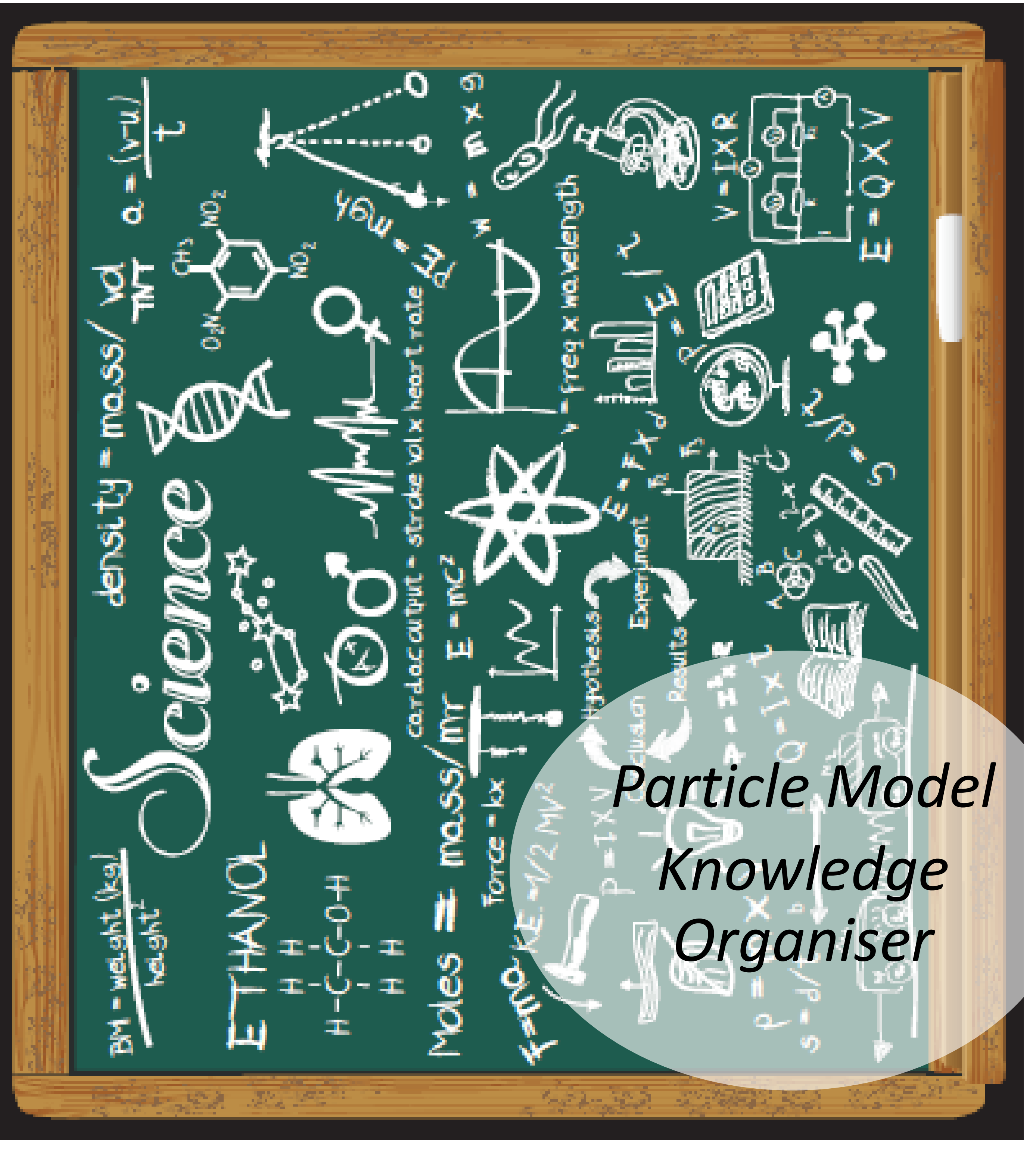
Science

End of Year 11 Target Grade

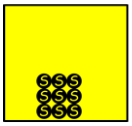
Name

Teacher Code

Class

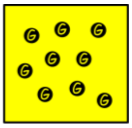


Particle Model Knowledge Organiser



- **Solids:** the **particles vibrate** but do **not** have **enough kinetic energy** to **break intermolecular bonds**. The **shape doesn't change** unless enough **thermal energy** is provided.

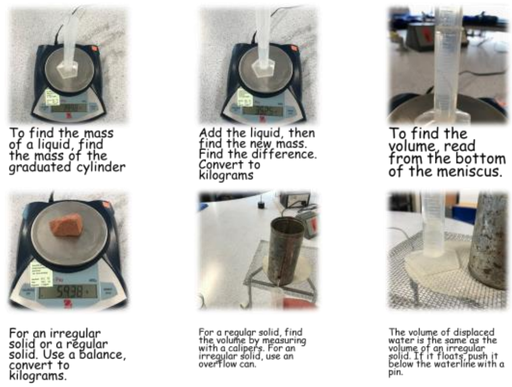
- **Liquids**: **particles vibrate** with **enough kinetic energy** to **change shape** but **without** enough **kinetic energy** to **vibrate** enough to **change their volume**.



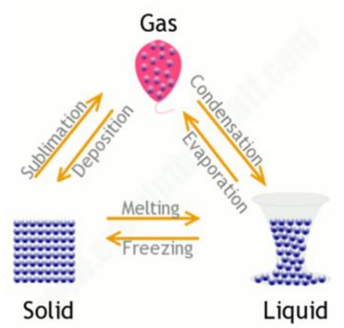
- **Gas**: **particles** have **enough kinetic energy** to change their **volume** to **fill in the container**. **Gas pressure** is caused by the **particles hitting** the **walls** of the container

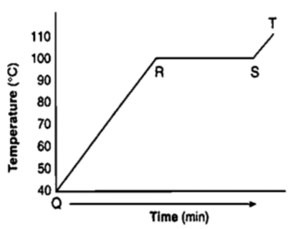
- To calculate **density** (**ρ**), measured in **kilograms per meter cubed** (**kg/m³**), **mass** (**m**) measured in **kilograms** (**kg**) is divided by **volume** (**V**) measures in **meters cubed** (**m³**).

Core practical 6: Investigating densities

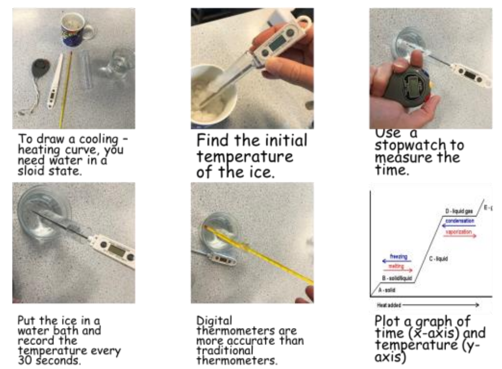


- A **change of state** can be brought about by **changing the temperature** or **pressure** of a material.
- Changes of state are **physical changes**, **not chemical**. They are **reversible** (can recover the **original properties**).
- **Mass** is **conserved**, but **volume** can **change**.





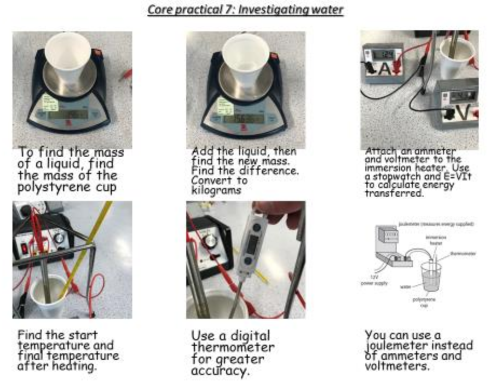
Core practical 7: Investigating water

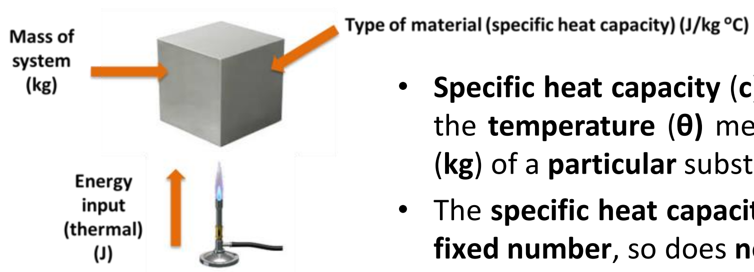


- **Heating** a substance will **increase** the **energy store** and **raise** its **temperature**.
- This will happen **until** the **substance changes state**
- In a **pure substance** the **change** of state will **happen** at **one temperature until** the **change occurs**
- The **thermal energy input** (the **heat energy** going **into** the **substance**) is used to **break intermolecular bonds** in the substance.

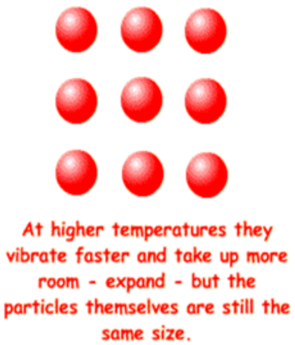
Core practical 7: Investigating water

- **Latent heat** is the **energy needed** to **change** the **state** of a **substance without** a **change** in **temperature**.
- The **energy supplied** is used to **change** the **internal energy store** of the substance.
- The **Energy** (**E or Q**) **measured** in **joules** (**J**) that is **required** to **change** the **state** of the a **substance** depends on the **mass** (**m**) measured in **kilograms** (**kg**) of the substance and the **specific latent heat** (**L**), which is **particular** to the substance.



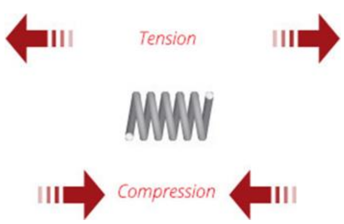


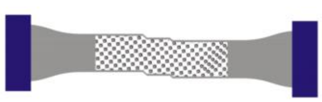
- **Specific heat capacity** (**c**) is the **amount** of **energy** (**E**) needed to **raise** the **temperature** (**θ**) measured in **degrees Celsius** (**°C**) of 1 **kilogram** (**kg**) of a **particular** substance.
- The **specific heat capacity** of any **particular material** or **substance** is a **fixed number**, so does **not change**.



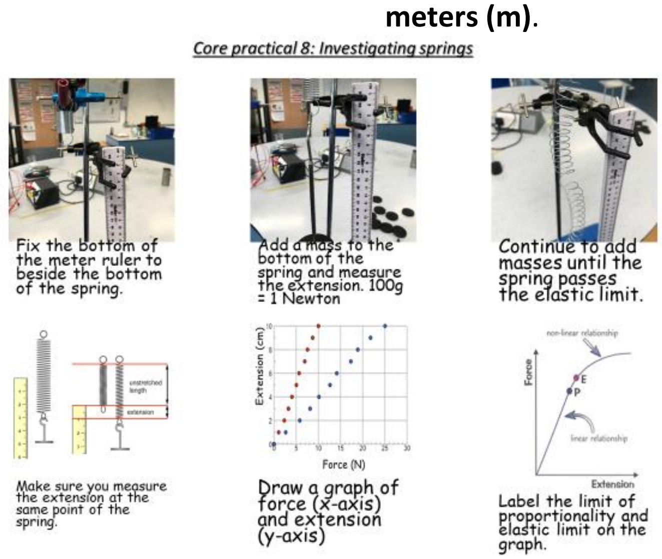
- **Gas pressure** is caused by **particles hitting** the **walls** of the containers.
- For a gas in a **fixed volume** container with a **fixed mass**:
- **Increasing** the **temperature increases** the **pressure** because the **particles** are **hitting** the container **walls more**.
- By **decreasing** the **temperature** the **pressure decreases** too.
- The total **kinetic energy increases** because the **thermal store increases**, particles **hit** the **walls** with **more force**.

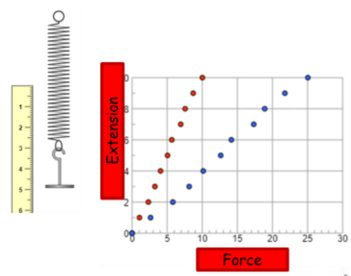
- **Absolute zero -273ºC** or **0K** is a term used to describe a **temperature** that is so low that there is **no kinetic energy** at all.
- This is a **theoretical number** on the **Kelvin scale** of **temperature**. Particles **do not** move or **vibrate** at all.
- To **convert** from **Celsius** to **Kelvin add 273** and to **convert** from **Kelvin** to **Celsius take away 273** – they are on the **same interval** of **scale** (an increase in 1^{O}C is the same as an increase in 1 K).

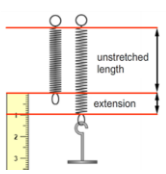


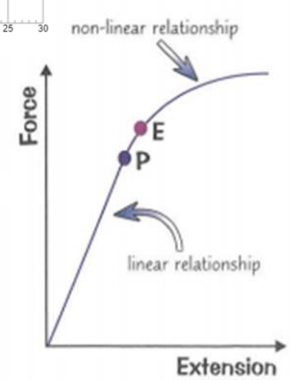


- In **springs** and other **elastic objects** like **rubber bands**; **stretching**, **bending** or **compressing** an object requires **more than one force**
- **Inelastic distortion**: The **atoms** in the spring **re-align** and do not go back to the original shape.
- **Elastic distortion**: The **atoms** in the spring **stretch** and **go back** to the **original** shape.
- The **spring constant (k)** is a number that measures **how much force (F)** measured in **Newtons (N)** is needed to **stretch** or **compress** a **spring** by a certain **length**. The length the spring changes is called the **extension (X)** measured in **meters (m)**.
- The amount of **energy (E)** in **joules (J)** needed to **stretch** the depends on the **spring constant (k)** and the **extension** of the **spring (X)** measured in **meters (m)**.









- When the **graph stops** being **linear**, the spring is **no longer elastic**.
- **Springs stretch** in **proportion** to the **force (F)** added up to the **limit of proportionality (P).** This is the **linear portion** of the graph.
- **After** the **limit of proportionality** the amount of **force doesn't** make a **predictable extension**.
- The **elastic limit** is where the **object becomes permanently stretched**.
- This is where the **non-linear** part of the graph begins.

Name	Equation symbol	Unit	Unit Symbol
$E = m \times L$			
Energy Transferred	*E*	Joule	J
Mass	*m*	Kilogram	kg
Specific Latent Heat	*L*	Joule per kilogram	J/kg
$E = m \times c \times \Delta\theta$			
Temperature	ϑ	Degree Celsius	°C
Energy	*E*	Joule	J
Mass	*m*	Kilogram	kg
Specific Heat Capacity	*c*	Joule per kilogram degree Celsius.	J/kg°C
$\rho = m \div V$			
Density	ρ	Kilogram meter cubed	kg/m^3
Mass	m	Kilogram	kg
Volume	V	Meter cubed	m^3
$E = 0.5 \text{ x } k \text{ x } X^2$			
Energy	E	Joules	J
Spring constant	K	Newtons per meter	N/m
Extension	x	meters	m
$F = X \text{ x } K$			
Force	F	Newton	N
Spring constant	K	Newtons per meter	N/m
Extension	x	meters	m