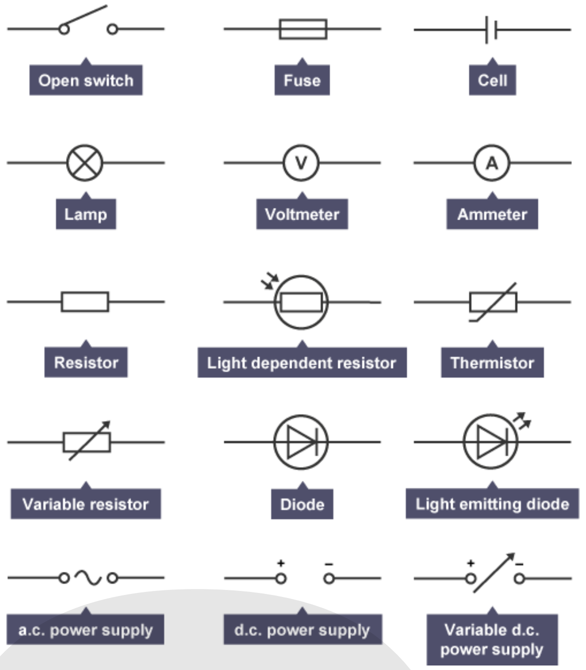
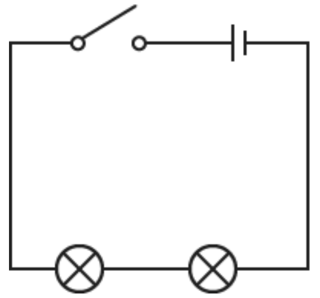
GCSE Science – Physics 1

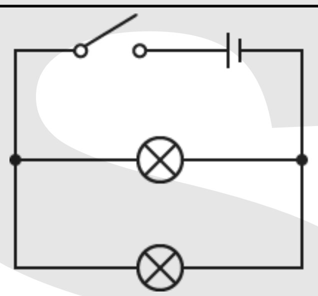
1.1 – Electrical circuits



Series circuits in which the current is the same throughout a circuit and voltages add up to the supply voltage.
If one component stops working the whole circuit will stop working

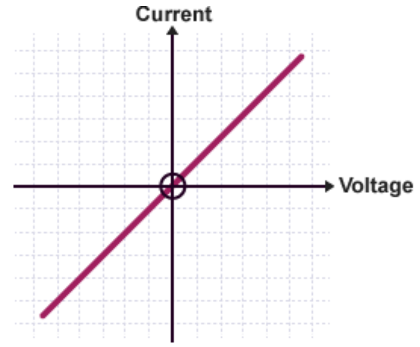


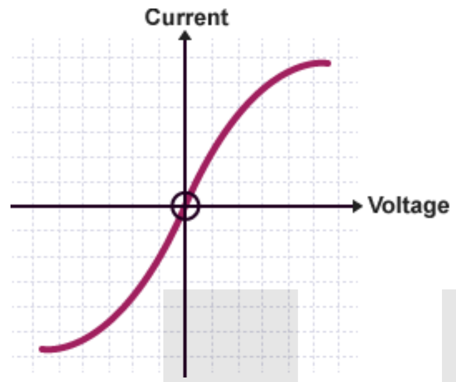
Parallel circuits in which the voltage is the same across each branch and the sum of the currents in each branch is equal to the current in the supply.



1.2 – Current voltage graphs

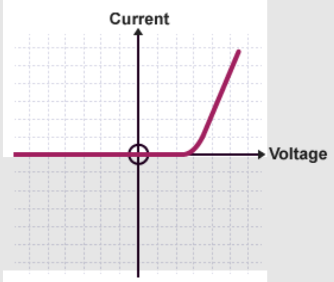
Resistor at constant temperature
The current flowing through a resistor at a constant temperature is directly proportional to the voltage across it. A component that gives a graph like this is said to follow **Ohm's Law**.





The filament lamp is a common type of light bulb. It contains a thin coil of wire called the filament. This heats up when an electric current passes through it and produces light as a result. The filament lamp does not follow Ohm's Law. Its resistance increases as the temperature of its filament increases.

The diode has a very high resistance in one direction. This means that current can only flow in the other direction. This is the graph of current against voltage for a diode. Normally a diode will not conduct until a particular voltage is reached.



1.3 – Non-renewable energy

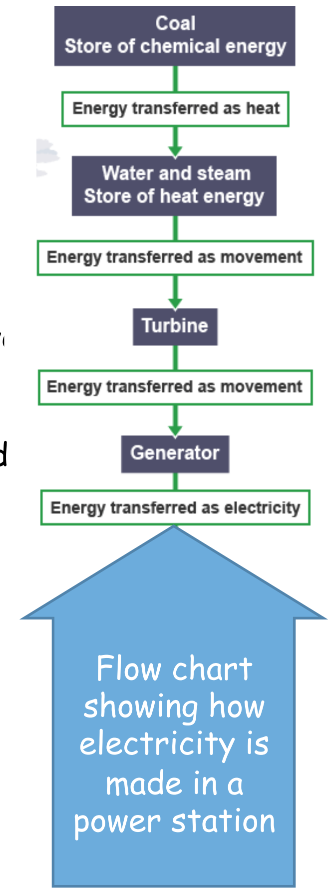
Fossil fuels are **non-renewable** because they will run out one day. Burning fossil fuels generates **greenhouse gases** and relying on them for energy generation is **unsustainable**.

Advantages of using fossil fuels

- At the moment, fossil fuels are relativ cheap and easy to obtain. This may not always be the case.
- Much of our infrastructure is designed to run using fossil fuels.

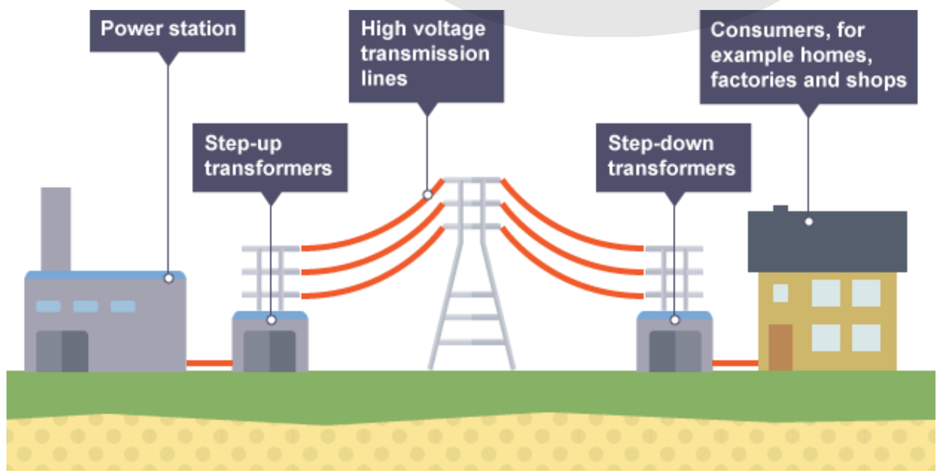
Disadvantages of using fossil fuels

- Fossil fuels are non-renewable energy resources. Their supply is limited and they will eventually run out, whereas fuels such as wood can be renewed endlessly.
- Coal and oil release sulfur dioxide gas when they burn, which contributes to acid rain.
- Fossil fuels release carbon dioxide when they burn, which adds to the greenhouse effect and increases **global warming**



1.4 – National grid

The National Grid ensures a reliable supply of electricity. If one power station breaks down, the grid will continue to supply electricity from other power stations in the grid.



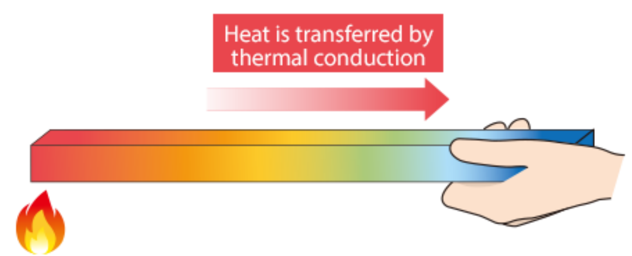
Step-up transformers increase voltage and decrease current – reducing energy losses in transmission lines making distribution more efficient.
Step-down transformers reduce voltage to safer levels for consumers.

power = voltage × current

1.5 – Conduction

- Conduction occurs in solids.
- Metals are good conductors.
- Non-metals and gases are usually poor conductors.
- Poor conductors are called insulators.
- Heat energy is conducted from the hot end of an object to the cold end.

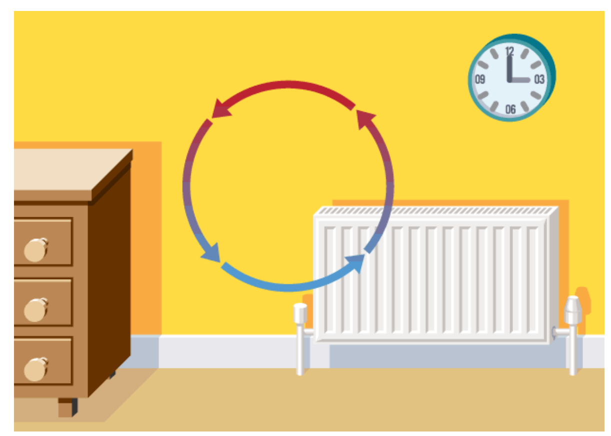
The **electrons** in a piece of metal can leave their atoms and move about in the metal as free (or de-localised) electrons. The parts of the metal atoms left behind are now positively charged metal **ions**. The ions are packed closely together and they vibrate continually. The hotter the metal, the more kinetic energy these vibrations have. This kinetic energy is transferred from hot parts of the metal to cooler parts by the free electrons.



1.6 – Convection

Heat can be transferred from one place to another by convection in liquids and gases (fluids).

- Liquids and gases expand when they are heated.
- Particles in liquids and gases move faster when they are heated than they do when they are cold.
- the particles take up more volume. This is because the gaps between particles increase, while the particles themselves stay the same size.
- liquid or gas in hot areas is less **dense** than the liquid or gas in cold areas, so it rises into the cold areas. The denser cold liquid or gas falls into the warm areas. In this way, **convection currents** that transfer heat from place to place are set up.

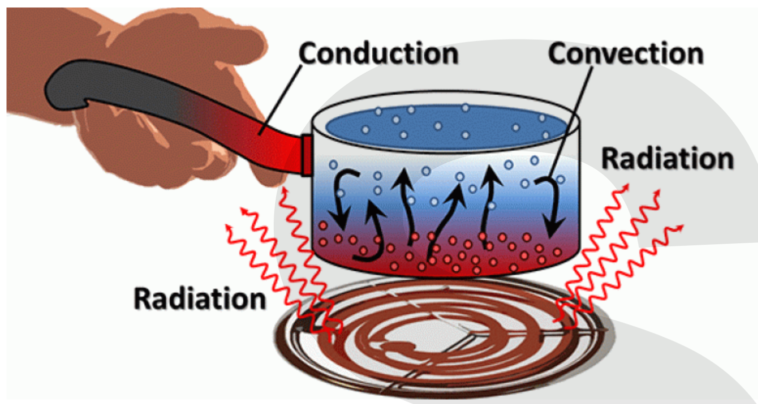


GCSE Science – Physics 1

1.7 – Radiation

Heat can be transferred by **infrared** radiation. Because no particles are involved, radiation can even work through the **vacuum** of space. This is why we can still feel the heat of the Sun even though it is 150 million kilometers from the Earth.

Surface	Absorption	Emission
Dull, matt or rough, dark coloured	Good	Good
Shiny, light coloured	Poor	Poor



1.8 – Electricity in the home

The amount of electrical energy transferred to an appliance depends on its power, and on the length of time it is switched on for. The kilowatt hour (kWh) is used as a unit of energy for calculating electricity bills.

$$\text{energy transferred (kilowatt/hour, kWh)} = \text{power (kilowatt, kW)} \times \text{time (hour, h)}$$

To convert from W to kW you must divide by 1,000.
To convert from seconds to hours you must divide by 3,600.

$$\text{units used (kWh)} = \text{power (kW)} \times \text{time (h)}$$

The energy in joules is equal to the power in watts × time in seconds.

$$\text{energy (J)} = \text{power (W)} \times \text{time (s)}$$

1.9 – Ring main

The function of the live wire is to carry current to the house/appliance at a high voltage.
The neutral wire completes the circuit and carries current away at low/zero voltage.
The earth wire is a safety wire that can carry current safely into the ground if a fault develops in a metal framed appliance. Appliances with metal cases are usually earthed. If the casing becomes live, a large current can flow along the low resistance earth wire and this high current will "blow" a fuse or trip a mcb.
Switches and fuses are placed into the live wire.
The ring main is a looped parallel circuit.

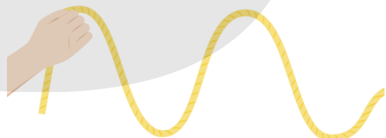
There are several advantages of using a ring main circuit:

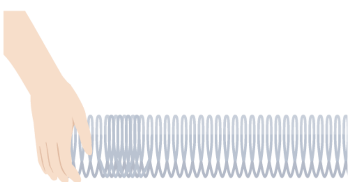
- The cables can be made thinner because there are two paths for the current;
- Each part of the cable carries less current because the current flows two ways;
- A ring main circuit is more convenient since sockets can be placed anywhere on the ring;
- Each socket has 230V applied and they can be operated separately.

1.10 – Waves

In transverse waves, the oscillations are at right angles to the direction of travel and energy transfer.
Examples of transverse waves include:

- all types of electromagnetic waves
- water waves
- seismic **S waves**



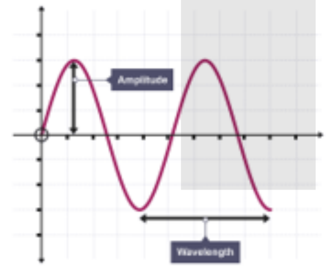


Longitudinal waves show areas of **compression** and **rarefaction**.
Examples of longitudinal waves include:

- sound waves
- seismic **P waves**

1.11 – More waves

Amplitude – As waves travel, they set up patterns of disturbance. The amplitude of a wave is its maximum disturbance from rest.



Wavelength (λ)– of a wave is the distance between a point on one wave and the same point on the next wave. It is often easiest to measure this from the crest (top) of one wave to the crest of the next wave or the trough (bottom) of one wave to the trough of the next wave.

Frequency – The frequency of a wave is the number of cycles of a wave that occur in one second. relationship between wavelength and frequency i.e. inversely proportional and between amplitude and energy.

wave speed = wavelength × frequency

1.12 – EM Spectrum

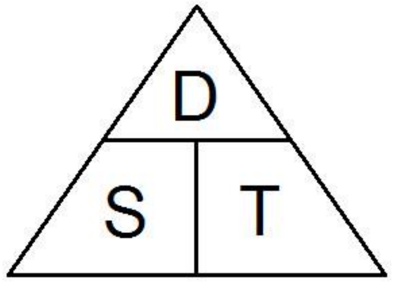
Electromagnetic radiation	Uses	Energy	Frequency	Wavelength
Radio waves 	Broadcasting and communications – their longer wavelength means they travel further in the Earth's atmosphere, reflecting off hills and the upper atmosphere.	Lowest	Lowest	Longest
Microwaves 	Cooking food – microwaves are absorbed by water molecules causing them to vibrate (heat up). Satellite transmissions – their wavelength penetrates our atmosphere.			
Infrared 	Heater and night vision equipment – all objects, including people, give out infrared rays which can be detected even at night. It's also used for television remote controls.			
Visible light 	Human vision, photography and optical fibres – it's the only part of the spectrum we can see.			
Ultraviolet 	Fluorescent lamps – they have chemicals inside them which absorb ultraviolet rays and convert the energy to visible light.			
X-rays 	Medical equipment – they enable us to see the internal structure of objects and materials by passing through some substances (eg body tissue) but being absorbed by others (eg bone).			
Gamma rays 	Sterilising food and medical equipment – they are highly penetrative and can kill. micro-organisms.	Highest	Highest	Shortest

GCSE Science – Physics 2

2.1 – Speed

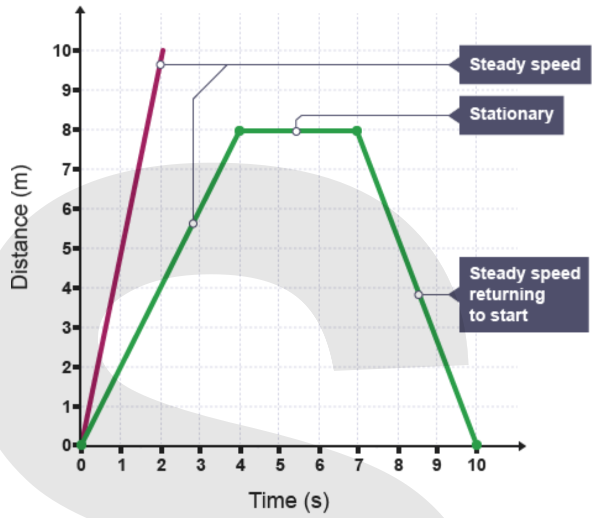
When an object moves in a straight line at a steady speed, you can calculate its average speed if you know how far it travels and how long it takes. The following equation shows the relationship between average speed, distance moved and time taken.

$$\text{average speed} = \frac{\text{distance moved}}{\text{time taken}}$$



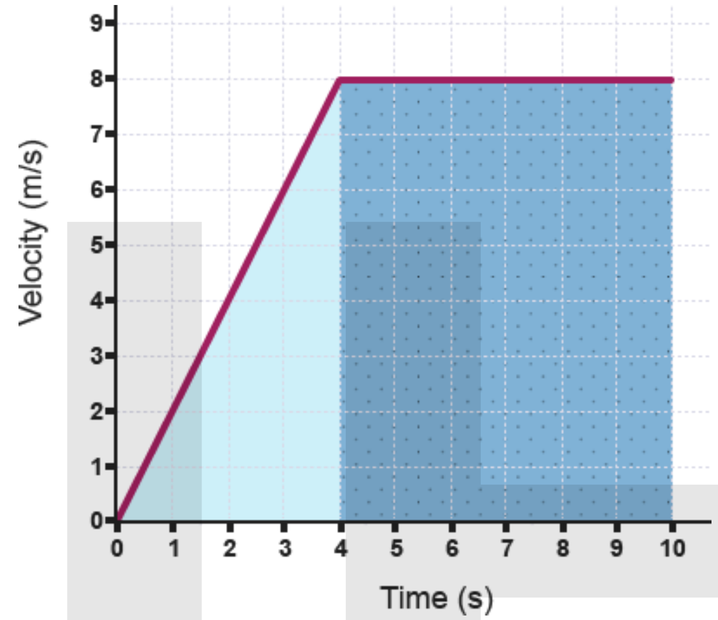
Speed time graph

Note that the steeper the line, the faster the object is travelling. The purple line is steeper than the green line because the purple line represents an object which is moving more quickly



2.2 – Velocity

The **velocity** of an object is **its speed in a particular direction**. Two cars travelling at the same speed but in opposite directions have different velocities.
When an object is moving with a constant velocity, the line on the graph is horizontal. When the horizontal line is at zero velocity, the object is at rest. When an object is undergoing constant **acceleration**, the line on the graph is straight but sloped.



2.3 – Newtons first law

Newton's First Law states that a body will continue in its state of rest or **uniform motion**, in a straight line unless a net or **resultant force** acts upon it.
This simply means that balanced forces will have no effect on the motion of an object.

- It could be still.
- It could be moving at constant velocity (a steady speed in a straight line).
- It could be hovering or floating

Newton's Second Law

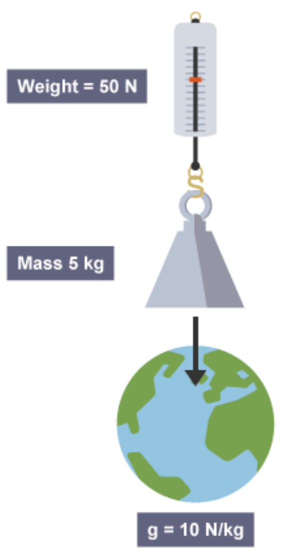
When the forces acting on an object do not balance, the **resultant force** will cause the object to **accelerate** in the direction of the resultant force.

Resultant force and acceleration are **directly proportional**. If the resultant force doubles, the acceleration of the vehicle also doubles if the mass of the vehicle is the same.

2.4 – Weight and mass

Mass is the amount of matter in an object. Mass is measured in **kilograms** (kg).

Weight is the force of gravity on your mass. **Gravity** is a force that attracts mass together.



On Earth, the gravitational field strength (g) is 10 N/kg which means that the mass of the Earth attracts every 1 kilogram mass with a weight force of 10 Newtons. Therefore, 1 kg mass has a weight on Earth of 10 N and a 5 kg mass will weigh 50 N.

$$\text{weight (N)} = \text{mass (kg)} \times \text{gravitational field strength (N/kg)}$$

2.5 – Work done

Work is done when a force acts on a moving body. Work is done whenever a force moves something.
Whenever work is done, energy is transferred from one place to another. The total amount of energy remains constant.

$$\text{Work done} = \text{Force} \times \text{Distance}$$

W is measured in joules, J
F is measured in newtons, N
d is measured in metres, m

So in the example above 10N of force is applied over 2m.

Work done = Force x Distance

Work done = 10 x 2 = 20J

2.6 – Car safety

When there is a car crash, the car, its contents and the passengers **decelerate** rapidly. They experience great **forces** because of the change in **momentum**, which can cause injuries. Modern cars have safety features that absorb **kinetic energy** in collisions.

Seat belts

Seat belts stop you tumbling around inside the car if there is a collision. However, they are designed to stretch a bit in a collision. This increases the time taken for the body's momentum to reach zero, and so reduces the forces on it.

Airbags

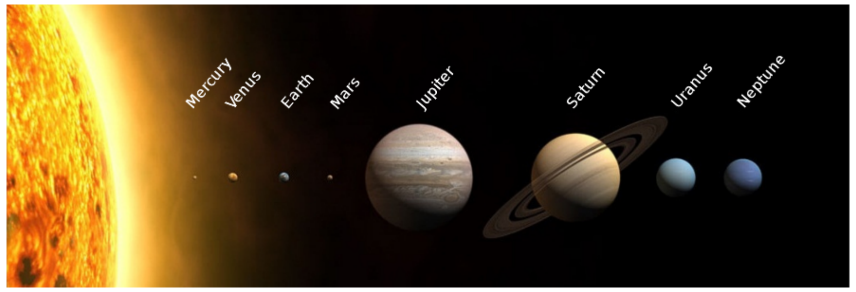
Airbags increase the time taken for the head's momentum to reach zero, and so reduce the forces on it. They also act as a soft cushion and prevent cuts.

Crumple zones

Crumple zones are areas of a vehicle that are designed to crush in a controlled way in a collision. They increase the time taken to change the momentum of the driver and passengers in a crash, which reduces the force involved.

GCSE Science – Physics 2

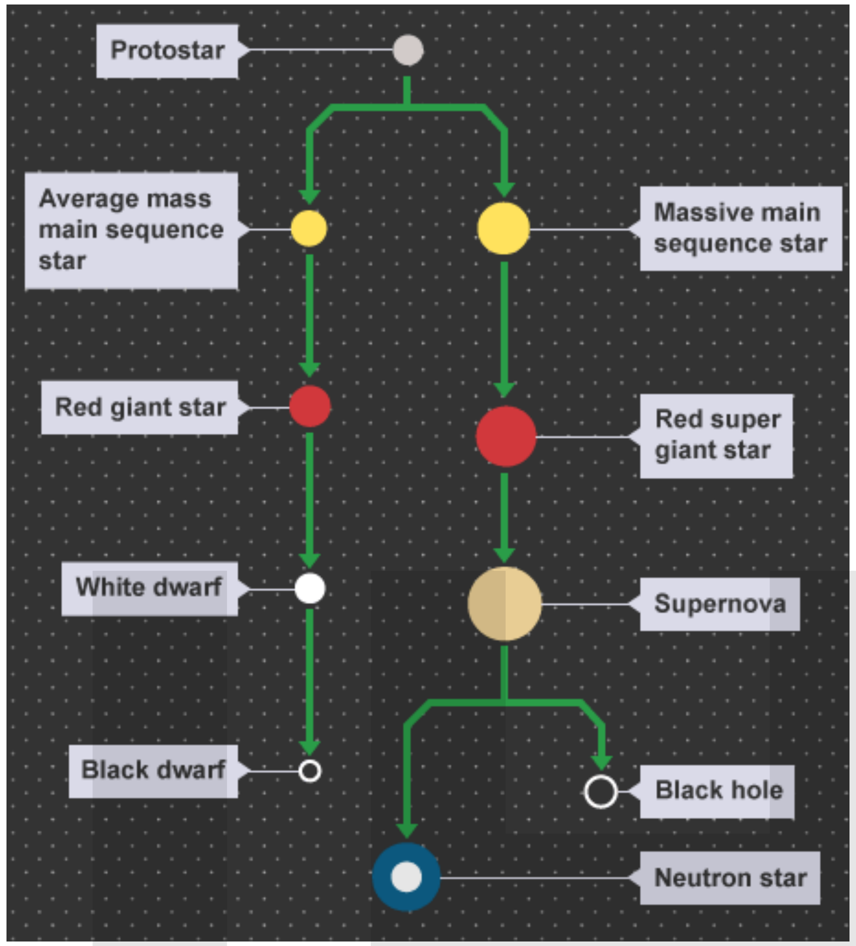
2.7 – Solar system



The Sun is our nearest **star**. The planets **orbit** the Sun.
The time taken to orbit the Sun **increases with distance** from the Sun.
Gravity keeps the planets in orbit around the Sun and the moons in orbit around their planets.
The **planets** go around the Sun in slightly squashed circular **elliptical orbits**.
Pluto is classified as a **dwarf planet** or planetoid. It has a highly elliptical or **eccentric orbit**.

Comets are balls of rock and ice. The ice melts as the comet gets closer to the Sun, producing its 'tail'. They have highly elliptical or eccentric orbits.	**Asteroids** are large rocks that are mainly found in a belt between Mars and Jupiter. A dwarf planet called Ceres can be found in this asteroid belt. The rocks in the asteroid belt may be remnants of a planet that failed to form due to the strong gravitational attraction of Jupiter.

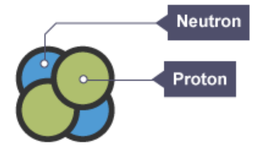
2.8 – Life cycle of a star



2.9 – Radioactive emissions

There are three main types of **ionising radiation** emitted from the unstable **nuclei** of **radioactive atoms**. These are alpha, beta and gamma radiation.

- Alpha radiation consists of **alpha particles**. An alpha particle has two **protons and** two **neutrons**.



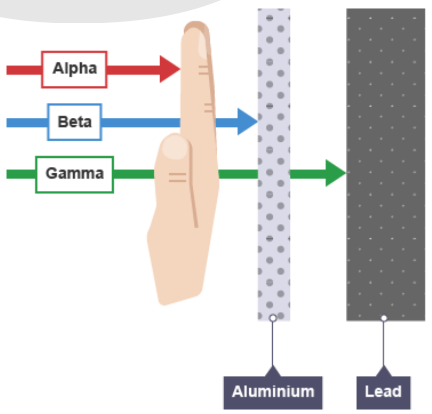
- **Beta radiation** consists of high-energy **electrons** emitted from the nucleus. These electrons have not come from the electron shells or energy levels around the nucleus. Instead, they form when a neutron splits into a proton and an electron. The electron then shoots out of the nucleus at high speed, leaving the new proton behind in the nucleus.
- Gamma **radiation** is very short **wavelength**, high **frequency electromagnetic radiation**. This is similar to other types of electromagnetic radiation, such as visible light and X-rays, which can travel long distances.

2.10 – Properties of radiation

Alpha radiation
Alpha radiation is the least penetrating. It can be stopped (or absorbed) by a human hand.

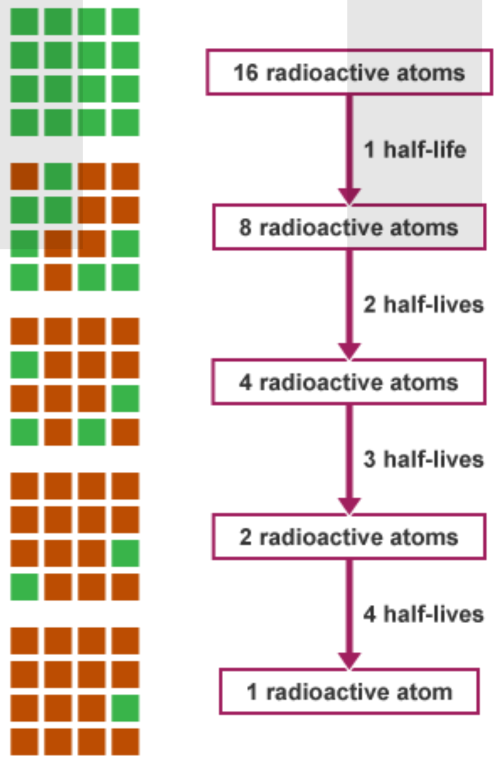
Beta radiation
Beta radiation can penetrate air and paper. It can be stopped by a thin sheet of aluminium.

Gamma radiation
Gamma radiation is the most penetrating. Even small levels can penetrate air, paper or thin metal. Higher levels can only be stopped by many centimetres of lead or many metres of concrete.



2.11 – Half life

When an **unstable nucleus** gives out an alpha or beta particle, the nucleus turns into the nucleus of a new element. This process is called **radioactive decay**.
Although radioactive decay is a **random** process, statistically, over a time called the **half-life**, half of the parent radioactive nuclei will have decayed.



In this decay model, the green squares represent the parent unstable nuclei. They decay into the red squares – the **daughter nuclei**.
The process is random. You can't tell when a green will turn into a red, or which green will decay, but after every half-life, half of the green parents will have decayed into red daughters.

6 – Uses of radiation

Sterilizing medical instruments and prolonging the life of fruit
Gamma radiation kills microbes and can be used to sterilize medical instruments and kill the bacteria on fruit and vegetables so they stay fresh longer.

Smoke alarms
An isotope of americium which emits **alpha particles** is used in smoke alarms. Alpha radiation **ionises** the air and this allows a small current to flow between two electrodes. Alpha is weakly penetrating so smoke stops it, the current drops and the alarm goes off.

Blood and fluid tracers
A tracer is something that shows how an object moves. **Radioactive tracers** are added to liquids to show if they are flowing correctly. They can show the movement of pollution, eg sewage or waste oil from factories. However, they are used mainly in medicine to monitor blood flow.