P1H

AQA GCSE Combined Science (9-1)

Topic 1: Energy

4.1.1 Energy changes in a system, and the ways energy is stored before and after such changes			
4.1.1.1 Energy stores and systems	☺	😐	☹
A **system** is an object or group of objects.			
There are **changes** in the way energy is **stored** when a system changes.			
For example: • an object projected upwards • a moving object hitting an obstacle • an object accelerated by a constant force • a vehicle slowing down • bringing water to a boil in an electric kettle.			
<u>Students should be able to:</u> ★ Describe all the changes involved in the way energy is stored when a system changes, for common situations (including the examples above).			
★ Throughout this Energy topic, calculate the changes in energy involved when a system is changed by: **heating, work done** by **forces, work done** when a **current flows.**			
★ Use calculations to show on a common scale how the overall energy in a system is redistributed when the system is changed.			
4.1.1.2 Changes in energy	☺	😐	☹
The **kinetic energy** of a **moving object** can be calculated using the equation: kinetic energy = 0.5 × mass × (speed)^2	$E_k = \frac{1}{2} m v^2$			
• kinetic energy, E_k, in joules, **J** • mass, *m*, in kilograms, **kg** • speed, *v*, in metres per second, **m/s**			
The amount of **elastic potential energy** stored in a **stretched spring** can be calculated using the equation: elastic potential energy = 0.5 × spring constant × (extension)^2	$E_e = \frac{1}{2} k e^2$ (assuming the limit of proportionality has not been exceeded)			
• elastic potential energy, E_e, in joules, **J** • spring constant, *k*, in newtons per metre, **N/m** • extension, *e*, in metres, **m**			
The amount of **gravitational potential energy** gained by an **object raised** above ground level can be calculated using the equation: gravitational potential energy = mass × gravitational field strength (g) × height	$E_p = m g h$			
• gravitational potential energy, E_p, in joules, **J** • mass, *m*, in kilograms, **kg** • gravitational field strength, *g*, in newtons per kilogram, **N/kg** (*In any calculation the value of the gravitational field strength (g) will be given*) • height, *h*, in metres, **m**			

<u>Students should be able to:</u> ★ Calculate the amount of energy associated with a **moving object**, a **stretched spring** and an **object raised** above ground level.			
★ **Recall** and apply the equation for **kinetic energy**			
★ Apply the equation for **elastic potential energy**, which is given on the **Physics equation sheet**			
★ **Recall** and apply the equation for **gravitational potential energy**			
4.1.1.3 Energy changes in systems	☺	😐	☹
The amount of energy stored in or released from a system as its **temperature changes** can be calculated using the equation: change in thermal energy = mass × specific heat capacity × temperature change | $\Delta E = m\ c\ \Delta\theta$			
• change in thermal energy, Δ*E*, in joules, **J** • mass, *m*, in kilograms, **kg** • specific heat capacity, *c*, in joules per kilogram per degree Celsius, **J/kg °C** • temperature change, Δθ, in degrees Celsius, **°C**			
The **specific heat capacity of a substance** is the amount of **energy** required to raise the **temperature** of **one kilogram** of the substance by **one degree Celsius**.			
<u>Students should be expected to:</u> ★ Apply the equation for **specific heat capacity**, which is given on the **Physics equation sheet**.			
REQUIRED PRACTICAL: Specific Heat Capacity. **AT 1 and 5.**			
4.1.1.4 Power	☺	😐	☹
Power is defined as the **rate** at which **energy is transferred** or the rate at which **work is done**.			
power = $\frac{\text{energy transferred}}{\text{time}}$ | $P = \frac{E}{t}$			
power = $\frac{\text{work done}}{\text{time}}$ | $P = \frac{W}{t}$			
• power, *P*, in watts, **W** • energy transferred, *E*, in joules, **J** • work done, *W*, in joules, **J** • time, *t*, in seconds, **s**			
An energy transfer of **1 joule per second** is equal to a power of **1 watt**.			
<u>Students should be able to:</u> ★ **Recall** and apply both of the equations for **power**.			
★ Give **examples** that illustrate the definition of power e.g. comparing two electric motors that both lift the same weight through the same height but one does it faster than the other.			
4.1.2 Conservation and dissipation of energy			
4.1.2.1 Energy transfers in a system	☺	😐	☹
Energy can be **transferred** usefully, stored or dissipated, but **cannot** be **created** or **destroyed**.			
Whenever there are energy transfers in a system only part of the energy is **usefully transferred**. The rest of the energy is **dissipated** so that it is stored in less useful ways. This energy is often described as being '**wasted**'.			
Unwanted energy transfers can be reduced in a number of ways, for example through **lubrication** and the use of **thermal insulation**.			

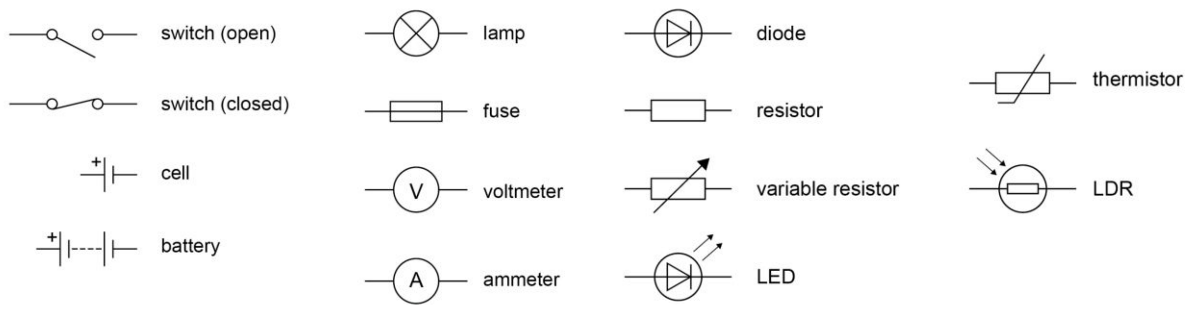
The higher the **thermal conductivity** of a material the higher the **rate of energy transfer** by conduction across the material.			
Students should be able to: ★ Describe, with examples, where there are energy transfers in a closed system, that there is no net change to the total energy.			
★ Describe, with examples, how in all system changes energy is dissipated, so that it is stored in less useful ways. The energy is often described as being 'wasted'.			
★ Explain ways of reducing unwanted energy transfers, for example, through lubrication and the use of thermal insulation.			
★ Describe how the rate of cooling of a building is affected by the thickness and thermal conductivity of its walls. *Students do not need to know the definition of thermal conductivity.*			
4.1.2.2 Efficiency	☺	😐	☹
The **energy efficiency** for any energy transfer can be calculated using the equation: $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$			
Efficiency may also be calculated using the equation: $\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$			
Students should be able to: ★ **Recall** and apply both equations for **efficiency**.			
★ Calculate or use efficiency values as a **decimal** or as a **percentage**.			
★ (HT only) Describe ways to **increase** the **efficiency** of an intended energy transfer.			
4.1.3 National and global energy resources			
The main **energy resources** available for use on Earth include: fossil fuels (coal, oil and gas), nuclear fuel, bio-fuel, wind, hydroelectricity, geothermal, the tides, the Sun and water waves.			
A **renewable energy** resource is one that is being (or can be) **replenished** as it is used.			
The uses of energy resources include: **transport**, **electricity generation** and **heating**.			
Students should be able to: ★ Describe the main energy sources available. *Descriptions of how energy resources are used to generate electricity are not required.*			
★ Distinguish between energy resources that are **renewable** and energy resources that are **non-renewable**.			
★ **Compare** ways that different energy resources are used, the **uses** to include transport, electricity generation and heating.			
★ Understand why some energy resources are more **reliable** than others.			
★ Describe the **environmental impact** arising from the use of different energy resources.			
★ Explain **patterns** and **trends** in the use of energy resources.			
★ Consider the **environmental issues** that may arise from the use of different energy resources.			
★ Show that science has the ability to identify **environmental issues** arising from the use of energy resources but not always the **power** to deal with the issues because of **political**, **social**, **ethical** or **economic** considerations.			

Topic 2: Electricity

4.2.1 Current, potential difference and resistance

4.2.1.1 Standard circuit diagram symbols

Circuit diagrams use standard symbols.



<u>Students should be able to:</u>

★ Draw and interpret **circuit diagrams**.

★ **Recall** all the circuit symbols shown above

4.2.1.2 Electrical charge and current

For **electrical charge** to flow through a closed circuit the circuit must include a source of **potential difference**.

Electric current is a flow of electrical charge. The size of the electric current is the **rate** of **flow** of electrical **charge**.

Charge flow, current and time are linked by the equation:

charge flow = current × time	$Q = I\,t$

- charge flow, *Q*, in coulombs, **C**
- current, *I*, in amperes, **A** (amp is acceptable for ampere)
- time, *t*, in seconds, **s**

The current at any point in a single closed loop of a circuit has the same value as the current at any other point in the same closed loop.

<u>Students should be able to:</u>

★ **Recall** and apply the equation for **current** stated above.

4.2.1.3 Current, resistance and potential difference

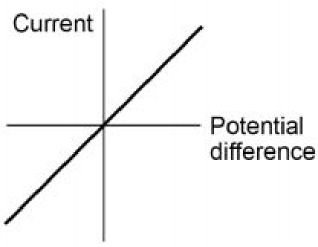
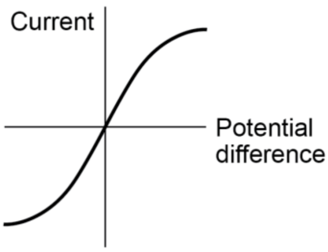
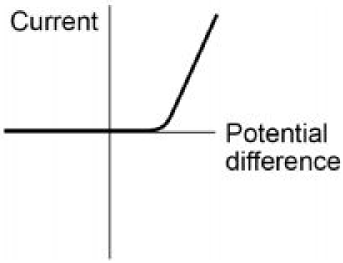
The **current** (*I*) through a component depends on both the **resistance** (*R*)of the component and the **potential difference** (*V*) across the component.

The **greater the resistance** of the component the **smaller the current** for a given potential difference (p.d.) across the component.

Current, potential difference or resistance can be calculated using the equation:

potential difference = current × resistance	$V = I\,R$

- potential difference, *V*, in volts, **V**
- current, *I*, in amperes, **A** (amp is acceptable for ampere)
- resistance, *R*, in ohms, **Ω**

<u>Students should be able to:</u> ★ **Recall** and apply the equation linking **current**, **potential difference** and **resistance**.			
★ Recognise that **potential difference** refers to **voltage**.			
REQUIRED PRACTICAL – Resistance. **AT 1, 6 and 7.**			
4.2.1.4 Resistors	☺	😐	☹
The current through an **ohmic conductor** (at a constant temperature) is **directly proportional** to the potential difference across the resistor. This means that the resistance remains constant as the current changes. 			
The **resistance** of components such as **lamps**, **diodes**, **thermistors** and **LDRs** is not constant; it changes with the **current** through the component.			
The resistance of a **filament lamp** increases as the temperature of the filament increases. 			
The current through a **diode** flows in one direction only. The diode has a very high resistance in the reverse direction. 			
The resistance of a **thermistor** decreases as the **temperature** increases.			
The **applications** of thermistors in circuits e.g. a **thermostat** is required.			
The resistance of an **LDR** decreases as **light** intensity increases.			
The **application** of LDRs in circuits e.g. **switching lights on** when it gets dark is required.			
<u>Students should be able to:</u> ★ **Explain** that, for some resistors, the value ***R*** remains **constant** but that in others it can **change** as the **current** changes.			
★ **Explain** the design and use of a circuit to measure the **resistance** of a component by measuring the **current** through, and **potential difference** across, the component.			
★ **Draw** an appropriate circuit diagram using correct circuit symbols.			
★ Use **graphs** to determine whether circuit components are linear or non-linear and relate the curves produced to the function and properties of the component.			
MS 4c Plot two variables from experimental or other data.			

MS 4d Determine the slope and intercept of a linear graph.			
MS 4e Draw and use the slope of a tangent to a curve as a measure of rate of change.			
REQUIRED PRACTICAL – I-V characteristics. **AT 6 and 7.**			
4.2.2 Series and parallel circuits			
There are two ways of joining electrical components, in **series** and in **parallel**. Some circuits include both series and parallel parts.			
For components connected in **<u>series</u>**: • there is the **same current** through each component. • the total **potential difference** of the power supply is **shared** between the components. • the total **resistance** of two components is the **sum** of the resistance of each component: $\boldsymbol{R_{total} = R_1 + R_2 + ...}$			
For components connected in **<u>parallel</u>**: • the **potential difference** across each component is the **same**. • the **total current** through the whole circuit is the **sum of the currents** through the separate components. • the **total resistance** of two resistors is **less** than the resistance of the smallest individual resistor.			
<u>Students should be able to:</u> ★ **Describe** the **difference** between **series** and **parallel** circuits.			
★ **Explain** qualitatively why adding resistors in **series increases** the total resistance whilst adding resistors in **parallel decreases** the total resistance.			
★ **Explain** the design and use of d.c. **series circuits** for measurement and testing purposes.			
★ **Calculate** the currents, potential differences and resistances in d.c. **series** circuits.			
★ **Solve problems** for circuits which include resistors in series using the concept of equivalent resistance.			
4.2.3 Domestic uses and safety			
4.2.3.1 Direct and alternating current	☺	😐	☹
Mains electricity is an **a.c. supply**. In the United Kingdom it has a **frequency** of **50 Hz** and is about **230 V**.			
An **alternating current** (a.c.) is one that continuously **changes direction**.			
Cells and batteries supply current that always passes in the **same direction**. This is called **direct current** (d.c.).			
<u>Students should be able to:</u> ★ Explain the difference between **direct** and **alternating potential difference**.			
4.4.3.2 Mains electricity	☺	😐	☹
Most electrical appliances are connected to the mains using **three-core cable**.			
The insulation covering each wire is colour coded for easy identification: • **live** wire – **brown** • **neutral** wire – **blue** • **earth** wire – **green** and **yellow** stripes.			
The **live** wire carries the **alternating potential** difference from the supply. The **neutral** wire completes the circuit. The **earth** wire is a **safety wire** to stop the appliance becoming live.			

The potential difference between the **live** wire and earth (0 V) is about 230 V. The **neutral** wire is at, or close to, earth potential (0 V). The **earth** wire is at 0 V, it only carries a current if there is a fault.			
Our bodies are at earth potential (0 V). Touching the live wire produces a large potential difference across our body. This causes a current to flow through our body, resulting in an **electric shock**.			
Students should be able to: ★ **Explain** that a **live wire** may be dangerous even when a switch in the mains circuit is open.			
★ **Explain** the **dangers** of providing any connection between the live wire and earth.			
4.2.4 Energy transfers			
4.2.4.1 Power	☺	😐	☹
The power of a device is related to the potential difference across it and the current through it by the equation: power = potential difference × current $P = V\,I$			
power = (current)^2 × resistance $P = I^2\,R$			
• power, *P*, in watts, **W** • potential difference, *V*, in volts, **V** • current, *I*, in amperes, **A** (amp is acceptable for ampere) • resistance, *R*, in ohms, **Ω**			
Students should be able to: ★ **Recall** and apply both equations for **power**.			
★ **Explain** how the **power** transfer in any circuit device is related to the **potential difference** across it and the **current** through it, and the energy changes over time.			
4.2.4.2 Energy transfers in everyday appliances	☺	😐	☹
Everyday electrical appliances are designed to bring about **energy transfers**.			
The amount of energy an appliance transfers depends on **how long** the appliance is switched on for and the **power** of the appliance.			
The amount of energy transferred by **electrical work** can be calculated using the equation: energy transferred = power × time $E = P\,t$			
• energy transferred, *E*, in joules, **J** • power, *P*, in watts, **W** • time, *t*, in seconds, **s**			
Work is done when **charge flows** in a circuit.			
energy transferred = charge flow × potential difference $E = Q\,V$			
• energy transferred, *E*, in joules, **J** • charge flow, *Q*, in coulombs, **C** • potential difference, *V*, in volts, **V**			
Students should be able to: ★ **Recall** and apply both equations for **energy transfer**.			
★ **Describe** how different domestic appliances transfer energy from **batteries** or **a.c.** mains to the **kinetic energy** of electric **motors** or the energy of **heating devices**.			

★ **Explain** how the power of a circuit device is related to: • the **p.d.** across it and the **current** through it. • the **energy** transferred over a given **time**.			
★ **Describe**, with examples, the relationship between the **power ratings** for domestic electrical appliances and the changes in stored energy when they are in use.			
4.2.4.3 The National Grid	☺	😐	☹
The **National Grid** is a system of **cables** and **transformers** linking power stations to consumers.			
Electrical power is transferred from power stations to consumers using the National Grid.			
Step-up transformers are used to **increase** the **potential difference** from the power station to the transmission cables then **step-down transformers** are used to **decrease**, to a much lower value, the potential difference for domestic use.			
This is done because, for a given power, increasing the potential difference **reduces** the **current**, and hence **reduces** the **energy losses** due to **heating** in the **transmission cables**.			
<u>Students should be able to:</u> ★ **Explain** why the National Grid system is an efficient way to transfer energy.			

Topic 3: Particle model of matter

4.3.1 Changes of state and the particle model			
4.3.1.1 Density of materials	☺	😐	☹
The **density** of a material is defined by the equation: density = $\frac{\text{mass}}{\text{volume}}$ $\rho = \frac{m}{V}$			
• density, ρ, in kilograms per metre cubed, **kg/m³** • mass, m, in kilograms, **kg** • volume, V, in metres cubed, **m³**			
The **particle model** can be used to explain • the different states of matter • differences in density			
<u>Students should be able to:</u> ★ **Recall** and apply the equation for **density**.			
★ **Recognise/draw** simple diagrams to model the difference between **solids**, **liquids** and **gases** [*links with chemistry*].			
★ **Explain** the differences in **density** between the different states of matter in terms of the arrangement of atoms or molecules.			
REQUIRED PRACTICAL – Density. **AT 1.**			
4.3.1.2 Changes of state	☺	😐	☹
Changes of state are **physical changes**: the change does not produce a new substance. If the change is reversed the substance recovers its original properties.			
<u>Students should be able to:</u> ★ **Describe** how when substances **change state** (melt, freeze, boil, evaporate, condense or sublimate), mass is conserved.			

4.3.2 Internal energy and energy transfers			
4.3.2.1 Internal energy	☺	😐	☹
Energy is **stored** inside a system by the **particles** (atoms and molecules) that make up the system. This is called **internal energy**.			
Internal energy is the **total kinetic energy and potential energy** of all the particles (atoms and molecules) that make up a system.			
Heating changes the energy stored within the system by increasing the energy of the particles that make up the system. This either raises the **temperature** of the system or produces a **change of state**			
4.3.2.2 Temperature changes in a system and specific heat capacity	☺	😐	☹
If the temperature of the system increases: The increase in **temperature** depends on the **mass** of the substance heated, the type of **material** and the **energy input** to the system.			
change in thermal energy = mass × specific heat capacity × temperature change — $\Delta E = m\, c\, \Delta\theta$			
• change in thermal energy, Δ*E*, in joules, **J** • mass, *m*, in kilograms, **kg** • specific heat capacity, *c*, in joules per kilogram per degree Celsius, **J/kg °C** • temperature change, Δθ, in degrees Celsius, **°C**			
The **specific heat capacity** of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.			
Students should be able to: ★ **Apply** the equation for **specific heat capacity** which is given on the **Physics equation sheet**.			
4.3.2.3 Changes of heat and specific latent heat	☺	😐	☹
If a change of state happens: The energy needed for a substance to **change state** is called **latent heat**. When a change of state occurs, the energy supplied changes the energy stored (**internal energy**) but **not the temperature**.			
The **specific latent heat** of a substance is the amount of energy required to change the state of one kilogram of the substance with no change in temperature.			
The following equation applies: thermal energy for a change of state = mass × specific latent heat — $E = m\, L$			
• energy, *E*, in joules, **J** • mass, *m*, in kilograms, **kg** • specific latent heat, *L*, in joules per kilogram, **J/kg**			
Specific latent heat of **fusion** – change of state from solid to liquid			
Specific latent heat of **vaporisation** – change of state from liquid to vapour			
Students should be able to: ★ **Interpret** heating and cooling **graphs** that include changes of state.			
★ **Distinguish** between specific heat capacity and specific latent heat.			
★ **Apply** the equation for **specific latent heat** which is given on the **Physics equation sheet**.			

4.3.3 Particle model and pressure

4.3.3.1 Particle motion in gases	☺	😐	☹
The molecules of a gas are in **constant random motion**. The **temperature** of the gas is related to the **average kinetic energy** of the molecules. The higher the temperature the greater the average kinetic energy and so the faster the average speed of the molecules.			
When the molecules **collide** with the wall of their container they exert a **force** on the wall. The total force exerted by all of the molecules inside the container on a **unit area** of the walls is the gas **pressure**.			
Changing the **temperature** of a gas, held at constant volume, changes the **pressure** exerted by the gas.			
Students should be able to: ★ **Explain** how the motion of the molecules in a gas is related to both its **temperature** and its **pressure**.			
★ **Explain** qualitatively the relationship between **temperature** of a gas and its **pressure** at constant **volume**.			

Topic 4: Atomic Structure

4.4.1 Atoms and isotopes

4.4.1.1 The structure of an atom	☺	😐	☹
Atoms are very small, having a radius of about **1×10^{-10} metres**.			
The basic structure of an atom is a **positively charged nucleus** composed of both **protons** and **neutrons** surrounded by **negatively charged electrons**.			
The radius of a nucleus is less than 1/10 000 of the radius of an atom. Most of the **mass** of an atom is concentrated in the **nucleus**.			
The electrons are arranged at different distances from the nucleus (different **energy levels**). The electron arrangements may change with the **absorption** of **electromagnetic radiation** (move further from the nucleus; a higher energy level) or by the **emission** of electromagnetic radiation (move closer to the nucleus; a lower energy level).			
Students should be able to: ★ Recognise expressions given in **standard form**.			
4.4.1.2 Mass number, atomic number and isotopes	☺	😐	☹
In an atom the number of **electrons** is **equal** to the number of **protons** in the nucleus. Atoms have no overall electrical charge.			
All atoms of a particular **element** have the **same number** of **protons**. The number of protons in an atom of an element is called its **atomic number**.			
The total number of **protons** and **neutrons** in an atom is called its **mass** number.			
Atoms can be represented as shown in this example: (Mass number) 23 (Atomic number) 11 Na $^{23}_{11}\text{Na}$			
Atoms of the same element can have **different** numbers of **neutrons**; these atoms are called **isotopes** of that element.			
Atoms turn into **positive ions** if they **lose** one or more outer **electron**(s).			

Students should be able to: ★ Relate differences between **isotopes** to differences in conventional representations of their identities, charges and masses.			
4.4.1.3 The development of the model of the atom (*common content with chemistry*)	☺	😐	☹
New experimental evidence may lead to a **scientific model** being changed or replaced.			
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 that the atom was a ball of positive charge with negative electrons embedded in it.			
The results from the **alpha particle scattering experiment** led to the conclusion that the mass of an atom was concentrated at the centre (nucleus) and that the nucleus was charged. This **nuclear model** replaced the plum pudding model.			
Niels Bohr adapted the nuclear model by suggesting that **electrons orbit** the nucleus at specific distances. The theoretical calculations of Bohr agreed with experimental observations.			
Later experiments led to the idea that the **positive charge** of any nucleus could be subdivided into a whole number of smaller particles, each particle having the same amount of positive charge. The name **proton** was given to these particles.			
The experimental work of **James Chadwick** provided the evidence to show the existence of **neutrons** within the nucleus. This was about 20 years after the nucleus became an accepted scientific idea.			
Students should be able to: ★ **Describe** the **difference** between the **plum pudding model** of the atom and the **nuclear model** of the atom.			
★ **Describe** why the **new evidence** from the scattering experiment led to a **change** in the atomic model. *Details of experimental work supporting the Bohr model are not required. Details of these experiments are not required. Details of Chadwick's experimental work are not required.*			
4.4.2 Atoms and nuclear radiation			
4.4.2.1 Radioactive decay and nuclear radiation	☺	😐	☹
Some atomic nuclei are **unstable**. The nucleus gives out radiation as it changes to become more stable. This is a **random** process called **radioactive decay**.			
Activity is the **rate** at which a source of unstable nuclei decays.			
Activity is measured in **becquerel** (Bq)			
Count-rate is the number of decays recorded **each second** by a detector (e.g. Geiger-Muller tube).			
The nuclear radiation emitted may be: • an **alpha particle** (α) – this consists of **two neutrons** and **two protons**, it is the same as a helium nucleus			
• a **beta particle** (β) – a high speed **electron** ejected from the nucleus as a neutron turns into a proton			
• a **gamma ray** (γ) – **electromagnetic radiation** from the nucleus			
• a **neutron** (n).			
Alpha particles have a range in air of just a **few centimetres** and are absorbed by a thin sheet of **paper**. Alpha particles are **strongly ionising**.			
Beta particles have a range in air of a **few metres** and are completely absorbed by a sheet of **aluminium** about 5 mm thick. Beta particles are **moderately ionising**.			

Gamma rays travel great distances through the air and pass through most materials but are absorbed by a **thick sheet of lead** or several metres of **concrete**. Gamma rays are **weakly ionising**.			
<u>Students should be able to:</u> ★ **Apply** their knowledge to the uses of radiation and **evaluate** the best sources of radiation to use in a given situation.			
Required knowledge of the properties of alpha particles, beta particles and gamma rays is limited to their **penetration** through materials, their **range** in air and **ionising power**.			
4.4.2.2 Nuclear equations	☺	😐	☹
Nuclear equations are used to represent radioactive decay.			
In a nuclear equation an **alpha particle** may be represented by the symbol: $^{4}_{2}\mathrm{He}$			
And a **beta particle** by the symbol: $^{0}_{-1}\mathrm{e}$			
The emission of the different types of nuclear radiation may cause a change in the **mass** and /or the **charge** of the **nucleus**. For example: $^{219}_{86}\text{radon} \longrightarrow {}^{215}_{84}\text{polonium} + {}^{4}_{2}\mathrm{He}$ So **alpha decay** causes both the **mass** and **charge** of the nucleus to decrease.			
$^{14}_{6}\text{carbon} \longrightarrow {}^{14}_{7}\text{nitrogen} + {}^{0}_{-1}\mathrm{e}$ So **beta decay** does not cause the mass of the nucleus to change but does cause the **charge** of the nucleus to increase. *Students are not required to recall these two examples.*			
The emission of a **gamma ray** does not cause the mass or the charge of the nucleus to change.			
<u>Students should be able to:</u> ★ Use the **names** and **symbols** of common nuclei and particles to write **balanced equations** that show single **alpha** (α) and **beta** (β) decay. This is limited to balancing the atomic numbers and mass numbers. *The identification of daughter elements from such decays is not required.*			
4.4.2.3 Half-lives and the random nature of radioactive decay	☺	😐	☹
Radioactive decay is **random**. It is not possible to predict which individual nucleus will decay next. But, with a large enough number of nuclei, it is possible to predict how many will decay in a certain amount of time.			
The **half-life** of a radioactive isotope is the **time** it takes for the **number of nuclei** of the isotope in a sample to **halve**, or the time it takes for the **count rate** (or activity) from a sample containing the isotope to fall to **half** its initial level.			
<u>Students should be able to:</u> ★ **Explain** the concept of half-life and how it is related to the random nature of radioactive decay.			
★ **Determine** the half-life of a radioactive isotope from given information.			
★ (HT only) **Calculate** the net decline, expressed as a **ratio**, in a radioactive emission after a given number of half-lives.			
4.4.2.4 Radioactive contamination	☺	😐	☹
Radioactive contamination is the **unwanted** presence of materials containing **radioactive atoms** on other materials.			

The **hazard** from contamination is due to the **decay** of the contaminating atoms. The **type of radiation** emitted affects the **level** of hazard.			
Irradiation is the process of **exposing** an object to nuclear radiation. The irradiated object does not become radioactive.			
Suitable **precautions** must be taken to protect against any hazard that the **radioactive source** used in the process of **irradiation** may present.			
Students should be able to: ★ **Compare** the hazards associated with contamination and irradiation.			
★ **Understand** that it is important for the findings of studies into the effects of radiation on humans to be **published** and **shared** with other scientists so that the findings can be checked by **peer review**.			

A copy of the equation sheet that will be provided in the exams can be found on the following page.

AQA Realising potential

GCSE Combined Science: Trilogy
Physics Equation sheet

1	(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance	$v^2 - u^2 = 2\,a\,s$
2	elastic potential energy = 0.5 × spring constant × (extension)^2	$E_e = \frac{1}{2}\,k\,e^2$
3	change in thermal energy = mass × specific heat capacity × temperature change	$\Delta E = m\,c\,\Delta\theta$
4	period = $\frac{1}{\text{frequency}}$	
5	**force on a conductor (at right angles to a magnetic field) carrying a current = magnetic flux density × current × length**	$F = B\,I\,l$
6	thermal energy for a change of state = mass × specific latent heat	$E = m\,L$
7	**potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil**	$V_s\,I_s = V_p\,I_p$