

Edexcel GCSE Additional Science 2011

GCSE Additional Science: Biology

Topic 1: The building blocks of cells	
1.1 Describe the function of the components of a bacterial cell including chromosomal DNA, plasmid DNA, flagella and cell wall	Cells
1.2 Describe the function of the components of a plant cell including chloroplast, large vacuole, cell wall, cell membrane, mitochondria, cytoplasm and nucleus	Cells
1.3 Describe the function of the components of an animal cell including cell membrane, mitochondria, cytoplasm and nucleus	Cells
1.4 Describe how plant and animal cells can be studied in greater detail with a light microscope	Cells
1.5 Demonstrate an understanding of how changes in microscope technology have enabled us to see cells with more clarity and detail than in the past, including simple magnification calculations	
1.6 Recall that a gene is a section of a molecule of DNA and that it codes for a specific protein	Genes and Protein Synthesis
1.7 Describe a DNA molecule as: a) two strands coiled to form a double helix b) strands linked by a series of complementary base pairs joined together by weak hydrogen bonds: i adenine (A) with thymine (T); ii cytosine (C) with guanine (G)	DNA
1.8 Investigate how to extract DNA from cells	DNA
1.9 Explain an understanding of how the structure of DNA was discovered, including the roles of the scientists Watson, Crick, Franklin and Wilkins	DNA
1.10 (HT) Demonstrate an understanding of the implications of sequencing the human genome (Human Genome Project) and of the collaboration that took place within this project	DNA
1.11 Demonstrate an understanding of the process of genetic engineering, including the removal of a gene from the DNA of one organism and the insertion of that gene into the DNA of another organism	Altering Genes
1.12 Discuss the advantages and disadvantages of genetic engineering to produce GM organisms, including: a) beta carotene in golden rice to reduce vitamin A deficiency in humans; b) the production of human insulin by genetically modified bacteria; c) the production of herbicide-resistant crop plants	Altering Genes
1.13 Describe the division of a cell by mitosis as the production of two daughter cells, each with identical sets of chromosomes in the nucleus to the parent cell, and that this results in the formation of two genetically identical diploid body cells	Mitosis
1.14 Recall that mitosis occurs during growth, repair and asexual reproduction	Mitosis
1.15 Recall that, at fertilisation, haploid gametes combine to form a diploid zygote	Meiosis and Reproduction
1.16 Describe the division of a cell by meiosis as the production of four daughter cells, each with half the number of chromosomes, and that this results in the formation of genetically different haploid gametes	Meiosis and Reproduction
1.17 Recall that cloning is an example of asexual reproduction that produces genetically identical copies	Cloning
1.18 (HT) Demonstrate an understanding of the stages in the production of cloned mammals, including: a) removal of diploid nucleus from a body cell; b) enucleation of egg cell; c) insertion of diploid nucleus into enucleated egg cell; d) stimulation of the diploid nucleus to divide by mitosis; e) implantation into surrogate mammals	Cloning
1.19 Demonstrate an understanding of the advantages, disadvantages and risks of cloning mammals	Cloning
1.20 Recall that stem cells in the embryo can differentiate into all other types of cells, but that cells lose this ability as the animal matures	Stem Cells

1.21 Demonstrate an understanding of the advantages, disadvantages and risks arising from adult and embryonic stem cell research	Stem Cells
1.22 Describe how the order of bases in a section of DNA decides the order of amino acids in the protein	Genes and Protein Synthesis
1.23 (HT) Demonstrate an understanding of the stages of protein synthesis, including transcription and translation: a) the production of complementary mRNA strand in the nucleus; b) the attachment of the mRNA to the ribosome; c) the coding by triplets of bases (codons) in the mRNA for specific amino acids; d) the transfer of amino acids to the ribosome by tRNA; e) the linking of amino acids to form polypeptides	Genes and Protein Synthesis
1.24 Describe each protein as having its own specific number and sequence of amino acids, resulting in different-shaped molecules that have different functions, including enzymes	Genes and Protein Synthesis
1.25 Demonstrate an understanding of how gene mutations change the DNA base sequence and that mutations can be harmful, beneficial or neither	Genes and Protein Synthesis
1.26 Describe enzymes as biological catalysts	Enzymes
1.27 Demonstrate an understanding that enzymes catalyse chemical reactions occurring inside and outside living cells, including: a) DNA replication; b) protein synthesis; c) digestion	Enzymes
1.28 Describe the factors affecting enzyme action, including: a) temperature; b) substrate concentration; c) pH	Enzymes
1.29 Recall that enzymes are highly specific for their substrate	Enzymes
1.30 Demonstrate an understanding of the action of enzymes in terms of the 'lock-and-key' hypothesis	Enzymes
1.31 Describe how enzymes can be denatured due to changes in the shape of the active site	Enzymes
1.32 Investigate the factors that affect enzyme activity	Enzymes

Edexcel GCSE Additional Science 2011

GCSE Additional Science: Chemistry

Unit C2: Discovering chemistry**Boardworks presentation**

0.1 Recall the formulae of elements and simple compounds in the unit	Throughout
0.2 Represent chemical reactions by word equations and simple balanced equations	Throughout
0.3 Write balanced chemical equations including the use of state symbols (s), (l), (g) and (aq) for a wide range of reactions in this unit	Throughout
0.4 Assess practical work for risks and suggest suitable precautions for a range of practical scenarios for reactions in this unit	Throughout
0.5 Demonstrate an understanding that hazard symbols used on containers: a) indicate the dangers associated with the contents; b) inform people about safe-working procedures with these substances in the laboratory	Throughout

Topic 1: Atomic structure and the periodic table

1.1 Explain how Mendeleev: a) arranged the elements, known at that time, in a periodic table by using properties of these elements and their compounds; b) used his table to predict the existence and properties of some elements not then discovered	The Periodic Table
1.2 Classify elements as metals or non-metals according to their position in the periodic table	The Periodic Table
1.3 Describe the structure of an atom as a nucleus containing protons and neutrons, surrounded by electrons in shells (energy levels)	Atomic Structure
1.4 Demonstrate an understanding that the nucleus of an atom is very small compared to the overall size of the atom	Atomic Structure
1.5 Describe atoms of a given element as having the same number of protons in the nucleus and that this number is unique to that element	Atomic Structure
1.6 Recall the relative charge and relative mass of: a) a proton; b) a neutron; c) an electron	Atomic Structure
1.7 Demonstrate an understanding that atoms contain equal numbers of protons and electrons	Atomic Structure
1.8 Explain the meaning of the terms: a) atomic number; b) mass number; c) relative atomic mass	Atomic Structure / Isotopes
1.9 Describe the arrangement of elements in the periodic table such that: a) elements are arranged in order of increasing atomic number, in rows called periods; b) elements with similar properties are placed in the same vertical column, called groups	The Periodic Table
1.10 (HT) Demonstrate an understanding that the existence of isotopes results in some relative atomic masses not being whole numbers	Isotopes
1.11 (HT) Calculate the relative atomic mass of an element from the relative masses and abundances of its isotopes	Isotopes
1.12 Apply rules about the filling of electron shells (energy levels) to predict the electronic configurations of the first 20 elements in the periodic table as diagrams and in the form 2.8.1	Isotopes
1.13 Describe the connection between the number of outer electrons and the position of an element in the periodic table	Electron Arrangement

Topic 2: Ionic compounds and analysis

2.1 Demonstrate an understanding that atoms of different elements can combine to form compounds by the formation of new chemical bonds	Ions and Ionic Bonding
2.2 Describe how ionic bonds are formed by the transfer of electrons to produce cations and anions	Ions and Ionic Bonding
2.3 Describe an ion as an atom or group of atoms with a positive or negative charge	Ions and Ionic Bonding

2.4 Describe the formation of sodium ions, Na ⁺ , and chloride ions, Cl ⁻ , and hence the formation of ions in other ionic compounds from their atoms, limited to compounds of elements in groups 1, 2, 6 and 7	Ions and Ionic Bonding
2.5 Demonstrate an understanding of the use of the endings –ide and –ate in the names of compounds	Ions and Ionic Bonding
2.6 Deduce the formulae of ionic compounds (including oxides, hydroxides, halides, nitrates, carbonates and sulfates) given the formulae of the constituent ions	Ions and Ionic Bonding
2.7 (HT) Describe the structure of ionic compounds as a lattice structure: a) consisting of a regular arrangement of ions; b) held together by strong electrostatic forces (ionic bonds) between oppositely-charged ions	Ionic Compounds
2.8 Describe and explain the properties of ionic substances including sodium chloride and magnesium oxide, limited to: a) melting points and boiling points; b) whether they conduct electricity as solids, when molten and in aqueous solution	Ionic Compounds
2.9 Recall the general rules which describe the solubility of common types of substances in water: a) all common sodium, potassium and ammonium salts are soluble; b) all nitrates are soluble; c) common chlorides are soluble except those of silver and lead; d) common sulfates are soluble except those of lead, barium and calcium; e) common carbonates and hydroxides are insoluble except those of sodium, potassium and ammonium	Solubility
2.10 Demonstrate an understanding that insoluble salts can be formed as precipitates by the reaction of suitable reagents in solution	Precipitation Reactions
2.11 Demonstrate an understanding of the method needed to prepare a pure, dry sample of an insoluble salt	Making Salts
2.12 Prepare an insoluble salt by precipitation	Making Salts
2.13 Use solubility rules to predict whether a precipitate is formed when named solutions are mixed together and to name the precipitate	Solubility
2.14 Recall that the insoluble salt, barium sulfate, is given as a 'barium meal' to X-ray patients because: a) it is opaque to X-rays; b) it is safe to use as, although barium salts are toxic, its insolubility prevents it entering the blood	Solubility
2.15 Describe tests to show the following ions are present in solids or solutions: a) Na ⁺ , K ⁺ , Ca ²⁺ , Cu ²⁺ using flame tests; b) CO ₃ ²⁻ using dilute acid and identifying the carbon dioxide evolved; c) SO ₄ ²⁻ using dilute hydrochloric acid and barium chloride solution; d) Cl ⁻ using dilute nitric acid and silver nitrate solution	Spectroscopy and Flame Tests / Precipitation Reactions
2.16 Recall that chemists use spectroscopy (a type of flame test) to detect the presence of very small amounts of elements and that this led to the discovery of new elements, including rubidium and caesium	Spectroscopy and Flame Tests

Topic 3: Covalent compounds and separation techniques

3.1 Describe a covalent bond as a pair of electrons shared between two atoms	Covalent Bonding
3.2 Recall that covalent bonding results in the formation of molecules	Covalent Bonding
3.3 Explain the formation of simple molecular, covalent substances using dot and cross diagrams, including: a) hydrogen; b) hydrogen chloride; c) water; d) methane; e) (HT) oxygen; f) (HT) carbon dioxide	Covalent Bonding
3.4 Classify different types of elements and compounds by investigating their melting points and boiling points, solubility in water and electrical conductivity (as solids and in solution) including sodium chloride, magnesium sulphate, hexane, liquid paraffin, silicon(IV) oxide, copper sulfate, and sucrose (sugar)	Ionic Compounds / Covalent Bonding / Giant Covalent Structures
3.5 Describe the properties of typical simple molecular, covalent compounds, limited to: a) low melting points and boiling points, in terms of weak forces between molecules; b) poor conduction of electricity	Covalent Bonding
3.6 Demonstrate an understanding of the differences between the properties of simple molecular, covalent substances and those of giant molecular, covalent substances, including diamond and graphite	Giant Covalent Structures

3.7 (HT) Explain why, although they are both forms of carbon and giant molecular substances, graphite is used to make electrodes and as a lubricant, whereas diamond is used in cutting tools	Giant Covalent Structures
3.8 Describe the separation of two immiscible liquids using a separating funnel	
3.9 Describe the separation of mixtures of miscible liquids by fractional distillation, by referring to the fractional distillation of liquid air to produce nitrogen and oxygen	
3.10 Describe how paper chromatography can be used to separate and identify components of mixtures, including colouring agents in foodstuffs	Chromatography
3.11 Evaluate the information provided by paper chromatograms, including the calculation of R _f values, in a variety of contexts, such as the food industry and forensic science	Chromatography

Topic 4: Groups in the periodic table

4.1 Classify elements as alkali metals (group 1), halogens (group 7), noble gases (group 0) and transition metals based on their position in the periodic table	The Periodic Table
4.2 Describe the structure of metals as a regular arrangement of positive ions surrounded by a sea of delocalised electrons	Metals and Alloys
4.3 Describe and explain the properties of metals, limited to malleability and the ability to conduct electricity	Metals and Alloys
4.4 Recall that most metals are transition metals and that their typical properties include: a) high melting point; b) the formation of coloured compounds	Transition Metals
4.5 Demonstrate an understanding that elements and compounds can be classified as: a) ionic; b) simple molecular covalent; c) giant molecular covalent; d) metallic, and that each type of substance has different physical properties, including relative melting point and boiling point, relative solubility in water and ability to conduct electricity (as solids and in solution)	Ionic Compounds / Covalent Bonding / Giant Covalent Structures / Metals and Alloys
4.6 Describe alkali metals as: a) soft metals; b) metals with comparatively low melting points	Group 1 Alkali Metals
4.7 Describe the reactions of lithium, sodium and potassium with water to form hydroxides which are alkaline, and hydrogen gas	Group 1 Alkali Metals
4.8 Describe the pattern in reactivity of the alkali metals lithium, sodium and potassium with water, use this pattern to predict the reactivity of other alkali metals and (HT) explain the pattern	Group 1 Alkali Metals
4.9 Recall the colours and physical states of the halogens at room temperature	Group 7 Halogens
4.10 Describe the reaction of halogens with metals to form metal halides	Group 7 Halogens
4.11 Recall that halogens react with hydrogen to produce hydrogen halides which dissolve in water to form acidic solutions	Group 7 Halogens
4.12 Investigate displacement reactions of halogens reacting with halide ions in solution	Group 7 Halogens
4.13 Describe the relative reactivity of the halogens as shown by their displacement reactions with halide ions in aqueous solution	Group 7 Halogens
4.14 Describe the noble gases as chemically inert, compared with the other elements, and demonstrate an understanding that this lack of reactivity can be explained by the electronic arrangements in their atoms	Group 0 Noble Gases
4.15 Demonstrate an understanding that the discovery of the noble gases was due to chemists: a) noticing that the density of nitrogen made in a reaction differed from that of nitrogen obtained from air; b) developing a hypothesis about the composition of the air; c) performing experiments to test this hypothesis and show the presence of the noble gases	Group 0 Noble Gases

4.16 Relate the uses of the noble gases to their properties, including: a) inertness (including providing an inert atmosphere for welding and in filament lamps); b) low density (including filling balloons); c) non-flammability	Group 0 Noble Gases
4.17 Use the pattern in a physical property of the noble gases, such as boiling point or density, to estimate an unknown value for another member of the group	Group 0 Noble Gases

Topic 5: Chemical reactions

5.1 Measure temperature changes accompanying some of the following types of change: a) salts dissolving in water; b) neutralisation reactions; c) displacement reactions; d) precipitation reactions	Energy and Reactions
5.2 Define an exothermic change or reaction as one in which heat energy is given out, including combustion reactions or explosions	Energy and Reactions
5.3 Define an endothermic change or reaction as one in which heat energy is taken in, including photosynthesis or dissolving ammonium nitrate in water	Energy and Reactions
5.4 Describe the breaking of bonds as endothermic and the making of bonds as exothermic	Energy and Reactions
5.5 Demonstrate an understanding that the overall heat energy change for a reaction is: a) exothermic if more heat energy is released making bonds in the products than is required to break bonds in the reactants; b) endothermic if less heat energy is released making bonds in the products than is required to break bonds in the reactants	Energy and Reactions
5.6 (HT) Draw and interpret simple graphical representations of energy changes occurring in chemical reactions (no knowledge of activation energy is required)	Energy and Reactions
5.7 Investigate the effect of temperature, concentration and surface area of a solid on the rate of a reaction such as hydrochloric acid and marble chips	Changing Reaction Rates
5.8 Recall that the rates of chemical reactions vary from very fast, explosive reactions to very slow reactions	Measuring Reaction Rates
5.9 Describe the effect of changes in temperature, concentration and surface area of a solid on the rate of reaction	Changing Reaction Rates
5.10 Describe how reactions can occur when particles collide and (HT) explain how rates of reaction are increased by increasing the frequency and/or energy of collisions	Changing Reaction Rates
5.11 (HT) Demonstrate an understanding that not all collisions lead to a reaction, especially if particles collide with low energy	Changing Reaction Rates
5.12 Recall the effect of a catalyst on the rate of reaction	Catalysts
5.13 Demonstrate an understanding that catalytic converters in cars: a) have a high surface area to increase the rate of reaction of carbon monoxide and unburnt fuel from exhaust gases with oxygen from the air to produce carbon dioxide and water; b) work best at high temperatures	Catalysts

Topic 6: Quantitative chemistry

6.1 Calculate relative formula mass given relative atomic masses	Formulae and Equations
6.2 Calculate the formulae of simple compounds from reacting masses and understand that these are empirical formulae	Formulae and Equations
6.3 Determine the empirical formula of a simple compound, such as magnesium oxide	Formulae and Equations
6.4 Calculate the percentage composition by mass of a compound from its formula and the relative atomic masses of its constituent elements	Formulae and Equations
6.5 (HT) Use balanced equations to calculate masses of reactants and products	Quantitative Chemistry
6.6 Recall that the yield of a reaction is the mass of product obtained in the reaction	

6.7 Demonstrate an understanding that the actual yield of a reaction is usually less than the yield calculated using the chemical equation (theoretical yield)	Yield
6.8 Calculate the percentage yield of a reaction from the actual yield and the theoretical yield	Yield
6.9 Demonstrate an understanding of the reasons why reactions do not give the theoretical yield due to factors, including: a) incomplete reactions; b) practical losses during the preparation; c) competing, unwanted reactions	Yield
6.10 Demonstrate an understanding that many reactions produce waste products which: a) are not commercially useful; b) can present economic, environmental and social problems for disposal	Yield
6.11 (HT) Demonstrate an understanding that chemists in industry work to find the economically most favourable reactions where: a) the percentage yield is high; b) all the products of the reaction are commercially useful; c) the reaction occurs at a suitable speed	Yield

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GCSE Additional Science: Physics

Unit P2: Physics for your future
Boardworks presentation

0.1 Use equations given in this unit, or in a given alternate form	Throughout
0.2 Use and rearrange equations given in this unit	Throughout
0.3 Demonstrate an understanding of which units are required in equations	Throughout

Topic 1: Static and current electricity

1.1 Describe the structure of the atom, limited to the position, mass and charge of protons, neutrons and electrons	Atoms and Isotopes
1.2 Explain how an insulator can be charged by friction, through the transfer of electrons	Static Electricity
1.3 Explain how the material gaining electrons becomes negatively charged and the material losing electrons is left with an equal positive charge	Static Electricity
1.4 Recall that like charges repel and unlike charges attract	Static Electricity
1.5 Demonstrate an understanding of common electrostatic phenomena in terms of movement of electrons, including: a) shocks from everyday objects; b) lightning; c) attraction by induction such as a charged balloon attracted to a wall and a charged comb picking up small pieces of paper	Static Electricity
1.6 Explain how earthing removes excess charge by movement of electrons	Static Electricity
1.7 Explain some of the uses of electrostatic charges in everyday situations, including paint and insecticide sprayers	Static Electricity
1.8 Demonstrate an understanding of some of the dangers of electrostatic charges in everyday situations, including fuelling aircraft and tankers together with the use of earthing to prevent the build-up of charge and danger arising	Static Electricity
1.9 Recall that an electric current is the rate of flow of charge	Electrical Circuits
1.10 Recall that the current in metals is a flow of electrons	Electrical Circuits
1.11 Use the equation: charge (coulomb, C) = current (ampere, A) x time (second, s) $Q = I \times t$	Electrical Circuits
1.12 Recall that cells and batteries supply direct current (d.c.)	Electricity Supply
1.13 Demonstrate an understanding that direct current (d.c.) is movement of charge in one direction only	Electricity Supply

Topic 2: Controlling and using electric current

2.1 Describe how an ammeter is placed in series with a component to measure the current, in amps, in the component	Electrical Circuits
2.2 Explain how current is conserved at a junction	Series and Parallel Circuits
2.3 Explain how the current in a circuit depends on the potential difference of the source	Current, Voltage and Resistance
2.4 Describe how a voltmeter is placed in parallel with a component to measure the potential difference (voltage), in volts, across it	Electrical Circuits
2.5 (HT) Demonstrate an understanding that potential difference (voltage) is the energy transferred per unit charge passed and hence that the volt is a joule per coulomb	Electrical Circuits
2.6 Investigate the relationship between potential difference (voltage), current and resistance	Current, Voltage and Resistance
2.7 Explain how changing the resistance in a circuit changes the current and how this can be achieved using a variable resistor	Current, Voltage and Resistance
2.8 Use the equation: potential difference (volt, V) = current (ampere, A) x resistance (ohm, Ω) $V = I \times R$	Current, Voltage and Resistance
2.9 Demonstrate an understanding of how current varies with potential difference for the following devices a) filament lamps; b) diodes; c) fixed resistors	Current, Voltage and Resistance / Circuit Components
2.10 Demonstrate an understanding of how the resistance of a lightdependent resistor (LDR) changes with light intensity	Circuit Components

2.11 Demonstrate an understanding of how the resistance of a thermistor changes with change of temperature (negative temperature coefficient thermistors only)	Circuit Components
2.12 Explain why, when there is an electric current in a resistor, there is an energy transfer which heats the resistor	Circuit Components
2.13 (HT) Explain the energy transfer (in 2.12 above) as the result of collisions between electrons and the ions in the lattice	Circuit Components
2.14 Distinguish between the advantages and disadvantages of the heating effect of an electric current	Circuit Components
2.15 Use the equation: electrical power (watt, W) = current (ampere, A) x potential difference (volt, V) $P = I \times V$	Electrical Power
2.16 Use the equation: energy transferred (joule, J) = current (ampere, A) x potential difference (volt, V) x time (second, s) $E = I \times V \times t$	Electrical Power

Topic 3: Motions and forces

3.1 Demonstrate an understanding of the following as vector quantities: a) displacement; b) velocity; c) acceleration; d) force	Speed
3.2 Interpret distance/time graphs including determination of speed from the gradient	Speed
3.3 Recall that velocity is speed in a stated direction	Speed
3.4 Use the equation: speed (m/s) = distance (m) / time (s)	Speed
3.5 Use the equation: acceleration (metre per second squared, m/s ²) = change in velocity (metre per second, m/s) / time taken (second, s) $a = (v - u)/t$	Speed
3.6 Interpret velocity/time graphs to: a) compare acceleration from gradients qualitatively; b) calculate the acceleration from the gradient (for uniform acceleration only); c) (HT) determine the distance travelled using the area between the graph line and the time axis (for uniform acceleration only)	Speed
3.7 Draw and interpret a free-body force diagram	Forces
3.8 Demonstrate an understanding that when two bodies interact, the forces they exert on each other are equal in size and opposite in direction and that these are known as action and reaction forces	Forces
3.9 Calculate a resultant force using a range of forces (limited to the resultant of forces acting along a line) including resistive forces	Forces
3.10 Demonstrate an understanding that if the resultant force acting on a body is zero, it will remain at rest or continue to move at the same velocity	Forces
3.11 Demonstrate an understanding that if the resultant force acting on a body is not zero, it will accelerate in the direction of the resultant force	Forces
3.12 Demonstrate an understanding that a resultant force acting on an object produces an acceleration which depends on: a) the size of the resultant force; b) the mass of the object	Speed
3.13 Use the equation: force (newton, N) = mass (kilogram, kg) x acceleration (metre per second squared, m/s ²) $F = m \times a$	Speed
3.14 Use the equation: weight (newton, N) = mass (kilogram, kg) x gravitational field strength (newton per kilogram, N/kg) $W = m \times g$	Falling Objects
3.15 Investigate the relationship between force, mass and acceleration	Speed
3.16 Recall that in a vacuum all falling bodies accelerate at the same rate	Falling Objects
3.17 Demonstrate an understanding that: a) when an object falls through an atmosphere air resistance increases with increasing speed b) air resistance increases until it is equal in size to the weight of the falling object; c) when the two forces are balanced, acceleration is zero and terminal velocity is reached	Falling Objects

Topic 4: Momentum, energy, work and power	
4.1 Recall that the stopping distance of a vehicle is made up of the sum of the thinking distance and the braking distance	Stopping Distances
4.2 Demonstrate an understanding of the factors affecting the stopping distance of a vehicle, including: a) the mass of the vehicle; b) the speed of the vehicle; c) the driver's reaction time; d) the state of the vehicle's brakes; e) the state of the road; f) the amount of friction between the tyre and the road surface	Stopping Distances
4.3 Investigate the forces required to slide blocks along different surfaces, with differing amounts of friction	Stopping Distances
4.4 Use the equation: momentum (kilogram metre per second, kg m/s) = mass (kilogram, kg) × velocity (metre per second, m/s) to calculate the momentum of a moving object	Momentum and Collisions
4.5 Demonstrate an understanding of momentum as a vector quantity	Momentum and Collisions
4.6 Demonstrate an understanding of the idea of linear momentum conservation	
4.7 Demonstrate an understanding of the idea of rate of change of momentum to explain protective features including bubble wraps, seat belts, crumple zones and air bags	Momentum and Collisions
4.8 Investigate how crumple zones can be used to reduce the forces in collisions	Car Safety
4.9 (HT) Use the equation: force (newton, N) = change in momentum (kilogram metre per second, kg m/s) / time (second, s) $F = (mv - mu) / t$ to calculate the change in momentum of a system, as in 4.6	Momentum and Collisions
4.10 Use the equation: work done (joule, J) = force (newton, N) x distance moved in the direction of the force (metre, m) $E = F \times d$	Work and Power
4.11 Demonstrate an understanding that energy transferred (joule, J) is equal to work done (joule, J)	Work and Power
4.12 Recall that power is the rate of doing work and is measured in watts, W	Work and Power
4.13 Use the equation: power (watt, W) = work done (joule, J) / time taken (second, s) $P = E / t$	Work and Power
4.14 Recall that one watt is equal to one joule per second, J/s	Work and Power
4.15 Use the equation: gravitational potential energy (joule, J) = mass (kilogram, kg) x gravitational field strength (newton per kilogram, N/kg) x vertical height (metre, m) $GPE = m \times g \times h$	Potential and Kinetic Energy
4.16 Use the equation: kinetic energy (joule, J) = $\frac{1}{2}$ x mass (kilogram, kg) x velocity ² ((metre/second) ² (m/s) ²) $KE = \frac{1}{2} \times m \times v^2$	Potential and Kinetic Energy
4.17 Demonstrate an understanding of the idea of conservation of energy in various energy transfers	Potential and Kinetic Energy
4.18 (HT) Carry out calculations on work done to show the dependence of braking distance for a vehicle on initial velocity squared (work done to bring a vehicle to rest equals its initial kinetic energy)	Stopping Distances
Topic 5: Nuclear fission and nuclear fusion	
5.1 Describe the structure of nuclei of isotopes using the terms atomic (proton) number and mass (nucleon) number and using symbols	Atoms and Isotopes
5.2 Explain how atoms may gain or lose electrons to form ions	Atoms and Isotopes
5.3 Recall that alpha and beta particles and gamma rays are ionising radiations emitted from unstable nuclei in a random process	Radioactive Substances
5.4 Recall that an alpha particle is equivalent to a helium nucleus, a beta particle is an electron emitted from the nucleus and a gamma ray is electromagnetic radiation	Radioactive Decay
5.5 Compare alpha, beta and gamma radiations in terms of their abilities to penetrate and ionise	Ionizing Radiation

5.6 Demonstrate an understanding that nuclear reactions can be a source of energy, including fission, fusion and radioactive decay	Nuclear Fuels and Fission
5.7 Explain how the fission of U-235 produces two daughter nuclei and two or more neutrons, accompanied by a release of energy	Nuclear Fuels and Fission
5.8 Explain the principle of a controlled nuclear chain reaction	Nuclear Fuels and Fission
5.9 Explain how the chain reaction is controlled in a nuclear reactor including the action of moderators and control rods	Nuclear Fuels and Fission
5.10 Describe how thermal (heat) energy from the chain reaction is converted into electrical energy in a nuclear power station	Nuclear Fuels and Fission
5.11 Recall that the products of nuclear fission are radioactive	Nuclear Fuels and Fission
5.12 Describe nuclear fusion as the creation of larger nuclei from smaller nuclei, accompanied by a release of energy and recognise fusion as the energy source for stars	Nuclear Fusion
5.13 Explain the difference between nuclear fusion and nuclear fission	Nuclear Fusion
5.14 (HT) Explain why nuclear fusion does not happen at low temperatures and pressures, due to electrostatic repulsion of protons	Nuclear Fusion
5.15 (HT) Relate the conditions for fusion to the difficulty of making a practical and economic form of power station	Nuclear Fusion
5.16 Demonstrate an understanding that new scientific theories, such as 'cold fusion', are not accepted until they have been validated by the scientific community	Nuclear Fusion

Topic 6: Advantages and disadvantages of using radioactive materials

6.1 Explain what is meant by background radiation, including how regional variations within the UK are caused in particular by radon gas	Radioactive Substances
6.2 Recall the origins of background radiation from Earth and space	Radioactive Substances
6.3 Describe uses of radioactivity, including: a) household fire (smoke) alarms; b) irradiating food; c) sterilisation of equipment; d) tracing and gauging thicknesses; e) diagnosis and treatment of cancer	Ionizing Radiation
6.4 Describe how the activity of a radioactive source decreases over a period of time	Half-life
6.5 Recall that the unit of activity of a radioactive isotope is the Becquerel, Bq	Half-life
6.6 Recall that the half-life of a radioactive isotope is the time taken for half the undecayed nuclei to decay	Half-life
6.7 Use the concept of half-life to carry out simple calculations on the decay of a radioactive isotope, including graphical representations	Half-life
6.8 Investigate models which simulate radioactive decay	Radioactive Decay
6.9 Demonstrate an understanding of the dangers of ionising radiation in terms of tissue damage and possible mutations and relate this to the precautions needed	Ionizing Radiation
6.10 Describe how scientists have changed their ideas of radioactivity over time, including: a) the awareness of the hazards associated with radioactive sources; b) why the scientific ideas change over time	Ionizing Radiation
6.11 Discuss the long-term possibilities for storage and disposal of nuclear waste	Half-life
6.12 Evaluate the advantages and disadvantages of nuclear power for generating electricity, including the lack of carbon dioxide emissions, risks, public perception, waste disposal and safety issues	Nuclear Fuels and Fission