Revise this well

AQA Physics P2.1-2.2 – Force and motion

P2

GCSE Additional Science

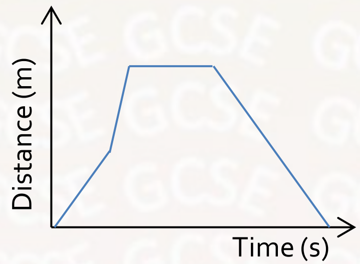
Speed (m/s) = distance (m)/time (s)

Distance-time graph:
gradient of the line = **speed**

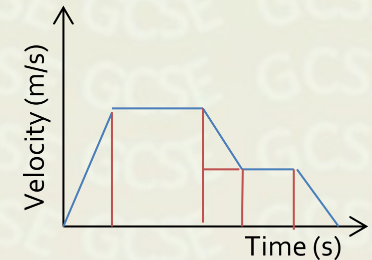
Line sloping <u>upwards</u> = object is moving <u>away</u> from starting point

Line sloping <u>downwards</u> = object is moving <u>back</u> to starting point

<u>Flat</u> line = object has <u>stopped</u>



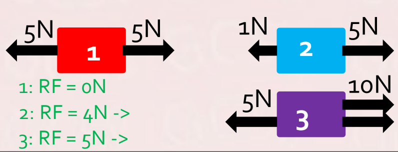
Velocity
This is an object's speed in a given direction (fwd, bkw, down, up)
Velocity-time graph: gradient of the line = **acceleration** (m/s^2) = change in velocity (m/s) / time (s)
Line sloping <u>upwards</u> = object is <u>accelerating</u>
Line sloping <u>downwards</u> = object is <u>decelerating</u>
<u>Flat</u> line = <u>constant velocity</u>
<u>Area</u> underneath the graph = <u>distance</u> travelled



Resultant force (RF)

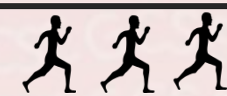
Two objects that interact with each other, exert <u>equal and opposite forces</u> on each other. For example, when a gun is fired, the bullet experiences a forward force from the gun. At the same time the bullet exerts a backwards force on the gun. As a result, the gun recoils.

There are many forces acting on an object. The force that has the same effect as all the forces acting on the object is called the **resultant force**:



When a resultant force acts on an object, it may cause a change in the object's state of rest or motion.

If the <u>RF is zero</u> and the object is <u>stationary</u>, the object will <u>remain stationary</u>.



If the <u>RF is zero</u> and the object is <u>moving</u>, it will <u>continue moving</u> at the <u>same</u> speed in the same direction.

If the <u>RF is not zero</u>, the object will <u>accelerate</u> in the direction of the RF.
The acceleration depends on the force and the mass of the object. If the force is large, so is the acceleration. If the mass is large, the acceleration is small:
force= mass x acceleration.

Distance-time graph video	Velocity-time graph video	Using velocity-time graphs video	Acceleration video	RF video	Exam questions	Exam answers

Revise this well

AQA Physics P2.2a – Braking forces

P2

Additional Science

A car that travels at a constant speed has equal and opposite forces acting on it: <u>forward thrust</u> from the engine (driving force) and <u>drag (air resistance and friction)</u>.
When a car moves along the motorway with the driver trying to overtake another vehicle, the acceleration of the car decreases although the push of the engine remains constant. This is due to the fact that, as speed increases, air resistance and friction also increase, reducing the resultant force and therefore the acceleration.

Resistive forces (air resistance/friction)

Driving force

Stopping a vehicle

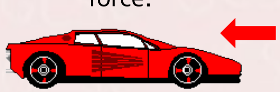
The greater the speed of a vehicle, the greater the <u>braking force</u> needed to stop the vehicle in a certain distance.

When a driver sees a hazard, the vehicle will continue travelling a certain distance before the driver reacts and applies the brakes. The reaction time of the driver depends on whether the driver is <u>tired</u>, <u>distracted</u>, has <u>drunk</u> alcohol or taken <u>drugs</u>. The distance the vehicle travels during this time is called the **thinking distance**.

Once the brakes have been applied, the car continues to travel forwards. This is called the **braking distance**. It is affected by <u>road, brake and tyre conditions</u> as well as the <u>mass</u> of the vehicle.

Top speeds

As the car is <u>more streamlined</u>, it will reach a <u>higher speed</u> than the lorry as its <u>resistive force is smaller</u>. Therefore it will take a higher speed before driving force = resistive force.



<u>Not streamlined</u>, so <u>large resistive force</u> (air resistance and drag). Driving force = resistive force reached at low speeds.

Energy transfer

When a driver applies the brakes, <u>work</u> is done by the friction force between the brakes and the wheel. Kinetic energy is reduced and transferred to thermal energy. The brakes become hot.

Hybrid cars are fitted with a **regenerative braking system.** The car is slowed down by putting the <u>motor in reverse</u>. This slows the wheels down. As the car is slowed down, the car <u>battery is recharged</u>. This means work is done to <u>convert kinetic energy to electrical and chemical energy.</u>

Resultant Forces video	Braking forces video	Exam questions	Exam answers

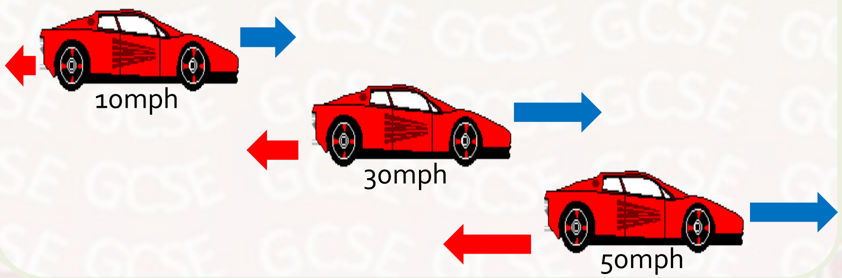
Additional Science

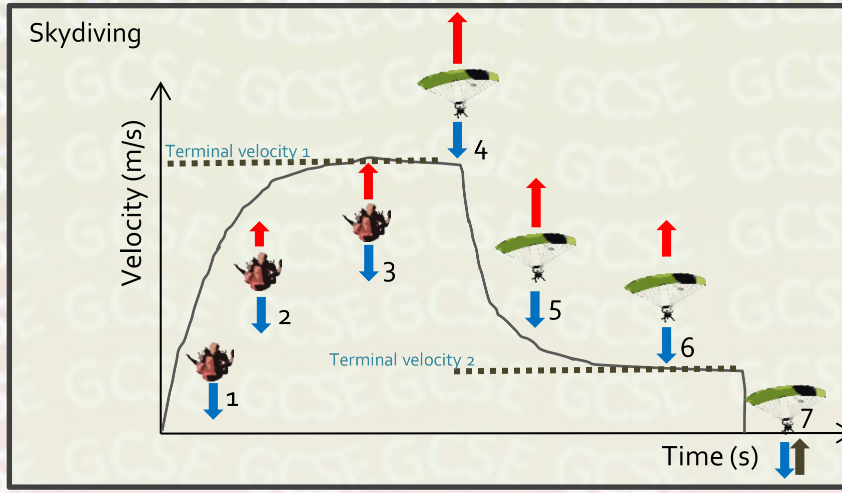
Revise this well

AQA Physics P2.2b – Terminal velocity

P2

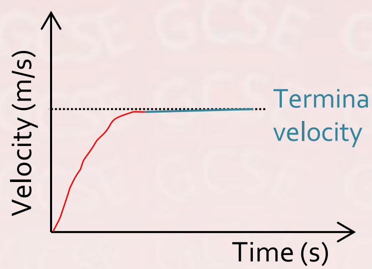
As mentioned on the slide 'Forces and motion', as the speed of a vehicle increases, the size of the resistive forces also increases. Eventually, both will be equal in size. The resultant force will equal zero, and the vehicle is moving at a constant speed called **terminal velocity**.





Terminal velocity graph

Where the line levels out, terminal velocity has been reached.



Terminal velocity video	Exam questions	Exam answers

Sky diving description

1: When the skydiver jumps out of the plane, the only force acting on the skydiver is weight [Weight (N) = mass (kg) x gravitational field strength (N/kg)]. The skydiver accelerates downwards.

2: As the speed increases, so does air resistance. As weight is larger than air resistance, the skydiver accelerates downwards.

3: Eventually, weight and air resistance are equal; terminal velocity is reached. (RF=0)

4: when the parachute is opened, the surface area increases which means air resistance increases. As air resistance is now greater than weight; the velocity decreases.

5: However, as velocity decreases, so does air resistance.

6: Eventually, weight and air resistance are equal again, and a new, lower terminal velocity is reached. (RF=0)

7: When the skydiver lands on the ground, weight and the push of the ground are equal.

Revise this well

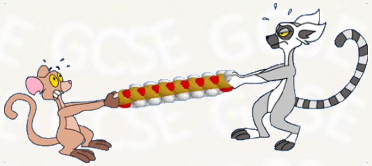
AQA Physics P2.2c – Forces and elasticity

P2

GCSE

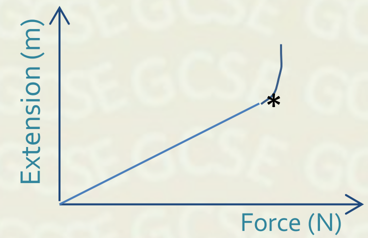
Additional Science

If a <u>force</u> is <u>acting</u> on an object, the <u>shape</u> of the object is most likely going to be <u>changed</u>.



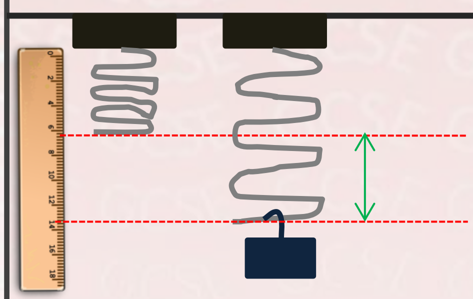
When a force is applied to an **elastic** object, such as a spring or rubber band, work is done to change the shape of the object. The <u>work done is stored as elastic potential energy</u> which can be converted to other useful types of energy while the objects return back to their original shape:

When an object, such as a spring or elastic band, is stretched, the <u>**extension** of the object is **directly proportional to** the **force** applied</u> (**Hooke's law**). <u>Directly proportional</u> means that if the results are plotted on a graph, the line is a straight line that goes through the origin.



*Once the **limit of proportionality** has been reached, the relationship is no longer directly proportional. Beyond the 'limit of proportionality', the object is no longer able to return to its original shape.

The experiment to determine the limit of proportionality



1. Measure the length of the unstretched spring
2. Attach the first weight and measure the extension of the spring.
3. Repeat with further weights until the limit of proportionality is reached.

Hooke's law

If an object's extension is directly proportional to the force applied, the object obeys Hooke's law. The law can be mathematically expressed as:

Force (N) = extension (m) x spring constant (N/m)

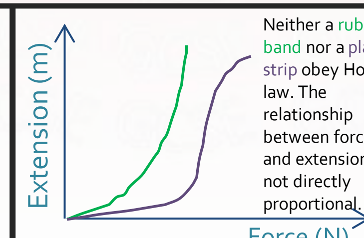
Many objects obey Hooke's law up to a point: the limit of proportionality.
Elastic bands and plastic bag strips have a low limit of proportionality. Metal springs have a high limit of proportionality.

Hooke's law video

Exam questions

Exam answers

Elastic potential energy can be converted to kinetic energy to make an object move (as in a wind-up toy or jack-in-the-box). Some of the energy makes the atoms inside the object vibrate and this causes the object to become warmer.



Neither a rubber band nor a plastic strip obey Hooke's law. The relationship between force and extension is not directly proportional.

Revise this well

AQA Physics P2.3a – Forces and energy

P2

Additional Science

When a force is applied to an object to make it move a distance, **work** is done. The relationship between work, force and distance is described in the equation: **Work (J) = Force (N) x distance (m).**
Power is the amount of work done (or energy transferred) per unit time.

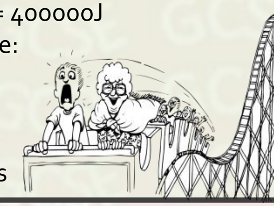
When work is done, energy is transferred. In most cases, work is done against friction or gravity.
Dragging a box up a ramp is easier than lifting it directly. Less force is needed as using the ramp increases the distance, so the force is reduced. Work is done against a fraction of gravity, not the direct force.

Rollercoaster rides- what is the speed at the bottom of the slide?

At the top of the rollercoaster, the carriage and the passengers have GPE. As the carriage travels downwards, the GPE is transferred to KE.

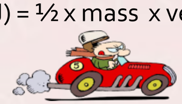
Example: the highest point of the rollercoaster slide is 50m. The carriage and passengers have a combined mass of 800kg. With what velocity will the carriage arrive at the bottom of the slide?

GPE = mass x height x g = 800kg x 50m x 10N/kg = 400000J
GPE is transferred to KE at the bottom of the slide:
KE = 400000J
KE = ½ x mass x velocity 2 =>
400000 J= ½ x 800 kg x velocity^2
Velocity^2 = 800000/800 = 1000; velocity = 31.6m/s



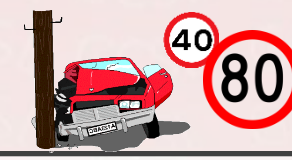
Gravitational potential energy and kinetic energy

The position of an object in a gravitational field determines how much gravitational potential energy it has.	How much kinetic energy an object has depends on its mass and its speed.
GPE (J) = mass x height x gravitational field strength	KE (J) = ½ x mass x velocity^2



Speeding

Sticking to the speed limit is important. If the speed of a car doubles, the amount of energy transferred during a collision quadruples. In the KE formula, velocity is squared. This means that the KE increases by a factor of 4 (2^2) if the velocity increases by a factor of 2. If the mass of the vehicle doubles, so does the KE.



KE & GPE video	Work & Power video	Exam questions	Exam answers

Additional Science

Revise this well

AQA Physics P2.3b – Momentum

P2

All moving objects have **momentum**. Momentum (p) is proportional to mass and velocity and defined as:

Momentum (kg m/s) = mass (kg) x velocity(m/s)

Because velocity has a direction, momentum has a direction.

Example 1: How much momentum does a car have when it stops at a zebra crossing? Zero, as the velocity will be zero.

Example 2: A ball of mass 200g is thrown and travels at a velocity of 30m/s. What is the momentum? 0.2kg x 30m/s = 6kg m/s

Momentum and collisions

When a collision or explosion happens in a **closed system** (meaning that there are no external forces acting), momentum is conserved. This means that the total momentum before the event is equal to the total momentum after the event.

Example: Skater 1  has a mass of 70kg and travels at 2m/s towards skater 2  who has a mass of 48kg and travels at 3m/s towards skater 1.
At what velocity do the two skaters move after the collision?

Momentum of skater 1= 70kg x 2m/s = 140kg m/s;
Momentum of skater 2 = 48kg x 3m/s = 144kg m/s;
Total momentum before = 284kg m/s = total momentum after.

Total momentum after = (mass of both skaters) x velocity

Velocity = total momentum after / mass of both skaters = 284kg /118 = 2.4m/s

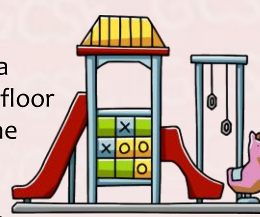
Car safety features

There are four main safety features in cars: **air bags, seat belts, crumple zones and side impact bars.**

Their purpose is to ensure that during a crash the time taken to stop the car and bodies inside the car increases. This in turn decreases the rate of change in momentum (it increases the time taken for momentum to reach zero). As a result the force on the car and people is reduced, as is the risk of injury.

Playground safety

Most new playgrounds have rubber flooring.
The purpose is the same as that of airbags, seatbelts, side impact bars and crumple zones. If a child falls off the swing, it will land on the rubber floor which makes the child slow down and increase the time taken for the momentum to reach zero.
This meant that the force exerted by the floor on the child is less and the risk of injury is reduced.



Momentum video

Impact forces video

Exam questions

Exam answers

Revise this well

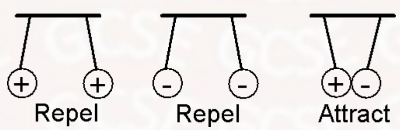
AQA Physics P2.4a – Static electricity

P2

Additional Science

When you <u>rub</u> two insulating materials against each other, they will become charged as the <u>electrons</u> from one material are <u>transferred</u> to the other material. The material that has lost the electrons becomes positively charged whereas the material that gained the electrons, becomes negatively charged.

Two objects that are charged, exert a force on each other. Depending on the charge of the objects, they either <u>repel or attract:</u>



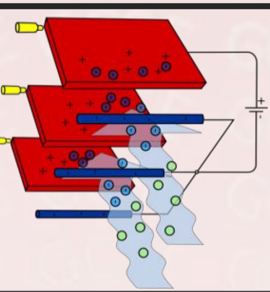
Making use of static electricity

Spray painting: Each paint droplet is given the same charge. This makes the droplets repel and produce a fine spray for an even cover. The object to be painted is given the opposite charge so the paint is attracted to it.

Van der Graaf generator:
Why does your hair begin to rise ? Each individual hair becomes negatively charged. As like charges repel, the hairs begin to rise to be as far away from each other as possible.

Chimney cleaning

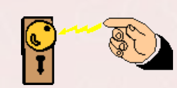
Smoke particles rise up the chimney and pick up a negative charge as they pass through a negatively charged grid (here in blue). The now negatively charged smoke particles are attracted to some positively charged plates within the chimney (here in red) where they become stuck until they are knocked off and removed when the chimney is cleaned.



Dangers of static electricity

The more charge is put on an object, the higher the voltage is between the object and earth.

When you walk across a nylon carpet, you become charged as the soles of your shoes rub against the carpet. When you then touch a metal door handle or another person, you feel a 'shock'. Electrons jump from your body to the door handle or other person- if you look carefully you can see the electrons jumping (spark).



When planes are refuelled, the fuel rubs against the fuel pipe and becomes charged. Fuel is flammable, and it would be dangerous if there was a spark. For that reason, the plane and the fuel tanker are connected by a copper wire to prevent the fuel from becoming charged by friction (this is called <u>earthing</u>).

Static electricity video

Exam questions

Exam answers

AQA Physics P2.4b – Circuits and Resistance I

Revise this well

GCSE Additional Science

P2

1. An electric current is the flow of **charge**. The size of a current depends on how much charge flows per unit time:
Current I (amperes) = Charge Q (Coulombs) / time t (seconds); I = Q/t

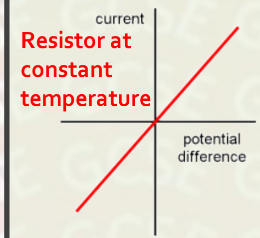
2. An electric current transfers energy E. **Power** is a measure of how much energy is transferred per unit time, **P=E/t.**

3. The potential difference, or voltage V, between two points is the **work** done W (or energy transferred E) per coulomb of charge that passes between the two points, **E= V x Q or W = V x Q**

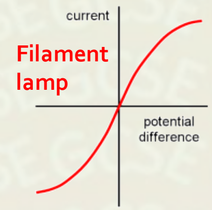
4. You can see that all three formulae are linked via E or Q. Hence you can substitute E and Q in equations 2 and 3 and find that **P= I x V** as well.

Resistance R (measured in ohms Ω)

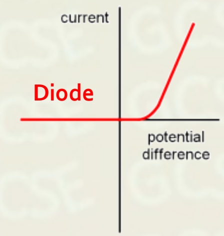
When electrons pass through a conductor, they collide with the vibrating ions inside the conductor. This is known as resistance and physically defined as **Resistance R (ohms) = Voltage / Current**. The greater the resistance, the smaller the current for a given voltage. From a voltage-current graph, the resistance can be worked out by calculating the gradient of the line:



Resistance remains constant

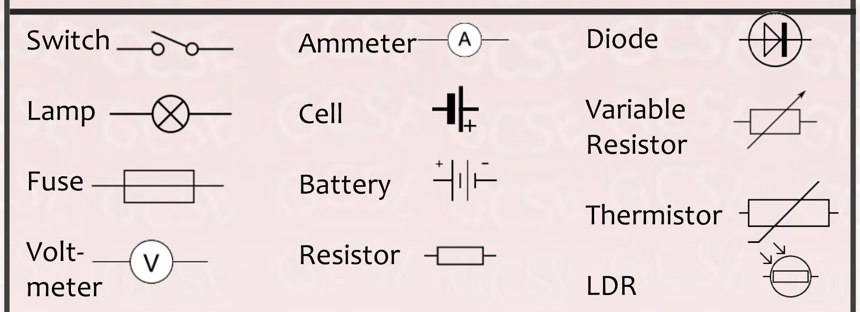


As the bulb gets hotter, resistance increases



Very high resistance in reverse direction

Circuit symbols



An **LED** (light emitting diode) emits light when a current flows through it in the forward direction.

For an **LDR** (light dependent resistor) the resistance decreases as light intensity increases which means the current increases. LDRs are used in street lamps.

For a **thermistor**, the resistance decreases as the temperature increases. Thermistors are used in fire alarms. If there is a fire, the resistance of the thermistor falls; the current increases and an alarm sounds.

All three are **non-ohmic** types of resistors as the resistance is not constant at a constant temperature. They do no obey **Ohm's law** (the current through a resistor at constant temperature is directly proportional to the voltage across the resistor.).

Electric circuits video | Voltage and current video | Resistance video | LED, LDR, thermistor | Lamp and diode video | E=VxQ video | Exam questions | Exam answers

Revise this well

AQA Physics P2.4b – Circuits and Resistance II

P2

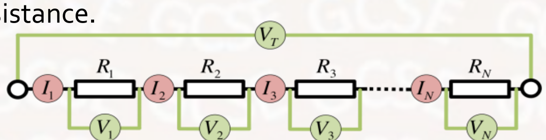
GCSE

Additional Science

Voltage (potential difference) and current in a series circuit

The current is the same in all places and through all components.

The potential difference supplied by the cell or battery is shared between the different components of the circuits and depends on each component's resistance.



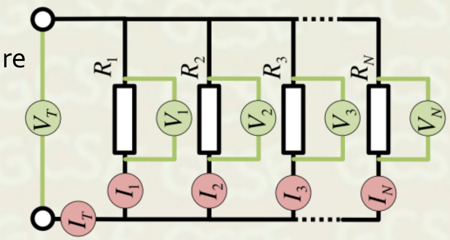
If V total = 12V, and the current is 2A everywhere, V1,V2,V3 and V_N all equal 3V provided they all have the same resistance (assuming N = 4)

Voltage and current in a parallel circuit

The potential difference across each component in a parallel circuit is the same.
The current is not; the total current is the sum of the currents through each component of the circuit.

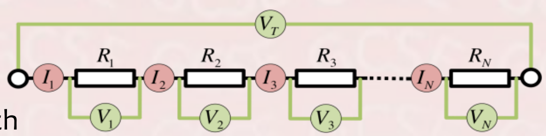
If V_T is 12V, all other V values are also 12V.

If the resistances are all equal, and if I_T is 4A, I1, I2, I3 and I_N will all be 1A (if N=4)



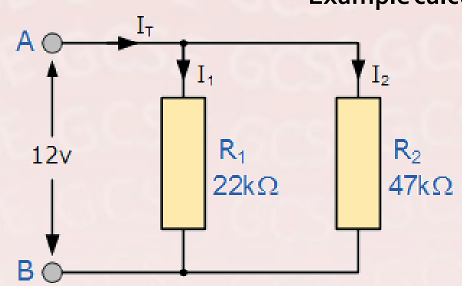
Resistance in a series circuit

In a series circuit, the total resistance is the sum of the resistance of each component.



If the current is 3A, and the voltage of each component is 3V, each component has a resistance of R = V/I = 3/3 = 1Ω.
If there are 4 resistors, the total resistance will equal 4Ω.

Example calculation



R1 = 22000 Ω, V1 = 12V;
I1 = V1 / R1 = 12/22000 = 0.00055A

R2 = 47000 Ω; V2 = 12V;
I2 = V2/R2 = 12/470000 = 0.00026A
I_T = 0.00055 + 0.00026 = 0.0008A

Series & parallel circuits video

Current & Heat video (comparing bulbs)

Exam questions

Exam answers

Revise this well

AQA Physics P2 .5– Household electricity

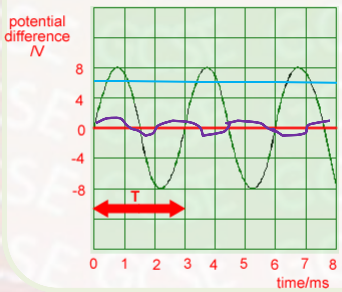
P2

GCSE

Additional Science

Current that flows in one direction is called **direct current (d.c.).** This type of current is provided by cells and batteries.

Current that changes direction is called **alternating current (a.c.).** UK mains electricity supplies and a.c. current at a frequency of 50Hz (there are 50 changes per second) and a voltage of 230V.



An oscilloscope can display d.c. current (blue) or a.c. current (live wire: green; neutral wire: purple). The amplitude of the wave is the maximum voltage supplied. The x axis represents the time T taken for one cycle.

Frequency is calculated the following way:

Frequency (Hz) = 1/time per cycle (seconds)

Fuses and Residual current circuit breakers (RCCBs)

If the current is too large, the fuse blows (the wire inside the fuse melts) which breaks the circuit. Fuses come in sizes of 1A, 3A, 5A, 13A. If the fuse rating is too low, the fuse melts before the appliance can work. If the fuse is too high, too much current might flow and the appliance might catch fire.

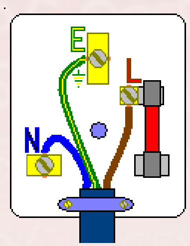
To calculate the <u>size of fuse</u> needed:

Current (through appliance) =Power rating of appliance/voltage (usually 230V).

Select a fuse that is one rating higher than the answer. (if answer is 1A, pick a 3A fuse.)

<u>RCCBs</u> break a circuit much <u>faster</u> than fuses (it only takes 0.05s) and they can be <u>reset</u> once the fault has been repaired.

3-pin plug and cables



Plastic casing and plastic cable for insulation to prevent shock
Fuse in series with live wire.
Insulated live wire (brown)
Insulated neutral wire (blue)
Insulated Earth wire (green and yellow)- needed only if the appliance has a metal casing. If the live wire is accidentally connected to the metal casing, the current will flow to earth and the fuse will melt.
Cable grip to hold the cable in place

Safety first

You should not touch any electrical appliances that are switched on while your skin is wet. You are more likely to receive an electrical shock <u>as wet skin has a lower resistance than dry skin.</u>

When wiring a plug, the following mistakes are common:
Selecting the wrong fuse rating
Connecting the wires to the wrong pins
Not securing the cable
Having too much bare wire exposed.

Calculating power video

AC/DC video

Plugs and cables video

Fuses & RCCBs video

Fuse ratings video

Exam questions

Exam answers

Revise this well

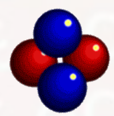
AQA Physics P2.6a – Radiation And Its Uses

P2

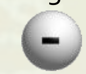
Additional Science

Atoms that give out alpha, beta or gamma radiation from their nuclei are called **radioactive**.

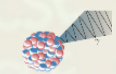
Alpha radiation is made of **helium nuclei**. The symbol is ${}^{4}_{2}\alpha$. An alpha particle is **absorbed by paper** and its **range** in air is about 5cm. It is **deflected** by an electric and magnetic field because of its 2+ charge. As it is the **most ionising** type of radiation, it is most dangerous if ingested. Ionising means that it is able to **knock electrons off other atoms**.



When a neutron changes into a proton and electron, the electron is lost as **beta radiation**. The **mass** is almost 0, the **charge** 1- and the range in air about 1 m. Beta radiation is stopped by a few mm of **aluminium**. It is also deflected in an electric and magnetic field. It is **less ionising than alpha radiation.**



Gamma (δ) radiation is an **electromagnetic wave.** It does not have a charge or mass and it travels further than both alpha and beta radiation. It can only be **stopped by several meters of concrete or a thick sheet of lead.**



Nuclear equations show which particles are lost from the nucleus of a radioactive atom.

During alpha decay the **mass number goes down by 4, the atomic number by 2:**	During beta decay the **mass number remains unchanged** and the **atomic number increases by 1**:
${}^{228}_{90}\text{Th} \rightarrow {}^{224}_{88}\text{Ra} + {}^{4}_{2}\alpha$	${}^{40}_{19}\text{K} \rightarrow {}^{40}_{20}\text{Ca} + {}^{0}_{-1}\beta$

Alpha, beta and gamma radiation applications

When answering **exam questions** think about which type of radiation is most suitable (this depends on what material the type of radiation is stopped by).

Alpha radiation is used inside smoke detectors. 	Beta radiation is used as a tracer to find leaks in water pipes or leaks in blood vessels. It can also be used to monitor the thickness of metal sheets.	Gamma radiation is used to sterilise medical equipment or food and destroy cancer cells during radiotherapy.

Features of alpha, beta and gamma video

Dangers and uses of radiation video

Decay equations video

Exam questions

Exam answers

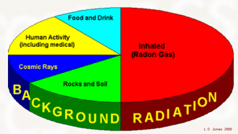
Revise this well

AQA Physics P2.6b – Radiation And Its Uses

P2

GCSE Additional Science

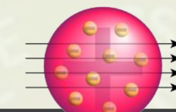
Substances that are radioactive give out radiation from the nuclei of their atoms all the time.

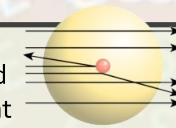


As a result there is **background radiation** around us. Most of it comes from **natural sources** such as **radon gas** released from **rocks, soil and building materials**. Other natural sources are food and **cosmic rays** (which you are more exposed to if you are flying frequently). **Man-made sources** of background radiation are **nuclear power stations**, fallout from **nuclear weapons testing** and exposure to **medical** procedures (e.g. X-rays).

Plum pudding model

Early scientists imagined that the structure of the atom was similar to that of a plum pudding: **positively charged matter** was making up the pudding **base** and the **electrons** were **embedded** into the positive matter like plums in the pudding base.



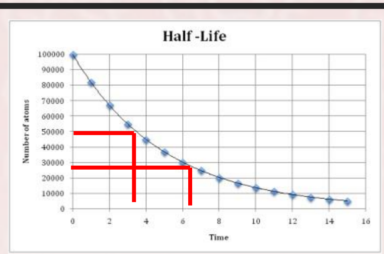


Rutherford's gold foil experiment

A scientist called Rutherford fired alpha particles at gold foil. He noticed that most alpha particles passed straight through, some were deflected or reflected. He concluded that the atom is mainly made of **empty space** with a **small positively charged nucleus** where **most of the mass** of the atom is located.

Half-life: the average time taken for the count rate of a sample to halve (time taken for half the nuclei in a sample to decay)

Radioactive decay is random. Each radioactive material has a unique half-life which does not change. You can use a graph to calculate the half-life as shown here →

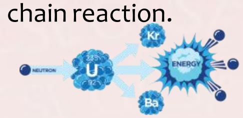


Nuclear fission: a large **nucleus splits** into two or more fragments. It occurs inside nuclear power stations where uranium-235 or plutonium-239 are split to release large amounts of energy.

Step 1: The U-235/Pu-239 nucleus absorbs a neutron.

Step 2: the U-235/Pu-239 nucleus splits into two. 2-3 neutrons and energy is released.

Step 3: The neutrons released go on to split other U-235/Pu-239 nuclei and start a chain reaction.



The energy released is used to heat water and produce steam which drives a turbine connected to a generator which produces electricity.

Isotopes video

Background radiation video

Plum pudding video

Half lives video

Fission video

Exam questions

Exam answers

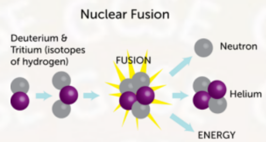
Revise this well

AQA Physics P2.7 – Nuclear Fusion & Stars

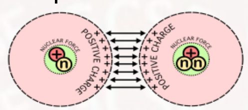
P2

GCSE Additional Science

During nuclear fusion two **small nuclei (usually hydrogen) join together** to form a larger nucleus. This process releases large amounts of **energy** and drives stars like our Sun.



For nuclear fusion to occur very high temperatures and pressures are needed to overcame the repulsion between the positive nuclei.



Nuclear fusion reactor pros:
Scientists are trying to build fusion reactors as an alternative to fission reactors and fossil fuel power stations. Nuclear fusion reactors would be **safer and cleaner** as **no radioactive waste** would be produced and there would be **no CO_2 emissions**. Huge amounts of **energy** would be released.

Nuclear fusion reactor cons:
It is at the moment too **expensive and difficult** to provide the high temperatures and pressures needed to start fusion. The **walls** of the fusion reactor would need to be able to withstand such high temperatures and at the moment such a material does not exist. To contain the hydrogen nuclei a large **magnetic field** is needed which is very expensive and difficult to achieve.

Life cycle of a small to medium sized star (similar to our Sun)

Dust and gas from space are pulled together by gravity. Friction produces heat and hydrogen nuclei fuse. A star is born. It enters the main sequence stage and remains stable for millions of years as the inward force of gravity is balanced by the outward force of radiation pressure. When the star runs out of hydrogen fuel, fusion slows down. The temperature decreases and the star expands and forms a red giant. Helium and other lighter elements fuse to form heavier elements. Eventually the inner core collapses, heats up and forms a white dwarf. As no more fusion occurs, the white dwarf fades out, goes cold and becomes a black dwarf.

Life cycle of a large star (larger than our Sun)

When these stars run out of fuel, they form red supergiants. When a red supergiant collapses, the compression reverses suddenly and the star explodes as a supernova. During a supernova, heavier elements such as iron are formed. (Scientists believe that the Universe was made up of hydrogen and helium and that heavier elements were distributed throughout the Universe when early stars exploded). The core left behind forms a neutron star (a very dense star made up of only neutrons) or black hole if sufficient mass is left behind.

Fusion video	Life cycle of stars video	Exam questions	Exam answers