<u>**YEAR 9**</u> - AQA GCSE COMBINED SCIENCE (9-1)

Cell Biology

Cell structure			
Eukaryotes and prokaryotes	☺	😐	☹
<u>Plant and animal cells</u> (eukaryotic cells) have a **cell membrane**, **cytoplasm** and genetic material enclosed in a **nucleus**.			
<u>Bacterial cells</u> (prokaryotic cells) are much smaller in comparison. They have **cytoplasm** and a **cell membrane** surrounded by a **cell wall**. The genetic material is not enclosed in a nucleus. It is a single **DNA loop** and there may be one or more small rings of DNA called **plasmids**.			
WS 4.4 Use prefixes **centi**, **milli**, **micro** and **nano**.			
MS 2a, 2h Demonstrate an understanding of the scale and size of cells and be able to make order of magnitude calculations.			
Animal and plant cells	☺	😐	☹
Students should be able to explain how the main **sub-cellular structures**, including the nucleus, cell membranes, mitochondria, chloroplasts in plant cells and plasmids in bacterial cells are related to their **functions**.			
Most <u>animal cells</u> have the following parts: • a **nucleus**, which controls the activities of the cell • **cytoplasm**, in which most of the chemical reactions take place • a **cell membrane**, which controls the passage of substances into and out of the cell • **mitochondria**, which is where aerobic respiration takes place • **ribosomes**, which are where protein synthesis occurs.			
In addition to the parts found in animal cells, <u>plant cells</u> often have: • **chloroplasts**, which absorb light to make food by photosynthesis • a **permanent vacuole** filled with cell sap.			
<u>Plant and algal cells</u> also have a **cell wall** made of **cellulose**, which strengthens the cell.			
Cell specialisation	☺	😐	☹
Students should be able to, when provided with appropriate information, explain how the **structure** of different types of cell relate to their **function** in a tissue, an organ or organ system, or the whole organism. Cells may be specialised to carry out a particular function: • **sperm cells**, **nerve cells** and **muscle cells** in animals • **root hair cells**, **xylem** and **phloem cells** in plants. •			
Cell differentiation	☺	😐	☹
As an organism develops, cells **differentiate** to form different types of cells. Most types of animal cell differentiate at an early stage whereas many types of plant cells retain the ability to differentiate throughout life. In mature animals, cell division is mainly restricted to **repair** and **replacement**. As a cell **differentiates** it acquires different sub-cellular structures to enable it to carry out a certain function. It has become a **specialised cell**.			

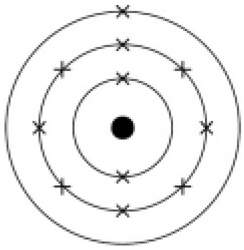
Microscopy	☺	😐	☹
An **electron microscope** has much higher **magnification** and **resolving power** than a light microscope. This means that it can be used to study cells in much finer detail. (*Limited to the differences in magnification and resolution.*) This has enabled biologists to see and understand many more **sub-cellular structures**.			
WS 1.1 Explain how electron microscopy has increased understanding of subcellular structures.			
WS 4.4 Use prefixes **centi**, **milli**, **micro** and **nano**.			
MS 1a, 1b, 2h, 3b Carry out calculations involving magnification, real size and image size using the formula: magnification = size of image / size of real object			
Cell division			
Chromosomes	☺	😐	☹
The nucleus of a cell contains **chromosomes** made of DNA molecules. Each chromosome carries a large number of **genes**.			
In body cells the chromosomes are normally **found in pairs**.			
Mitosis and the cell cycle	☺	😐	☹
Cells divide in a series of stages called the **cell cycle**. One of these stages is **mitosis** where the DNA, which has already been **copied**, **divides**.			
During the cell cycle the genetic material is doubled and then divided into two identical cells.			
Before a cell can divide it needs to grow and increase the number of sub-cellular structures such as **ribosomes** and **mitochondria**. The DNA replicates to form two copies of each chromosome. One set of chromosomes is pulled to each end of the cell and the nucleus divides. Finally, the cytoplasm and cell membranes divide to form two identical cells. *Knowledge of the stages of mitosis is not required.*			
Cell division by mitosis is important in the **growth** and **development** of multicellular organisms.			
Students should be able to recognise and describe situations in given contexts where mitosis is occurring.			
WS 1.2 Use **models** and **analogies** to develop explanations of how cells divide.			
Stem cells	☺	😐	☹
A **stem cell** is an **undifferentiated** cell of an organism which is capable of giving rise to many more cells of the same type, and from which certain other cells can arise from differentiation.			
Stem cells from human **embryos** and **adult bone marrow** can be **cloned** and made to differentiate into many different types of human cells. *Knowledge and understanding of stem cell techniques are not required.*			
Treatment with stem cells may be able to help conditions such as **diabetes** and **paralysis**.			
In **therapeutic cloning** an embryo is produced with the same genes as the patient. Stem cells from the embryo are not rejected by the patient's body so they may be used for **medical treatment**.			
The use of stem cells has potential risks such as transfer of **viral infection**, and some people have **ethical** or **religious objections**.			
Stem cells from **meristems** in **plants** can be used to produce clones of plants quickly and economically. • **Rare species** can be cloned to protect from **extinction**. • Large numbers of **identical crop plants** with special features such as **disease resistance**.			

Transport in cells			
Diffusion	☺	😐	☹
Substances may move into and out of cells across the **cell membranes** via **diffusion**.			
Diffusion is the spreading of the particles of any substance in solution, or particles of a gas, resulting in a net movement from an area of **higher concentration** to an area of **lower concentration**.			
Some of the substances transported in and out of cells by diffusion are **oxygen** and **carbon dioxide** in **gas exchange**, and of the waste product **urea** from cells into the **blood plasma** for **excretion** in the **kidney**.			
Factors which affect the **rate of diffusion** are: • the difference in concentrations (**concentration gradient**) • the **temperature** • the **surface area** of the membrane.			
A **single-celled organism** has a relatively **large surface area to volume ratio**. This allows sufficient transport of molecules into and out of the cell to meet the needs of the organism.			
In **multicellular organisms** the **smaller surface area to volume ratio** means surfaces and organ systems are specialised for exchanging materials. This is to allow sufficient molecules to be transported into and out of cells for the organism's needs. The effectiveness of an exchange surface is increased by: • having a large surface area • a membrane that is thin, to provide a short diffusion path • (in animals) having an efficient blood supply • (in animals, for gaseous exchange) being ventilated.			
Students should be able to explain how the small intestine and lungs in mammals, gills in fish, and the roots and leaves in plants, are adapted for exchanging materials.			
Osmosis	☺	😐	☹
Water may move across cell membranes via **osmosis**. Osmosis is the diffusion of **water** from a dilute solution to a concentrated solution through a **partially permeable membrane**.			
MS 1c, 2b, 4a, 4b, 4c, 4d Calculate percentages, use negative numbers and construct graphs.			
Active Transport	☺	😐	☹
Active transport moves substances from a more dilute solution to a more concentrated solution (against a concentration gradient). This **requires energy** from **respiration**.			
Active transport allows **mineral ions** to be absorbed into **plant root hairs** from very dilute solutions in the soil. Plants require ions for **healthy growth**.			
Students should be able to link the structure of a root hair cell to its function. (also in 4.1.1.3)			
It also allows **sugar molecules** to be absorbed from lower concentrations in the **gut** into the blood which has a higher sugar concentration. Sugar molecules are used for **cell respiration**.			
Students should be able to explain the differences between **diffusion**, **osmosis** and **active transport**.			
WS 1.4 Students should be able to describe how **kidney dialysis works**.			
WS 1.5 Use of **isotonic drinks** and **high energy drinks** in sport.			

AQA GCSE COMBINED SCIENCE (9-1)
Atomic Structure and the Periodic Table

Atoms, elements and compounds			
Atoms, elements and compounds	☺	😐	☹
All substances are made of **atoms**. An atom is the smallest part of an **element** that can exist.			
Atoms of each element are represented by a **chemical symbol**, eg O represents an atom of oxygen, Na represents an atom of sodium.			
There are about **100 different elements**. Elements are shown in the **periodic table**.			
Compounds are formed from elements by **chemical reactions**. Compounds contain two or more elements **chemically combined** in fixed proportions and can be represented by formulae using the symbols of the atoms from which they were formed. Compounds can only be separated into elements by chemical reactions.			
Chemical reactions can be represented by **word equations** or equations using symbols and formulae.			
Students will be supplied with a periodic table for the exam and should be able to: • use the names and symbols of the **first 20 elements** in the periodic table, the elements in **Groups 1 and 7**, and other elements in this specification. • name **compounds** of these elements from given formulae or symbol equations. • write **word equations** for the reactions in this specification. • write **formulae** and **balanced chemical equations** for the reactions in this specification. • (HT only) write balanced **half equations** and **ionic equations** where appropriate.			
Mixtures	☺	😐	☹
A **mixture** consists of two or more elements or compounds **not chemically combined** together. The **chemical properties** of each substance in the mixture are unchanged.			
Mixtures can be separated by physical processes such as **filtration**, **crystallisation**, **simple distillation**, **fractional distillation** and **chromatography**. These physical processes do not involve chemical reactions.			
WS 2.2 Describe, explain and give examples of the specified processes of separation.			
WS 2.3 Suggest suitable separation and purification techniques for mixtures when given appropriate information.			
AT 4 Safe use of a range of equipment to separate chemical mixtures.			
Scientific models of the atom (*common content with physics*)	☺	😐	☹
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 Rutherford and Marsden’s **alpha scattering experiments** led to the plum pudding model being replaced by the **nuclear 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.			

<table>
<tr><td>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.</td><td></td><td></td><td></td></tr>
<tr><td>In 1932, the experimental work of James Chadwick provided the evidence to show the existence of neutrons within the nucleus.</td><td></td><td></td><td></td></tr>
<tr><td>WS 1.1 Describe why the new evidence from the scattering experiment led to a change in the atomic model.</td><td></td><td></td><td></td></tr>
<tr><td>WS 1.2 Describe the difference between the plum pudding model of the atom and the nuclear model of the atom.</td><td></td><td></td><td></td></tr>
<tr><td>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.</td><td></td><td></td><td></td></tr>
<tr><th>Relative electrical charges of subatomic particles (some common content with physics)</th><th>☺</th><th>😐</th><th>☹</th></tr>
<tr><td>The relative electrical charges of the particles in atoms are:
<table>
<tr><th>Name of particle</th><th>Relative charge</th></tr>
<tr><td>Proton</td><td>+1</td></tr>
<tr><td>Neutron</td><td>0</td></tr>
<tr><td>Electron</td><td>–1</td></tr>
</table></td><td></td><td></td><td></td></tr>
<tr><td>In an atom, the number of electrons is equal to the number of protons in the nucleus. Atoms have no overall electrical charge (they are neutral).</td><td></td><td></td><td></td></tr>
<tr><td>The number of protons in an atom of an element is its atomic number. All atoms of a particular element have the same number of protons. Atoms of different elements have different numbers of protons.</td><td></td><td></td><td></td></tr>
<tr><td>WS 1.2 Students should be able to use the atomic model to describe atoms.</td><td></td><td></td><td></td></tr>
<tr><th>Size and mass of atoms (some common content with physics)</th><th>☺</th><th>😐</th><th>☹</th></tr>
<tr><td>Atoms are very small, having a radius of about 0.1 nm (1 x 10-10 m).</td><td></td><td></td><td></td></tr>
<tr><td>The radius of a nucleus is less than 1/10 000 of that of the atom (about 1 x 10-14 m).</td><td></td><td></td><td></td></tr>
<tr><td>WS 4.3 Use SI units and the prefix nano.</td><td></td><td></td><td></td></tr>
<tr><td>MS 1b Recognise expressions in standard form.</td><td></td><td></td><td></td></tr>
<tr><td>MS 1d Estimate the size and scale of atoms.</td><td></td><td></td><td></td></tr>
<tr><td>The relative masses of protons, neutrons and electrons are:
<table>
<tr><th>Name of particle</th><th>Relative mass</th></tr>
<tr><td>Proton</td><td>1</td></tr>
<tr><td>Neutron</td><td>1</td></tr>
<tr><td>Electron</td><td>Very small</td></tr>
</table></td><td></td><td></td><td></td></tr>
<tr><td>The sum of the protons and neutrons in an atom is its mass number</td><td></td><td></td><td></td></tr>
<tr><td>Atoms of the same element can have different numbers of neutrons; these atoms are called isotopes of that element.</td><td></td><td></td><td></td></tr>
<tr><td>Atoms can be represented as shown in this example:
(Mass number) 23
(Atomic number) 11 $^{23}_{11}\mathrm{Na}$</td><td></td><td></td><td></td></tr>
</table>

Students should be able to calculate the numbers of protons, neutrons and electrons in an atom or ion, given its atomic number and mass number.			
Electronic structure	☺	😐	☹
The electrons in an atom occupy the lowest available **energy levels** (innermost available **shells**). The electronic structure of an atom can be represented by numbers or by a diagram. For example, the electronic structure of **sodium** is **2,8,1** or  showing two electrons in the lowest energy level, eight in the second energy level and one in the third energy level. *Students may answer questions in terms of either energy levels or shells.*			
WS 1.2 Students should be able to represent the electronic structures of the **first twenty elements** of the periodic table in both forms.			
MS 5b Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects.			
The periodic table			
The periodic table	☺	😐	☹
The elements in the **periodic table** are arranged in order of atomic (proton) number and so that elements with similar properties are in columns, known as **groups**. The table is called a periodic table because similar properties occur at regular intervals.			
Elements in the same **group** in the periodic table have the same number of electrons in their outer shell (outer electrons) and this gives them similar **chemical properties**.			
WS 1.2 Explain how the position of an element in the periodic table is related to the arrangement of electrons in its atoms and hence to its atomic number.			
WS 1.2 Predict possible reactions and probable reactivity of elements from their positions in the periodic table.			
Development of the periodic table	☺	😐	☹
Before the discovery of protons, neutrons and electrons, scientists attempted to classify the elements by arranging them in order of their **atomic weights**.			
The early periodic tables were incomplete and some elements were placed in inappropriate groups if the strict order of atomic weights was followed.			
Mendeleev overcame some of the problems by **leaving gaps** for elements that he thought had not been discovered and in some places changed the order based on atomic weights.			
Elements with properties **predicted** by Mendeleev were discovered and filled the gaps. Knowledge of isotopes made it possible to explain why the order based on atomic weights was not always correct.			
Students should be able to describe these steps in the development of the periodic table.			
WS 1.1 Explain how testing a prediction can support or refute a new scientific idea.			
Metals and non-metals	☺	😐	☹
Elements that react to form **positive ions** are **metals**.			
Elements that do not form positive ions are non-metals.			

The majority of elements are metals. Metals are found to the left and towards the bottom of the periodic table. Non-metals are found towards the right and top of the periodic table.			
Explain the differences between **metals** and **non-metals** on the basis of their characteristic **physical** and **chemical properties**. *Links with 'Group 0', 'Group 1', 'Group 7' and 'Bonding, structure and the properties of matter'.*			
Explain how the **atomic structure** of metals and non-metals relates to their **position** in the periodic table.			
Explain how the **reactions of elements** are related to the **arrangement of electrons** in their atoms and hence to their **atomic number**.			
Group 0	☺	😐	☹
The elements in **Group 0** of the periodic table are called the **noble gases**. They are **unreactive** and do not easily form molecules because their atoms have **stable arrangements** of electrons. The noble gases have eight electrons in their outer energy level, except for helium, which has only two electrons.			
The **boiling poin**ts of the noble gases increase with increasing relative atomic mass (going down the group).			
WS 1.2 Explain how properties of the elements in Group 0 depend on the outer shell of electrons of the atoms.			
WS 1.2 Predict properties from given trends down the group.			
Group 1	☺	😐	☹
The elements in **Group 1** of the periodic table, known as the **alkali metals**: • are metals with **low density** (the first three elements in the group are less dense than water). • react with non-metals to form **ionic compounds** in which the metal ion carries a charge of **+1**. The compounds are white solids that dissolve in water to form colourless solutions. • react with water, releasing **hydrogen**. • form **hydroxides** that dissolve in water to give **alkaline solutions**.			
In Group 1, the reactivity of the elements increases going down the group.			
WS 1.2 Explain how properties of the elements in Group 1 depend on the outer shell of electrons of the atoms.			
WS 1.2 Predict properties from given trends down the group.			
Group 7	☺	😐	☹
The elements in **Group 7** of the periodic table, known as the **halogens**: • are non-metals • consist of **molecules** which are made up of **pairs of atoms** • react with metals to form **ionic compo**unds in which the **halide ion** carries a charge of **–1** • form molecular compounds with other non-metallic elements.			
In Group 7, the further down the group an element is the higher its relative molecular mass, melting point and boiling point.			
In Group 7, the reactivity of the elements decreases going down the group.			
A more reactive halogen can displace a less reactive halogen from an aqueous solution of its **salt**.			
WS 1.2 Explain how properties of the elements in Group 7 depend on the outer shell of electrons of the atoms.			
WS 1.2 Predict properties from given trends down the group.			

A copy of the periodic table is provided in the exam.

AQA GCSE COMBINED SCIENCE (9-1)
Particle model of matter

Changes of state and the particle model			
Density of materials	☺	😐	☹
The **density** of a material is defined by the equation: $density = \frac{mass}{volume}$ $\rho = \frac{m}{V}$ density, ρ, in kilograms per metre cubed, kg/m^3 mass, m, in kilograms, kg volume, V, in metres cubed, m^3			
Students should be able to recall and/or apply this equation to changes where mass is conserved.			
The particle model can be used to explain • the different states of matter • differences in density			
Students should be able to recognise/draw simple diagrams to model the difference between solids, liquids and gases [*common content with chemistry*].			
REQUIRED PRACTICAL – Density.			
Changes of state	☺	😐	☹
When substances **change state** (melt, freeze, boil, evaporate, condense or sublimate), mass is conserved.			
Students should understand why there is no change in the mass of a substance when it changes 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.			
Internal energy and energy transfers			
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.			
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.			
The following equation applies: $\boldsymbol{change\ in\ thermal\ energy = mass} \times \boldsymbol{specific\ heat\ capacity} \times \boldsymbol{temperature\ change}$ $\Delta \boldsymbol{E} = \boldsymbol{m\,c}\,\Delta\boldsymbol{\theta}$ change in thermal energy, ΔE, in joules, J mass, m, in kilograms, kg specific heat capacity, c, in joules per kilogram per degree Celsius, J/kg °C temperature change, $\Delta\theta$, 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.			
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: $energy\ for\ a\ change\ of\ state = mass \times specific\ latent\ heat \qquad E = m\,L$ 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.			
Particle model and pressure			
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.			
WS 1.2 Students should be able to use the particle model to explain the effect of changing temperature on the pressure of a gas held at constant volume.			

Energy changes in a system, and the ways energy is stored before and after such changes			
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.			

Conservation and dissipation of energy			
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.*			
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.			

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.			

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	$\text{period} = \frac{1}{\text{frequency}}$	
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**	$V_s\,I_s = V_p\,I_p$

AQA

The Periodic Table of Elements

Key

relative atomic mass **atomic symbol** name atomic (proton) number

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[97] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[267] **Rf** rutherfordium 104	[270] **Db** dubnium 105	[269] **Sg** seaborgium 106	[270] **Bh** bohrium 107	[270] **Hs** hassium 108	[278] **Mt** meitnerium 109	[281] **Ds** darmstadtium 110	[281] **Rg** roentgenium 111	[285] **Cn** copernicium 112	[286] **Nh** nihonium 113	[289] **Fl** flerovium 114	[289] **Mc** moscovium 115	[293] **Lv** livermorium 116	[293] **Ts** tennessine 117	[294] **Og** oganesson 118

* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.

Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.

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