Key Stage 4 Scheme of Work

MERIT
wellbeing and learning for life

Subject: Science

Long Term Planning

Y10 and Y11

Science AQA GCSE GRADES 9-1

Year 10 Long term Plan (5 lessons per week). A 6 week half term has approx. 30 lessons Year 10 curriculum is Paper 1 material. Year 11 is paper 2 material

TERM Y10	Sept 2024	Lessons		lessons	to Oct 2024	Lessons
	Chemistry		**Biology**		**Physics**	
Autumn 1	**Atomic structure** **Substantive**: A simple model of the atom, symbols, relative atomic mass, electronic charge and isotopes. The periodic table provides chemists with a structured organisation of the known chemical elements from which they can make sense of their physical and chemical properties. The historical development of	8	**Cell biology** **Substantive:** Cell structure; Cell division; Transport in cells. Cells are the basic unit of all forms of life. We explore how structural differences between types of cells enables them to perform specific functions within the organism. These differences in cells are controlled by genes in the nucleus. For an organism to function, substances move into and out	14	**Energy** **Substantive:** Energy changes in a system, and the ways energy is stored before and after such changes; Energy stores and transfers (kinetic, gravitational potential, thermal, etc.). Conservation and dissipation of energy; National and global energy resources). Efficiency and methods to reduce energy wastage.	9

	the periodic table and models of atomic structure provide good examples of how scientific ideas and explanations develop over time as new evidence emerges. The arrangement of elements in the modern periodic table can be explained in terms of atomic structure/trends in reactivity as well as providing evidence for the model of a nuclear atom with electrons in energy levels. NC: Atomic structure and the Periodic Table ♣ a simple model of the atom consisting of the nucleus and electrons, relative atomic mass, electronic charge and isotopes ♣ the number of particles in a given mass of a substance ♣ the modern Periodic Table, showing elements arranged in order of atomic number ♣ position of elements in the Periodic Table in relation to their atomic structure and		of cells using diffusion, osmosis and active transport. For an organism to grow, cells must divide by mitosis producing two new identical cells. If cells are isolated at an early stage of growth before they have become too specialised, they can retain their ability to grow into a range of different types of cells; development of stem cell technology. This is a new branch of medicine that allows doctors to repair damaged organs by growing new tissue from stem cells. NC: Cell biology ♣ cells as the basic structural unit of all organisms; adaptations of cells related to their functions; the main sub-cellular structures of eukaryotic and prokaryotic cells ♣ stem cells in animals and meristems in plants ♣ the need for transport systems in multicellular organisms, including plants **Disciplinary:** Use of light microscopes to observe and compare cells. Evaluating the		The concept of energy emerged in the 19th century. The idea was used to explain the work output of steam engines and then generalised to understand other heat engines. It also became a key tool for understanding chemical reactions and biological systems. Renewable and non-renewable energy resources. Limits to the use of fossil fuels and global warming are critical problems for this century. Physicists and engineers are working hard to identify ways to reduce our energy usage. NC: Energy ♣ energy changes in a system involving heating, doing work using forces, or doing work using an electric current; calculating the stored energies and energy changes involved ♣ power as the rate of transfer of energy ♣ conservation of energy in a closed system; dissipation ♣ calculating energy efficiency for any energy transfers ♣ renewable and non-renewable energy sources used on Earth; changes in how these are used.	

	arrangement of outer electrons Science 220 ♣ properties and trends in properties of elements in the same group ♣ characteristic properties of metals and non-metals ♣ chemical reactivity of elements in relation to their position in the Periodic Table. **Disciplinary:** Interpreting data on subatomic particles and isotopes. Using models to explain atomic structure. Identifying patterns and trends in the periodic table. Predicting properties of elements based on their group. **Mathematical requirements** ***Arithmetic and numerical computation*** *1b Recognise and use expressions in standard form* *1d Make estimates of the results of simple calculations*		ethical implications of using stem cells. Designing experiments to investigate osmosis. ***Required practical activity** 1: use a light microscope to observe, draw and label a selection of plant and animal cells. A magnification scale must be included. AT skills covered by this practical activity: biology AT 1 and 7. This practical activity also provides opportunities to develop WS and MS.* ***Required practical activity 2**: investigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue. AT skills covered by this practical activity: biology AT 1, 3 and 5. This practical activity also provides opportunities to develop WS and MS.* **Mathematical requirements** 1a Recognise and use expressions in decimal form. 2b Find arithmetic means. 2h Make order of magnitude calculations 1d Make estimates of the results of simple calculations		**Disciplinary:** Using equations to calculate energy transfers and efficiency. Analyzing data to compare energy resources. Interpreting Sankey diagrams to illustrate energy efficiency. Evaluating the environmental impact of energy resources. **Mathematical requirements** ***Arithmetic and numerical computation*** *1a Recognise and use expressions in decimal form* *1c Use ratios, fractions and percentages* ***Handling data*** *2c Construct and interpret frequency tables and diagrams, bar charts and histograms* ***Algebra*** *3b Change the subject of an equation* *3c Substitute numerical values into algebraic equations using appropriate units for physical quantities (chemistry and physics questions only)*	

	Geometry and trigonometry *5b Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects (chemistry and physics questions only)*		3a Understand and use the symbols: =, <, <<, >>, >, ∝ , ~ 3b Change the subject of an equation 1c Use ratios, fractions and percentages 5c Calculate areas of triangles and rectangles, surface areas and volumes of cubes 4a Translate information between graphical and numeric form 4b Understand that $y = mx + c$ represents a linear relationship 4c Plot two variables from experimental or other data 4d Determine the slope and intercept of a linear graph.		***Graphs*** *4a Translate information between graphical and numeric form*	
	C5.1: The periodic table (Development of the periodic table; Metals and non-metals; Group 0, Group 1 and Group 7).	5				
TCs	**Threshold concepts for all Chemistry topics:** TC1: Be familiar with, and use, technical terminology accurately; building up an		**Threshold concepts for all Biology topics:** TC1: Be familiar with, and		**Threshold concepts for all Physics topics:** TC1: Be familiar with, and use, technical terminology accurately;	

	extended specialist vocabulary TC2: To view chemistry at the molecular (sub microscopic level), observational (macroscopic) and symbolic levels. TC3: To explain the manifestations of the principle of 'electron configuration' through several chemical reactions. TC4: To symbolically describe chemical reactions using the language of redox, of word, of chemical and of ionic equations. TC5: To apply the three control, independent and dependent variables to a fair test investigation. TC6: Investigations including, making predictions, writing a method, analysing results and writing a conclusion. TC7: To understand changes of state through intermolecular forces and the strength of these forces determines the required temperature TC8: Surface area to volume ratio (SA:Vol) – governs many key processes inducing the rate of chemical reactions, heat loss, oxygen uptake,		use, technical terminology accurately; building up an extended specialist vocabulary TC2: Understand the structure-function relationship and that every structural feature helps serve a particular function within the molecular-, cellular-, tissue-, organ- and organ system- levels. TC3: Living organisms may form populations of single species, communities of many species and ecosystems, interacting with each other, with the abiotic/biotic factors of the environment TC4: Life on Earth is dependent on photosynthesis in which green plants produce organic compounds and oxygen TC5: To apply the three control, independent and dependent variables to a fair test investigation. TC6: Investigations including, making predictions, writing a method, analysing results and writing a conclusion. TC7: These organic compounds are used as fuels in cellular respiration and the manufacture of macromolecules necessary for life TC8: The chemicals in ecosystems are continually cycling through the natural world		building up an extended specialist vocabulary TC2: The use of models, as in the particle model of matter or the wave models of light and of sound TC3: The concept of cause and effect in explaining such links as those between force and acceleration, or between changes in atomic nuclei and radioactive emissions TC4: The phenomena of 'action at a distance,' and the related concept of the field as the key to analysing electrical, magnetic and gravitational effects TC5: To apply the three control, independent and dependent variables to a fair test investigation. TC6: Investigations including, making predictions, writing a method, analysing results and writing a conclusion. TC7: That differences, for example between pressures or temperatures or electrical potentials, are the drivers of change TC8: That proportionality, for example between weight and mass of an object or between force and extension in a spring, is an	

	diffusion and osmosis, absorption and metabolism.		TC9: The characteristics of a living organism are influenced by its genome and its interaction with the environment TC10: Evolution occurs by a process of natural selection and accounts both for biodiversity and how organisms are all related to varying		important aspect of many models in science. TC9: That energy is the capacity of a system to perform work or to cause change.	
AOs	AO1: Demonstrate knowledge and understanding of: scientific ideas; scientific techniques and procedures. AO2: Apply knowledge and understanding of: scientific ideas; scientific enquiry, techniques and procedures. AO3: Analyse information and ideas to: interpret and evaluate; make judgments and draw conclusions; develop and improve experimental procedures.		AO1: Demonstrate knowledge and understanding of: scientific ideas; scientific techniques and procedures. AO2: Apply knowledge and understanding of: scientific ideas; scientific enquiry, techniques and procedures. AO3: Analyse information and ideas to: interpret and evaluate; make judgments and draw conclusions; develop and improve experimental procedures.		AO1: Demonstrate knowledge and understanding of: scientific ideas; scientific techniques and procedures. AO2: Apply knowledge and understanding of: scientific ideas; scientific enquiry, techniques and procedures. AO3: Analyse information and ideas to: interpret and evaluate; make judgments and draw conclusions; develop and improve experimental procedures.	
Hinterland	*-Learn about the history of the atom; the scientists that were mainly responsible for hypothesising the existence of atoms /sub atomic particles.*		*-Understand how microscopy techniques have developed over time.* *-Explore some of the careers that are linked to Cell Biology* *-Cell Biology applies to gardening practises, farming practises, developing vaccines,*		*-Explore non-renewable energy resources and their impact on the environment.* *-Explore renewable energy resources, their advantages and disadvantages; comparing their use with non-renewable resources.*	

	-Describe the contributions of Marie Curie and Frederick Soddy to enhance our understanding of isotopes and the atomic model. *-Learn about the Scientists (Newlands and Mendeleev) that have contributed towards the current day periodic table.*		*developing medications, and most importantly, providing much better health care services to the people.*		*-Learn about the work of Esther Takeuchi, a materials scientist and chemical engineer, working on energy storage systems and power sources for biomedical devices.*	
	From Nov 2024 (after Oct half term)	**Lessons**			**To Dec 2024**	**Lessons**
	Chemistry		**Biology**		**Physics**	
Autumn 2	**Bonding, structure and properties of matter** **Substantive:** Chemists use theories of structure and bonding (ionic, covalent, metallic) to explain the physical and chemical properties of materials. Analysis of structures shows that atoms can be arranged in a variety of ways, some of which are molecular while others are giant structures. Theories of bonding explain how atoms are held together in these structures. Scientists use this knowledge of	15	**Organisation** **Substantive:** Principles of organisation; Animals: tissues, organs and systems; Plant tissues, organs and systems). The hierarchical organisation of multicellular organisms (cells → tissues → organs → organ systems). In this section we will learn about the human digestive system which provides the body with nutrients and the respiratory system that provides it with oxygen and removes carbon dioxide. In each case they provide dissolved materials that need	16		

	structure and bonding to engineer new materials with desirable properties. The properties of these materials (including polymers and nanotechnology) offer new applications in a range of different technologies. NC: Structure, bonding and the properties of matter changes of state of matter in terms of particle kinetics, energy transfers and the relative strength of chemical bonds and intermolecular forces types of chemical bonding: ionic, covalent, and metallic bulk properties of materials related to bonding and intermolecular forces bonding of carbon leading to the vast array of natural and synthetic organic compounds that occur due to the ability of carbon to form families of similar compounds, chains and rings		to be moved quickly around the body in the blood by the circulatory system. Damage to any of these systems can be debilitating if not fatal. Although there has been huge progress in surgical techniques, especially with regard to coronary heart disease, many interventions would not be necessary if individuals reduced their risks through improved diet and lifestyle. We will also learn how the plant's transport system is dependent on environmental conditions to ensure that leaf cells are provided with the water and carbon dioxide that they need for photosynthesis. NC: Transport systems ♣ the need for transport systems in multicellular organisms, including plants ♣ the relationship between the structure and functions of the human circulatory system Nutrition and digestion ♣ content of a healthy human diet: carbohydrates, lipids (fats and oils), proteins,			

	structures, bonding and properties of diamond, graphite, fullerenes and graphene **Disciplinary:** Drawing dot-and-cross diagrams to represent bonds. Explaining properties (e.g., melting point, conductivity) using bonding models. Evaluating the benefits and risks of nanotechnology. **<u>Mathematical requirements</u>** ***Arithmetic and numerical computation*** *1a Recognise and use expressions in decimal form* *1c Use ratios, fractions and percentages* ***Graphs*** *4a Translate information between graphical and numeric form* ***Geometry and trigonometry*** *5b Visualise and represent 2D and 3D forms including*		vitamins, minerals, dietary fibre and water, and why each is needed ♣ calculations of energy requirements in a healthy daily diet ♣ the consequences of imbalances in the diet, including obesity, starvation and deficiency diseases ♣ the tissues and organs of the human digestive system, including adaptations to function and how the digestive system digests food (enzymes simply as biological catalysts) ♣ the importance of bacteria in the human digestive system ♣ plants making carbohydrates in their leaves by photosynthesis and gaining mineral nutrients and water from the soil via their roots. Gas exchange systems ♣ the structure and functions of the gas exchange system in humans, including adaptations to function **Disciplinary**: Evaluating the impact of lifestyle factors (e.g., smoking, diet) on health. ***Required practical activity 3****: Use qualitative reagents to*			

	two dimensional representations of 3D objects (chemistry and physics questions only) *5c Calculate areas of triangles and rectangles, surface areas and volumes of cubes*		*test for a range of carbohydrates, lipids and proteins. To include: Benedict's test for sugars; iodine test for starch; and Biuret reagent for protein. AT skills covered by this practical activity: biology AT 2. This practical activity also provides opportunities to develop WS and MS.* Interpretation of enzyme activity graphs (temperature, pH). ***Required practical activity 4****: investigate the effect of pH on the rate of reaction of amylase enzyme. Students should use a continuous sampling technique to determine the time taken to completely digest a starch solution at a range of pH values. AT skills covered by this practical activity: biology AT 1, 2 and 5. This practical activity also provides opportunities to develop WS and MS.* **Mathematical requirements** ***Arithmetic and numerical computation*** *1a Recognise and use expressions in decimal form*			

			1c Use ratios, fractions and percentages ***Handling data*** *2c Construct and interpret frequency tables and diagrams, bar charts and histograms* *2d Understand the principles of sampling as applied to scientific data (biology questions only)* *2g Use a scatter diagram to identify a correlation between two variables (biology and physics* *questions only)* ***Graphs*** *4a Translate information between graphical and numeric form* ***Geometry and trigonometry*** *5c Calculate areas of triangles and rectangles, surface areas and volumes of cubes*			
TCs	**As above**		**As above**		**As above**	
AOs	**As above**		**As above**			
Hinterland			***-Careers involved in the field of food science.*** ***-Study the discovery of M Menten (enzymes and substrates) and how this***			

			impacted on what we know about science and how it's still useful in today's society.			
	Jan 2025 (after Xmas)	**Lessons**		**Lessons**	**To Feb 2025**	**Lessons**
	Chemistry		**Biology**		**Physics**	
Spring 1			**Infection and response** **Substantive:** Communicable diseases; Defence systems; Vaccines; Antibiotics; Discovery and development of drugs Pathogens such as viruses, bacteria, protists and fungi that cause infectious diseases in animals and plants. They depend on their host to provide the conditions and nutrients that they need to grow and reproduce. They frequently produce toxins that damage tissues and make us feel ill. Explore how we can avoid diseases by reducing contact with them, and how the body uses barriers against pathogens. Once inside the body our immune system is triggered which is usually strong enough to destroy the pathogen and prevent disease. When at risk from unusual/dangerous diseases	17	**Energy** continued **Substantive:** Energy changes in a system, and the ways energy is stored before and after such changes; Conservation and dissipation of energy; National and global energy resources. ***Required practical activity 14**: an investigation to determine the specific heat capacity of one or more materials. The investigation will involve linking the decrease of one energy store (or work done) to the increase in temperature and subsequent increase in thermal energy stored. AT skills covered by this practical activity: physics AT 1 and 5. This practical activity also provides opportunities to develop WS and MS*	9

			our body's natural system can be enhanced by the use of vaccination/range of antibiotics have been developed which have proved successful against a number of lethal diseases caused by bacteria. The development of drugs, including preclinical and clinical trials. Unfortunately, many groups of bacteria have now become resistant to these antibiotics. The race is now on to develop a new set of antibiotics. NC: Health, disease and the development of medicines ♣ the relationship between health and disease ♣ communicable diseases including sexually transmitted infections in humans (including HIV/AIDs) ♣ non-communicable diseases ♣ bacteria, viruses and fungi as pathogens in animals and plants ♣ body defences against pathogens and the role of the immune system against disease ♣ reducing and preventing the spread of infectious diseases in animals and plants ♣ the process of			

			discovery and development of new medicines ♣ the impact of lifestyle factors on the incidence of non-communicable diseases. **Disciplinary:** Analyzing data on the spread of diseases. Evaluating the benefits and risks of vaccines. Understanding and explaining the processes of drug testing and approval. Investigating antiseptic effectiveness using agar plates.			
TCs	**As above**		**As above**		**As above**	
AOs			**As above**		**As above**	
Hinterland			• ***Careers linked with knowledge of infection.*** • ***Study Kelly Chibale an african scientist that founded two drug discovery centres!*** •			

	Feb 2025 (after Feb half term	Lessons		Lessons	To April 2025	Lessons
Spring 2	**Chemical changes** **Substantive:** Understanding of chemical changes began when people began experimenting with chemical reactions in a systematic way and organising their results logically. Knowing about these different chemical changes meant that scientists could begin to predict exactly what new substances would be formed and use this knowledge to develop a wide range of different materials and processes using (neutralisations, extractions, displacements, electrolysis). It also helped biochemists to understand the complex reactions that take place in living organisms. Reactivity of metals including oxidation and reduction in terms of electrons (**HT only**); Reactions of acids	15			**Electricity** **Substantive:** Current, potential difference and resistance; Ohm's Law, Series and parallel circuits; electrical power and energy transfer in circuits, Domestic uses, mains voltage, plugs and safety; Energy transfers). The National grid and its role in electricity transmission Electric charge is a fundamental property of matter everywhere. Many circuits are powered with mains electricity, but portable electrical devices must use batteries of some kind. Electrical power fills the modern world with artificial light and sound, information and entertainment, remote sensing and control. The fundamentals of electromagnetism were worked out by scientists of the 19th century. However, power stations, like all machines, have a limited lifetime. If we all continue to demand more electricity this means building new power stations in every generation – but what mix of	17

	including strong and weak acids (**HT only**); Electrolysis including Representation of reactions at electrodes as half equations (**HT only**). NC: Chemical changes ♣ balanced chemical equations, ionic equations and state symbols ♣ the chemistry of acids; reactions with some metals and carbonates ♣ pH as a measure of hydrogen ion concentration and its numerical scale ♣ electrolysis of molten ionic liquids and aqueous ionic solutions ♣ reduction and oxidation in terms of loss or gain of oxygen. **Disciplinary Knowledge:** Investigating reactivity series through experiments. ***Required practical activity 8**: preparation of a pure, dry sample of a soluble salt from an insoluble oxide or carbonate, using a Bunsen burner to heat dilute acid and a water bath or electric heater to*				power stations can promise a sustainable future? NC: Electricity ♣ measuring resistance using p.d. and current measurements ♣ exploring current, resistance and voltage relationships for different circuit elements, including their graphical representations ♣ quantity of charge flowing as the product of current and time ♣ drawing circuit diagrams; exploring equivalent resistance for resistors in series ♣ the domestic a.c. supply; live, neutral and earth mains wires; safety measures ♣ power transfer related to p.d. and current, or current and resistance. **Disciplinary Knowledge:** Setting up and testing series and parallel circuits. Using multimeters to measure current, voltage, and resistance. Plotting I-V characteristics for different components (e.g., filament lamps, diodes). Evaluating the efficiency and safety of electrical appliances. ***Required practical activity 15**: use circuit diagrams to set up*	

	evaporate the solution. AT skills covered by this practical activity: chemistry AT 2, 3, 4 and 6. This practical activity also provides opportunities to develop WS and MS. ***Required practical activity 9:*** *investigate what happens when aqueous solutions are electrolysed using inert electrodes. This should be an investigation involving developing a hypothesis. AT skills covered by this practical activity: chemistry AT 3 and 7. This practical activity also provides opportunities to develop WS and MS.* **Mathematical requirements** ***Handling data*** *2h Make order of magnitude calculations*				*and check appropriate circuits to investigate the factors affecting the resistance of electrical circuits. This should include: • the length of a wire at constant temperature • combinations of resistors in series and parallel. AT skills covered by this practical activity: physics AT 1, 6 and 7. This practical activity also provides opportunities to develop WS and MS.* ***Required practical activity 16****: use circuit diagrams to construct appropriate circuits to investigate the I–V characteristics of a variety of circuit elements, including a filament lamp, a diode and a resistor at constant temperature. AT skills covered by this practical activity: physics AT 6 and 7. This practical activity also provides opportunities to develop WS and MS* **Mathematical requirements** ***Arithmetic and numerical computation*** *1c Use ratios, fractions and percentages* ***Handling data***	

					2c Construct and interpret frequency tables and diagrams, bar charts and histograms ***Algebra*** *3b Change the subject of an equation* *3c Substitute numerical values into algebraic equations using appropriate units for physical quantities (chemistry and physics questions only)* *3d Solve simple algebraic equations (biology and physics questions only)* ***Graphs*** *4c Plot two variables from experimental or other data* *4d Determine the slope and intercept of a linear graph* *4e Draw and use the slope of a tangent to a curve as a measure of rate of change (chemistry and physics questions only)*	
TCs	**As above**				**As above**	
AOs	**As above**				**As above**	
Hinterland	***Careers and everyday reactions with Chemical Changes.*** ***Humphry Davy discovered a number of new elements, e.g. potassium***				***Consider the features of UK mains supply and three core cable; Explain the use of live, neutral and earth wires.***	

	and sodium, by breaking down compounds of potassium and sodium using electrolysis.					
	April 2025 (After Easter)	**Lessons**		**Lessons**	**To May 2025**	**Lessons**
Summer 1	**Quantitative Chemistry** **Substantive:** Chemical measurements, conservation of mass and the quantitative interpretation of chemical equations; Use of amount of substance in relation to masses of pure substances e.g. moles (**HT only**); The concept of the mole and molar mass. Balancing chemical equations. Calculating reacting masses and yields. Concentration of solutions (g/dm^3 and mol/dm^3). Understanding percentage yield and atom economy. Chemists use quantitative analysis to determine the formulae of compounds and the equations for reactions. Given this	10			**Particle model of matter** **Substantive:** Changes of state and the particle model; Internal energy and energy transfers; Particle model and pressure States of matter and changes of state (solid, liquid, gas). The particle model and density calculations. Internal energy and the concepts of specific heat capacity and specific latent heat The particle model is widely used to predict the behaviour of solids, liquids and gases and this has many applications in everyday life. It helps us to explain a wide range of observations and engineers use these principles when designing vessels to withstand high temperatures, such as submarines and spacecraft. It also explains why it is difficult to make a good cup of tea high up a mountain!	10

	information, analysts can then use quantitative methods to determine the purity of chemical samples and to monitor the yield from chemical reactions. Chemical reactions can be classified in various ways. Identifying different types of chemical reaction allows chemists to make sense of how different chemicals react together, to establish patterns and to make predictions about the behaviour of other chemicals. Chemical equations provide a means of representing chemical reactions and are a key way for chemists to communicate chemical ideas. NC: Chemical analysis ♣ distinguishing between pure and impure substances ♣ separation techniques for mixtures of substances: filtration, crystallisation, chromatography, simple and fractional distillation ♣				NC: The structure of matter ♣ relating models of arrangements and motions of the molecules in solid, liquid and gas phases to their densities ♣ melting, evaporation, and sublimation as reversible changes ♣ calculating energy changes involved on heating, using specific heat capacity; and those involved in changes of state, using specific latent heat ♣ links between pressure and temperature of a gas at constant volume, related to the motion of its particles (qualitative). **Disciplinary Knowledge:** Analyzing particle behavior under different conditions. ***Required practical activity 17**: use appropriate apparatus to make and record the measurements needed to determine the densities of regular and irregular solid objects and liquids. Volume should be determined from the dimensions of regularly shaped objects, and by a displacement technique for irregularly shaped objects. Dimensions to be measured using appropriate apparatus such as a ruler,*	

	quantitative interpretation of balanced equations ♣ concentrations of solutions in relation to mass of solute and volume of solvent. **Disciplinary Knowledge:** Performing calculations involving moles and mass. Interpreting chemical equations and stoichiometry. Using experimental data to calculate yields. Evaluating the efficiency of reactions based on atom economy. **Mathematical requirements** ***Arithmetic and numerical computation*** *1a Recognise and use expressions in decimal form* *1b Recognise and use expressions in standard form* *1c Use ratios, fractions and percentages* ***Handling data*** *2a Use an appropriate number of significant figures*				*micrometer or Vernier callipers. AT skills covered by this practical activity: physics AT 1. This practical activity also provides opportunities to develop WS and MS* **Mathematical requirements** ***Arithmetic and numerical computation*** *1a Recognise and use expressions in decimal form* *1b Recognise and use expressions in standard form* *1c Use ratios, fractions and percentages* ***Algebra*** *3b Change the subject of an equation* *3c Substitute numerical values into algebraic equations using appropriate units for physical quantities (chemistry and physics questions only)* *3d Solve simple algebraic equations (biology and physics questions only)* ***Graphs*** *4a Translate information between graphical and numeric form*	

	Algebra *3a Understand and use the symbols:=, <, <<, >>, >,∝, ~* *3b Change the subject of an equation* *3c Substitute numerical values into algebraic equations using appropriate units for physical quantities (chemistry and physics questions only)*					
TCs	**As above**				**As above**	
A0s	**As above**				**As above**	
Hinterland					***Learn about the life of Joseph Black and his contribution to our understanding of specific latent and specific heat capacity.***	
	June 2025 (After May Half term)	**Lessons**		**No lessons**	**To July 2025**	**Lessons**
Summer 2	**Energy changes** **Substantive:** Exothermic and endothermic reaction including the energy change of reactions (**HT only**). Energy changes are an important part of chemical reactions. The interaction of particles often involves transfers of energy due to	12	**Bioenergetics** **Substantive:** Photosynthesis and Respiration. Explore how plants harness the Sun's energy (using chloroplasts) in photosynthesis (its equation, process, and limiting factors). in order to make food. This process liberates oxygen which has built up over millions of years in the Earth's	12	**Atomic structure** **Substantive:** The structure of the atom: protons, neutrons, and electrons. The discovery of the nucleus and the development of atomic models. Isotopes and radioactive decay (alpha, beta, gamma). Half-life and the random nature of radioactive decay, its use in radioactive	10

	the breaking and formation of bonds. Reactions in which energy is released to the surroundings are exothermic reactions, while those that take in thermal energy are endothermic. These interactions between particles can produce heating or cooling effects that are used in a range of everyday applications. Some interactions between ions in an electrolyte result in the production of electricity. Cells and batteries use these chemical reactions to provide electricity. Electricity can also be used to decompose ionic substances and is a useful means of producing elements that are too expensive to extract any other way. NC: Energy changes in chemistry ♣ Measurement of energy changes in chemical reactions		atmosphere. Both animals and plants use this oxygen to oxidise food in a process called aerobic respiration which transfers the energy that the organism needs to perform its functions. Conversely, anaerobic respiration does not require oxygen to transfer energy. During vigorous exercise the human body is unable to supply the cells with sufficient oxygen and it switches to anaerobic respiration. This process will supply energy but also causes the build-up of lactic acid in muscles which causes fatigue. NC: Photosynthesis ♣ photosynthesis as the key process for food production and therefore biomass for life ♣ the process of photosynthesis ♣ factors affecting the rate of photosynthesis Cellular respiration ♣ aerobic and anaerobic respiration in living organisms, including the breakdown of organic molecules to enable all the		dating and medical applications. Risks and benefits of radiation. Radioactive contamination. Ionising radiation is hazardous but can be very useful. Early researchers suffered from their exposure to ionising radiation. Rules for radiological protection were first introduced in the 1930s and subsequently improved. Today radioactive materials are widely used in medicine, industry, agriculture and electrical power generation. NC: Atomic structure ♣ the nuclear model and its development in the light of changing evidence ♣ masses and sizes of nuclei, atoms and small molecules ♣ differences in numbers of protons and neutrons related to masses and identities of nuclei; isotope characteristics and equations to represent changes ♣ ionisation; absorption or emission of radiation related to changes in electron orbits ♣ radioactive nuclei; emission of alpha or beta particles, neutrons, or gamma-rays, related to changes in the nuclear mass and/or charge ♣	

	(qualitative) ♣ Bond breaking, bond making, activation energy and reaction profiles (qualitative). **Disciplinary Knowledge:** Measuring temperature changes in reactions experimentally. ***Required practical activity 10****: investigate the variables that affect temperature changes in reacting solutions such as, eg acid plus metals, acid plus carbonates, neutralisations, displacement of metals. AT skills covered by this practical activity: chemistry AT 1, 3, 5 and 6. This practical activity also provides opportunities to develop WS and MS* **Mathematical requirements** ***Arithmetic and numerical computation*** *1a Recognise and use expressions in decimal form*		other chemical processes necessary for life ♣ a word summary for aerobic respiration ♣ the process of anaerobic respiration in humans and micro-organisms, including fermentation, and a word summary for anaerobic respiration ♣ the differences between aerobic and anaerobic respiration in terms of the reactants, the products formed and the implications for the organism. **Disciplinary Knowledge:** Interpreting graphs of photosynthesis rates under varying conditions. Quantitative understanding of respiration (energy release comparisons). Evaluating experimental results for reliability and validity. ***Required practical activity 5****: investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed. AT skills covered by this practical activity: biology AT 1, 2, 3, 4 and 5. This practical activity also*		radioactive materials, half-life, irradiation, contamination and their associated hazardous effects; waste disposal ♣ nuclear fission, nuclear fusion and our Sun's energy. **Disciplinary Knowledge:** Interpreting data on radioactive decay and half-life. Comparing models of the atom through historical context. Evaluating the applications and risks of nuclear radiation. Designing investigations into the behaviour of ionizing radiation. **Mathematical requirements** ***Arithmetic and numerical computation*** *1b Recognise and use expressions in standard form* *1c Use ratios, fractions and percentages* ***Algebra*** *3c Substitute numerical values into algebraic equations using appropriate units for physical quantities (chemistry and physics questions only)* *3d Solve simple algebraic equations (biology and physics questions only)* ***Graphs***	

	1c Use ratios, fractions and percentages *1d Make estimates of the results of simple calculations* ***Handling data*** *2h Make order of magnitude calculations* ***Graphs*** *4a Translate information between graphical and numeric form* *4b Understand that y = mx + c represents a linear relationship* *4c Plot two variables from experimental or other data* *4d Determine the slope and intercept of a linear graph* *4e Draw and use the slope of a tangent to a curve as a measure of rate of change (chemistry and physics questions only)* ***Geometry and trigonometry*** *5c Calculate areas of triangles and rectangles, surface areas and volumes of cubes.*		*provides opportunities to develop WS and MS* **Mathematical requirements** ***Arithmetic and numerical computation*** *1a Recognise and use expressions in decimal form* *1c Use ratios, fractions and percentages* *1d Make estimates of the results of simple calculations* ***Handling data*** *2c Construct and interpret frequency tables and diagrams, bar charts and histograms* ***Algebra*** *3a Understand and use the symbols: =, <, <<, >>, >, ∝, ~* *3d Solve simple algebraic equations (biology and physics questions only)* ***Graphs*** *4a Translate information between graphical and numeric form* *4c Plot two variables from experimental or other data*		*4a Translate information between graphical and numeric form*	
TCs	**As above**		**As above**		**As above**	

AOs	**As above**		**As above**		**As above**	
Hinterland	***Look at the lives and work of Roger Billings and Saiful Islam (in particular lithium-ion batteries and hydrogen fuel cells).***		***Investigate Ynes Mexia, who is a botanist known for her vast collection of plant specimen.***		***Explore the history and the most significant experimental discovery that contributed to our modern model of the atom.***	
TERM Y11	**Sept 2024**	**No lessons**		**No lessons**	**to Oct 2024**	**No lessons**
	Chemistry		**Biology**		**Physics**	
Autumn 1	**The rate and extent of chemical change** **Substantive:** Rate of reaction; Reversible reactions and dynamic equilibrium including the effect of changing conditions (concentration, temperature and pressure) on equilibrium (**HT only**). Chemical reactions can occur at vastly different rates. Whilst the reactivity of chemicals is a significant factor in how fast chemical reactions proceed, there are many variables (temperature, concentration, surface area, catalysts) that can be manipulated in order to speed them up or slow	15	**Homeostasis and response** **Substantive Knowledge:** The principles of homeostasis and examples (e.g., temperature, blood glucose regulation). The nervous system: structure and function of neurons and synapses. Reflex actions and the reflex arc. Hormonal control systems (e.g., insulin and the menstrual cycle). The role of negative feedback in maintaining balance. Homeostasis is the process by which living organisms maintain a stable internal environment despite external changes. This regulation is essential for survival because it ensures that the internal conditions of the body remain	15		

	them down. Chemical reactions may also be reversible and therefore the effect of different variables needs to be established in order to identify how to maximise the yield of desired product (Le Chatelier's Principle). Understanding energy changes that accompany chemical reactions is important for this process. In industry, chemists and chemical engineers determine the effect of different variables on reaction rate and yield of product. Whilst there may be compromises to be made, they carry out optimisation processes (Le Chatelier's Principle) to ensure that enough product is produced within a sufficient time, and in an energy-efficient way. NC: Rate and extent of chemical change ♣ factors that influence the rate of reaction: varying temperature or		within a narrow range that supports optimal functioning of cells, tissues, and organs. NC: Coordination and control ♣ principles of nervous coordination and control in humans ♣ the relationship between the structure and function of the human nervous system ♣ the relationship between structure and function in a reflex arc ♣ principles of hormonal coordination and control in humans ♣ hormones in human reproduction, hormonal and non-hormonal methods of contraception ♣ homeostasis. **Disciplinary Knowledge:** Using data to explain the effect of insulin on blood sugar levels. Evaluating medical technologies for treating diabetes (e.g., insulin pumps). Graphical interpretation of hormone levels during the menstrual cycle. ***Required practical activity 6:*** *plan and carry out an investigation into the effect of*			

	concentration, changing the surface area of a solid reactant or by adding a catalyst ♣ factors affecting reversible reactions. **Disciplinary Knowledge:** ***Required practical activity 11****: investigate how changes in concentration affect the rates of reactions by a method involving measuring the volume of a gas produced and a method involving a change in colour or turbidity. This should be an investigation involving developing a hypothesis. AT skills covered by this practical activity: chemistry AT 1, 3, 5 and 6. This practical activity also provides opportunities to develop WS and MS* Analyzing data to identify trends in reaction rates. Predicting how changes in conditions affect equilibrium position. <u>Mathematical requirements</u> ***Arithmetic and numerical computation***		*a factor on human reaction time. AT skills covered by this practical activity: biology AT 1, 3 and 4. This practical activity also provides opportunities to develop WS and MS.* **<u>Mathematical requirements</u>** ***Handling data*** *2c Construct and interpret frequency tables and diagrams, bar charts and histograms* ***Graphs*** *4a Translate information between graphical and numeric form*			

	1a Recognise and use expressions in decimal form *1c Use ratios, fractions and percentages* *1d Make estimates of the results of simple calculations* ***Graphs*** *4a Translate information between graphical and numeric form* *4b Understand that y = mx + c represents a linear relationship* *4c Plot two variables from experimental or other data* *4d Determine the slope and intercept of a linear graph* *4e Draw and use the slope of a tangent to a curve as a measure of rate of change (chemistry and physics questions only)* ***Geometry and trigonometry*** *5c Calculate areas of triangles and rectangles, surface areas and volumes of cubes*					

TCs	**Threshold concepts for all Chemistry topics:** TC1: Be familiar with, and use, technical terminology accurately; building up an extended specialist vocabulary TC2: To view chemistry at the molecular (sub microscopic level), observational (macroscopic) and symbolic levels. TC3: To explain the manifestations of the principle of 'electron configuration' through several chemical reactions. TC4: To symbolically describe chemical reactions using the language of redox, of word, of chemical and of ionic equations. TC5: To apply the three control, independent and dependent variables to a fair test investigation. TC6: Investigations including, making predictions, writing a method, analysing results and writing a conclusion. TC7: To understand changes of state through intermolecular forces and the strength of these forces determines the required temperature		**Threshold concepts for all Biology topics:** TC1: Be familiar with, and use, technical terminology accurately; building up an extended specialist vocabulary TC2: Understand the structure-function relationship and that every structural feature helps serve a particular function within the molecular-, cellular-, tissue-, organ- and organ system- levels. TC3: Living organisms may form populations of single species, communities of many species and ecosystems, interacting with each other, with the abiotic/biotic factors of the environment TC4: Life on Earth is dependent on photosynthesis in which green plants produce organic compounds and oxygen TC5: To apply the three control, independent and dependent variables to a fair test investigation. TC6: Investigations including, making predictions, writing a method, analysing results and writing a conclusion. TC7: These organic compounds are used as fuels in cellular respiration and the manufacture of macromolecules necessary for life		**Threshold concepts for all Physics topics:** TC1: Be familiar with, and use, technical terminology accurately; building up an extended specialist vocabulary TC2: The use of models, as in the particle model of matter or the wave models of light and of sound TC3: The concept of cause and effect in explaining such links as those between force and acceleration, or between changes in atomic nuclei and radioactive emissions TC4: The phenomena of 'action at a distance,' and the related concept of the field as the key to analysing electrical, magnetic and gravitational effects TC5: To apply the three control, independent and dependent variables to a fair test investigation. TC6: Investigations including, making predictions, writing a method, analysing results and writing a conclusion. TC7: That differences, for example between pressures or temperatures or electrical potentials, are the drivers of change	

	TC8: Surface area to volume ratio (SA:Vol) – governs many key processes inducing the rate of chemical reactions, heat loss, oxygen uptake, diffusion and osmosis, absorption and metabolism.		TC8: The chemicals in ecosystems are continually cycling through the natural world TC9: The characteristics of a living organism are influenced by its genome and its interaction with the environment TC10: Evolution occurs by a process of natural selection and accounts both for biodiversity and how organisms are all related to varying		TC8: That proportionality, for example between weight and mass of an object or between force and extension in a spring, is an important aspect of many models in science.	
AOs	AO1: Demonstrate knowledge and understanding of: scientific ideas; scientific techniques and procedures. AO2: Apply knowledge and understanding of: scientific ideas; scientific enquiry, techniques and procedures. AO3: Analyse information and ideas to: interpret and evaluate; make judgments and draw conclusions; develop and improve experimental procedures.		AO1: Demonstrate knowledge and understanding of: scientific ideas; scientific techniques and procedures. AO2: Apply knowledge and understanding of: scientific ideas; scientific enquiry, techniques and procedures. AO3: Analyse information and ideas to: interpret and evaluate; make judgments and draw conclusions; develop and improve experimental procedures.		AO1: Demonstrate knowledge and understanding of: scientific ideas; scientific techniques and procedures. AO2: Apply knowledge and understanding of: scientific ideas; scientific enquiry, techniques and procedures. AO3: Analyse information and ideas to: interpret and evaluate; make judgments and draw conclusions; develop and improve experimental procedures.	
Hinterland	***Learn about the different jobs that require the knowledge of rate and extent of chemical change.***		***Explore some of the careers that are linked to Homeostasis.*** ***Research the work of Kiran Mazumdar-Shaw and her***			

	Identify and explain optimum conditions needed in order to maximise yield in chemical processing using examples in industries.		***involvement in the development of biopharmaceuticals.***			
	From Nov 2024 (after Oct half term)				**To 21st Dec 2024**	
	Chemistry		Biology		Physics	
Autumn 2	**Organic chemistry** **Substantive Knowledge:** Structure and properties of hydrocarbons (alkanes and alkenes). Cracking and fractional distillation of crude oil. Reactions of alkenes and alcohols. Applications of organic compounds in everyday life. Organic chemistry is the branch of chemistry that focuses on the structure, properties, reactions, and synthesis of organic compounds, which contain carbon atoms. These compounds are the basis of life and are found in everything from plastics	10			**Forces** **Substantive Knowledge:** Scalar and vector quantities (e.g., distance vs. displacement). Contact and non-contact forces (e.g., friction, gravity, magnetism). Newton's laws of motion and their applications. Hooke's law for elastic materials. Momentum, terminal velocity, and stopping distances. Forces are fundamental interactions that cause objects to accelerate, change their velocity, or deform. They are responsible for nearly all physical phenomena in the universe. Forces and Elasticity are fundamental concepts in physics that describe how materials respond to external forces and	15

	and pharmaceuticals to proteins and DNA. NC: Chemical and allied industries ♣ carbon compounds, both as fuels and feedstock, and the competing demands for limited resources ♣ fractional distillation of crude oil and cracking to make more useful materials **Disciplinary Knowledge:** Writing chemical equations for reactions of hydrocarbons. Analyzing products of fractional distillation. Evaluating the environmental impacts of fossil fuel use.				deformations. Forces and Motion are foundational concepts in physics, and understanding them helps explain how objects move and interact with each other in the world around us. NC: Forces ♣ forces and fields: electrostatic, magnetic, gravity ♣ forces as vectors ♣ calculating work done as force x distance; elastic and inelastic stretching ♣ pressure in fluids acts in all directions: variation in Earth's atmosphere with height, with depth for liquids, up-thrust force (qualitative). Forces and motion ♣ speed of sound; estimating speeds and accelerations in everyday contexts ♣ interpreting quantitatively graphs of distance, time, and speed ♣ acceleration caused by forces; Newton's First Law ♣ weight and gravitational field strength ♣ decelerations and braking distances involved on roads.	
	Chemical analysis **Substantive:** Pure substances, formulations, and mixtures. Chromatography for	7			**Disciplinary Knowledge:** ***Required practical activity 18****: investigate the relationship between force and extension for a spring. AT skills covered by this*	

	separating and identifying compounds. Tests for gases (oxygen, carbon dioxide, hydrogen, chlorine). Identification of common gases. NC: <u>Chemical changes</u> ♣ identification of common gases <u>Chemical analysis</u> ♣ distinguishing between pure and impure substances ♣ separation techniques for mixtures of substances: chromatography **Disciplinary knowledge:** Designing chromatograms to identify unknown substances. Evaluating the reliability and accuracy of analytical methods. ***Required practical activity 12****: investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate Rf values. AT skills covered by this practical activity: chemistry AT 1 and 4. This*				*practical activity: physics AT 1 and 2. This practical activity also provides opportunities to develop WS and MS*.) Analyzing graphs of force-extension relationships. Forces and motion; ***Required practical activity 19****: investigate the effect of varying the force on the acceleration of an object of constant mass, and the effect of varying the mass of an object on the acceleration produced by a constant force. AT skills covered by this practical activity: physics AT 1, 2 and 3. This practical activity also provides opportunities to develop WS and MS;* Calculating forces, acceleration, and momentum using equations. Evaluating the safety implications of stopping distances in vehicles. **<u>Mathematical requirements</u>** ***Arithmetic and numerical computation*** *1a Recognise and use expressions in decimal form* *1b Recognise and use expressions in standard form* *1c Use ratios, fractions and percentages*	

	practical activity also provides opportunities to develop WS and MS **Mathematical requirements** ***Arithmetic and numerical computation*** *1a Recognise and use expressions in decimal form* *1c Use ratios, fractions and percentages* *1d Make estimates of the results of simple calculations* ***Handling data*** *2a Use an appropriate number of significant figures*				*1d Make estimates of the results of simple calculations* ***Handling data*** *2c Construct and interpret frequency tables and diagrams, bar charts and histograms* *2d Understand the principles of sampling as applied to scientific data (biology questions only)* *2f Understand the terms mean, mode and median* *2h Make order of magnitude calculations* ***Algebra*** *3a Understand and use the symbols: =, <, <<, >>, >, ∝, ~* *3b Change the subject of an equation* *3c Substitute numerical values into algebraic equations using appropriate units for physical quantities (chemistry and physics questions only)* ***Graphs*** *4a Translate information between graphical and numeric form* *4b Understand that y = mx + c represents a linear relationship* *4c Plot two variables from experimental or other data* *4d Determine the slope and intercept of a linear graph*	

					4f Understand the physical significance of area between a curve and the x-axis and measure it by counting squares as appropriate (physics questions only) ***Geometry and trigonometry*** *5a Use angular measures in degrees (physics questions only)* *5b Visualise and represent 2D and 3D forms including two dimensional representations of 3D* *objects (chemistry and physics questions only)*	
	7th Jan 2025 (after Xmas)	**Lessons**		**Lessons**	**To 15th Feb**	**Lessons**
	Chemistry		**Biology**		**Physics**	
Spring 1			**Inheritance, variation and evolution** **Substantive Knowledge:** DNA structure, the role of genes, and protein synthesis. Asexual and sexual reproduction, including mitosis and meiosis. Genetic inheritance, including Punnett squares and the importance of alleles.	16	**Waves** **Substantive Knowledge:** Properties of waves: amplitude, wavelength, frequency, and speed. Transverse and longitudinal waves (e.g., sound, light, water). The electromagnetic spectrum and its applications. Reflection, refraction, and diffraction of waves. A wave is a vibration or disturbance transmitted through a material (a medium) or	9

			NC: Evolution, inheritance and variation ♣ the genome as the entire genetic material of an organism ♣ how the genome, and its interaction with the environment, influence the development of the phenotype of an organism ♣ the potential impact of genomics on medicine ♣ most phenotypic features being the result of multiple, rather than single, genes ♣ single gene inheritance and single gene crosses with dominant and recessive phenotypes ♣ sex determination in humans ♣ genetic variation in populations of a species ♣ the process of natural selection leading to evolution ♣ the evidence for evolution ♣ developments in biology affecting classification ♣ the importance of selective breeding of plants and animals in agriculture. **Disciplinary Knowledge:** Solving genetic cross problems (e.g., predicting offspring genotypes and phenotypes). Interpreting fossil evidence for evolution.		through space. Waves transfer energy and information from one place to another, but they do not transfer material. NC: Wave motion ♣ amplitude, wavelength and frequency; relating velocity to frequency and wavelength ♣ transverse and longitudinal waves ♣ electromagnetic waves and their velocity in vacuum; waves transferring energy; wavelengths and frequencies from radio to gamma-rays ♣ velocities differing between media: absorption, reflection, refraction effects ♣ production and detection, by electrical circuits, or by changes in atoms and nuclei ♣ uses in the radio, microwave, infra-red, visible, ultra-violet, X-ray and gamma-ray regions, hazardous effects on bodily tissues. **Disciplinary Knowledge:** Using ray diagrams to explain reflection and refraction. Designing experiments to investigate the speed of sound in air. Evaluating the use of electromagnetic waves in communication and medicine.	

			Evaluating the advantages and disadvantages of genetic technologies. **<u>Mathematical requirements</u>** ***Arithmetic and numerical computation*** *1c Use ratios, fractions and percentages* ***Handling data*** *2c Construct and interpret frequency tables and diagrams, bar charts and histograms* *2e Understand simple probability (biology questions only)* ***Algebra*** *3a Understand and use the symbols: =, <, <<, >>, >, ∝, ~* ***Graphs*** *4a Translate information between graphical and numeric form*		***Required practical activity 20**: make observations to identify the suitability of apparatus to measure the frequency, wavelength and speed of waves in a ripple tank and waves in a solid and take appropriate measurements. AT skills covered by this practical activity: physics AT 4. This practical activity also provides opportunities to develop WS and MS* ***Required practical activity 21**: investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface. AT skills covered by this practical activity: physics AT 1 and 4. This practical activity also provides opportunities to develop WS and MS.*	
					Magnetism and Electromagnetism **Substantive:** Permanent and induced magnetism, magnetic forces and fields; The motor effect; Fleming's left-hand rule (**HT only**); Electric motors (**HT only**)).	5

					Magnetism is due to the magnetic fields around magnets. Electromagnetism is due to magnetic fields around electric currents. Uses include MRI scanners, the Maglev principle to propel trains, headphones, household appliances and many more. NC: Magnetism and electromagnetism ♣ exploring the magnetic fields of permanent and induced magnets, and the Earth's magnetic field, using a compass ♣ magnetic effects of currents; how solenoids enhance the effect ♣ how transformers are used in the national grid and the reasons for their use. **Disciplinary Knowledge:** Investigating magnetic fields using compasses and iron filings. Calculating forces on current-carrying conductors. **Mathematical requirements** ***Arithmetic and numerical computation*** *1c Use ratios, fractions and percentages* ***Algebra*** *3b Change the subject of an equation*	

					3c Substitute numerical values into algebraic equations using appropriate units for physical quantities (chemistry and physics questions only)	
	Feb 2025 (after Feb half term	**Lessons**		**Lessons**	**To 12th April 2025**	**Lessons**
Spring 2	**Chemistry of the atmosphere** **Substantive:** The composition and evolution of the Earth's atmosphere; Carbon dioxide and methane as greenhouse gases; Common atmospheric pollutants and their sources. Human activity and nature both impact changes in our atmosphere and environment. Environmental change raises important concerns over the future wellbeing of our planet; Global warming and climate change. Reducing carbon footprints and atmospheric pollutants. NC: Earth and atmospheric science ♣ evidence for	9	**Ecology** **Substantive Knowledge:** Interdependence and interactions within ecosystems. Biotic and abiotic factors affecting populations. Energy transfer through food chains and food webs. The carbon and water cycles. Human impacts on ecosystems (e.g., deforestation, pollution, climate change). NC: Ecosystems ♣ levels of organisation within an ecosystem ♣ some abiotic and biotic factors which affect communities; the importance of interactions between organisms in a community ♣ how materials cycle through abiotic and biotic components of ecosystems ♣ the role of	16		

	composition and evolution of the Earth's atmosphere since its formation ♣ evidence, and uncertainties in evidence, for additional anthropogenic causes of climate change ♣ potential effects of, and mitigation of, increased levels of carbon dioxide and methane on the Earth's climate ♣ common atmospheric pollutants: sulphur dioxide, oxides of nitrogen, particulates and their sources ♣ the Earth's water resources and obtaining potable water. **Disciplinary Knowledge:** Analyzing data on atmospheric changes over time. Evaluating the effectiveness of strategies to reduce carbon emissions. Engaging in debates on climate change and sustainable practices. **<u>Mathematical requirements</u>** ***Arithmetic and numerical computation***		microorganisms (decomposers) in the cycling of materials through an ecosystem ♣ organisms are interdependent and are adapted to their environment ♣ the importance of biodiversity ♣ methods of identifying species and measuring distribution, frequency and abundance of species within a habitat ♣ positive and negative human interactions with ecosystems. **Disciplinary Knowledge:** ***Required practical activity 7****: measure the population size of a common species in a habitat. Use sampling techniques to investigate the effect of a factor on the distribution of this species. AT skills covered by this practical activity: biology AT 1, 3, 4 and 6. This practical activity also provides opportunities to develop WS and MS* Calculating energy efficiency between trophic levels. Analyzing data on population changes due to environmental factors (predator/prey).			

	1c Use ratios, fractions and percentages		Evaluating conservation strategies and their effectiveness. **<u>Mathematical requirements</u>** ***Handling data*** *2b Find arithmetic means* *2c Construct and interpret frequency tables and diagrams, bar charts and histograms* *2f Understand the terms mean, mode and median* ***Graphs*** *4a Translate information between graphical and numeric form* *4e Draw and use the slope of a tangent to a curve as a measure of rate of change (chemistry and physics questions only)*			
	Using Resources **Substantive Knowledge:** Sustainable use of resources and recycling. Potable water production and water treatment. Life cycle assessments and their applications. Extraction of resources using chemistry (e.g.,	9				

	bioleaching, phytomining **HT only**). NC: <u>Earth and atmospheric</u> ♣ the Earth's water resources and obtaining potable water <u>Chemical and allied industries</u> ♣ life cycle assessment and recycling to assess environmental impacts associated with all the stages of a product's life ♣ the viability of recycling of certain materials ♣ carbon compounds, both as fuels and feedstock, and the competing demands for limited resources **Disciplinary Knowledge:** ***Required practical activity 13****: analysis and purification of water samples from different sources, including pH, dissolved solids and distillation. AT skills covered by this practical activity: chemistry AT 2, 3 and 4. This practical activity also provides opportunities to develop WS and MS.*					

	Interpreting life cycle assessment data.Evaluating the sustainability of industrial processes. **Mathematical requirements** ***Arithmetic and numerical computation*** *1a Recognise and use expressions in decimal form* *1c Use ratios, fractions and percentages* *1d Make estimates of the results of simple calculations* ***Handling data*** *2a Use an appropriate number of significant figures* *2c Construct and interpret frequency tables and diagrams, bar charts and histograms* *questions only)* *2h Make order of magnitude calculations* ***Graphs*** *4a Translate information between graphical and numeric form*					

	April 2025 (After Easter) Chemistry	Lessons	Biology	Lessons	To May 2025 Physics	Lessons
Summer 1	Atomic structure and the periodic table, Bonding, structure, and the properties of matter, Quantitative chemistry Chemical changes, Energy changes Intervention and booster lessons. Re visit core knowledge. Establish links between topics. Interpretation of exam style questions. Practice exam style questions. Use various techniques to consolidate knowledge		Cell biology, Organisation, Infection and response, Bioenergetics Intervention and booster lessons. Re visit core knowledge. Establish links between topics. Interpretation of exam style questions. Practice exam style questions. Use various techniques to consolidate knowledge		Energy, Electricity, Particle model of matter, Atomic structure Intervention and booster lessons. Re visit core knowledge. Establish links between topics. Interpretation of exam style questions. Practice exam style questions. Use various techniques to consolidate knowledge	
	3rd June 2025 (After May Half term) Chemistry	**Lessons**	**Biology**	**No lessons**	**To 22nd July 2025 Physics**	**Lessons**
Summer 2	The rate and extent of chemical change Organic chemistry Chemical analysis Chemistry of the atmosphere Using resources Intervention and booster lessons.		Homeostasis and response, Inheritance, variation and evolution, Intervention and booster lessons. Re visit core knowledge. Establish links between topics. Interpretation of exam style questions.		Forces, Waves, Magnetism and electromagnetism Intervention and booster lessons. Re visit core knowledge. Establish links between topics. Interpretation of exam style questions.	

	Re visit core knowledge. Establish links between topics. Interpretation of exam style questions. Use various learning techniques to consolidate knowledge.		Use various learning techniques to consolidate knowledge.		Use various learning techniques to consolidate knowledge.	

Combined Science Trilogy
2 year plan Biology

Chapter number and title from CPG	**Approx** Number of lessons	Exam paper	Year taught
B1 Cell biology	14	Paper 1	10
B2 Organisation	16	Paper 1	10
B3 Infection and response	17	Paper 1	10
B4 Bioenergetics	12	Paper 1	10
B5 Homeostasis and response	15	Paper 2	11
B6 Inheritance, variation and evolution	16	Paper 2	11
B7 Ecology	16	Paper 2	11

Combined Science Trilogy
2 year plan Chemistry

Chapter number and title	**Approx** Number of lessons	Exam paper	Year taught
C1 Atomic structure and the periodic table	13	Paper 1	10
C2 Bonding, structure, and the properties of matter	15	Paper 1	10
C3 Quantitative chemistry	10	Paper 1	10
C4 Chemical changes	15	Paper 1	10
C5 Energy changes	12	Paper 1	10
C The rate and extent of chemical change	15	Paper 2	11
C7 Organic chemistry	7	Paper 2	11
C8 Chemical analysis	9	Paper 2	11
C9 Chemistry of the atmosphere	9	Paper 2	11
C10 Using resources			

Combined Science Trilogy 2 year plan Physics

Chapter number and title	Number of lessons	Exam paper	Year taught
P1 Energy	18	Paper 1	10
P2 Electricity	17	Paper 1	10
P3 Particle model of matter	10	Paper 1	10
P4 Atomic structure	10	Paper 1	10
P5 Forces	15	Paper 2	11
P6 Waves	9	Paper 2	11
P7 Magnetism and electromagnetism	5	Paper 2	11

Practical assessment

Practical work is at the heart of science. There are three interconnected reasons for doing practical work.
They are:
1) To support and consolidate scientific concepts (knowledge and understanding). This is done by applying and developing what is known and understood of abstract ideas and models. Through practical work we are able to make sense of new information and observations, and provide insights into the development of scientific thinking.
2) To develop investigative skills. These transferable skills include: • devising and investigating testable questions • identifying and controlling variables • analysing, interpreting and evaluating data.
3) To build and master practical skills such as: • using specialist equipment to take measurements • handling and manipulating equipment with confidence and fluency • recognising hazards and planning how to minimise risk.

Questions in the written exams will draw on the knowledge and understanding students have gained by carrying out the practical activities listed below. **These questions will count for at least 15 % of the overall marks for the qualification**. Many of the questions will also focus on investigative skills and how well students can apply what they know to practical situations often in novel contexts.
There is a practical handbook to plan purposeful practical work that develops both practical and investigative skills and encourages the thinking behind the doing so that they can reach their potential.

Development of scientific thinking

Students should be able to:

Examples of what students could be asked to do in an exam ***WS 1.1*** *Understand how scientific methods and theories develop over time. Give examples to show how scientific methods and theories have changed over time. Explain, with an example, why new data from experiments or observations led to changes in models or theories. Decide whether or not given data supports a particular theory.* ***WS 1.2*** *Use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts. Recognise/draw/interpret diagrams. Translate from data to a representation with a model. Use models in explanations, or match features of a model to the data from experiments or observations that the model describes or explains. Make predictions or calculate quantities based on the model or show its limitations. Give examples of ways in which a model can be tested by observation or experiment.* ***WS 1.3*** *Appreciate the power and limitations of science and consider any ethical issues which may arise. Explain why data is needed to answer scientific questions, and why it may be uncertain, incomplete or not available. Outline a simple ethical argument about the rights and wrongs of a new technology.* ***WS 1.4*** *Explain everyday and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments. Describe and explain specified examples of the technological applications of science. Describe and evaluate, with the help of data, methods that can be used to tackle problems caused by human impacts on the environment.* ***WS 1.5*** *Evaluate risks both in practical science and the wider societal context, including perception of risk in relation to data and consequences. Give examples to show that there are hazards associated with science-based technologies which have to be considered alongside the benefits. Suggest reasons why the perception of risk is often very different from the measured risk (eg voluntary vs imposed risks, familiar vs unfamiliar risks, visible vs invisible hazards).* ***WS 1.6*** *Recognise the importance of peer review of results and of communicating results to a range of audiences. Explain that the process of peer review helps to detect false claims and to establish a consensus about which claims should be regarded as valid. Explain that reports of scientific developments in the popular media are not subject to peer review and may be oversimplified, inaccurate or biased.*

Experimental skills and strategies

Students should be able to: Examples of what students could be asked to do in an exam ***WS 2.1*** *Use scientific theories and explanations to develop hypotheses. Suggest a hypothesis to explain given observations or data.* ***WS 2.2*** *Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena. Describe a practical procedure for a specified purpose. Explain why a given practical procedure is well designed for its specified purpose. Explain the need to manipulate and control variables. Identify in a given context: • the independent variable as the one that is changed or selected by the investigator • the dependent variable that is measured for each change in the independent variable • control variables and be able to explain why they are kept the same. Apply understanding of apparatus and techniques to suggest a procedure for a specified purpose.* ***WS 2.3*** *Apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment. Describe/suggest/select the technique, instrument, apparatus or material that should be used for a particular purpose, and explain why.* ***WS 2.4*** *Carry out experiments appropriately having due regard for the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations. Identify the main hazards in specified practical contexts. Suggest methods of reducing the risk of harm in practical contexts.* ***WS 2.5*** *Recognise when to apply a knowledge of sampling techniques to ensure any samples collected are representative. Suggest and describe an appropriate sampling technique in a given context.* ***WS 2.6*** *Make and record observations and measurements using a range of apparatus and methods. Read measurements off a scale in a practical context and record appropriately.* ***WS 2.7*** *Evaluate methods and suggest possible improvements and further investigations. Assess whether sufficient, precise measurements have been taken in an experiment. Evaluate methods with a view to determining whether or not they are valid.*

Analysis and evaluation

Apply the cycle of collecting, presenting and analysing data, including:
Students should be able to: Examples of what students could be asked to do in an exam ***WS 3.****1 Presenting observations and other data using appropriate methods. Construct and interpret frequency tables and diagrams, bar charts and histograms. Plot two variables from experimental or other data.* ***WS 3.2*** *Translating data from one form to another. Translate data between graphical and numeric form.* ***WS 3.3*** *Carrying out and represent mathematical and statistical analysis. For example: • use an appropriate number of significant figures • find the arithmetic mean and range of a set of data • construct and interpret frequency tables and diagrams, bar charts and histograms • make order of magnitude calculations • change the subject of an equation • substitute numerical values into algebraic equations using appropriate units for physical quantities • determine the slope and intercept of a linear graph • draw and use the slope of a tangent to a curve as a measure of rate of change • understand the physical significance of area between a curve and the x-axis and measure it by counting squares as appropriate.* ***WS 3.4*** *Representing distributions of results and make estimations of uncertainty. Apply the idea that whenever a measurement is made, there is always some uncertainty about the result obtained. Use the range of a set of measurements about the mean as a measure of uncertainty.* ***WS 3.5*** *Interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), including identifying patterns and trends, making inferences and drawing conclusions. Use data to make predictions. Recognise or describe patterns and trends in data presented in a variety of tabular, graphical and other forms. Draw conclusions from given observations.* ***WS 3.6*** *Presenting reasoned explanations including relating data to hypotheses. Comment on the extent to which data is consistent with a given hypothesis. Identify which of two or more hypotheses provides a better explanation of data in a given context.* ***WS 3.7*** *Being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error.*
Apply the following ideas to evaluate data to suggest improvements to procedures and techniques. • An accurate measurement is one that is close to the true value. • Measurements are precise if they cluster closely. • Measurements are repeatable when repetition, under the same conditions by the same investigator, gives similar results. • Measurements are reproducible if similar results are obtained by different investigators with different equipment. • Measurements are affected by random error due to results varying in unpredictable ways; these errors can be reduced by making more measurements and reporting a mean value. • Systematic error is due to measurement results differing from the true value by a consistent amount each time. • Any anomalous values should be examined to try to identify the cause and, if a product of a poor measurement, ignored. ***WS 3.8*** *Communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions through paper-based and electronic reports and presentations using verbal, diagrammatic, graphical, numerical and symbolic forms.*

Scientific vocabulary, quantities, units, symbols and nomenclature

Students should be able to: Examples of what students could be asked to do in an exam ***WS 4.1*** *Use scientific vocabulary, terminology and definitions.* ***WS 4.2*** *Recognise the importance of scientific quantities and understand how they are determined.* ***WS 4.3*** *Use SI units (eg kg, g, mg; km, m, mm; kJ, J) and IUPAC chemical nomenclature unless inappropriate.* ***WS 4.4*** *Use prefixes and powers of ten for orders of magnitude (eg tera, giga, mega, kilo, centi, milli, micro and nano).* ***WS 4.5*** *Interconvert units.* ***WS 4.6*** *Use an appropriate number of significant figures in calculation.*

Use of apparatus and techniques

All students are expected to have carried out the required practical activities in Required practical activities. The following list includes opportunities for choice and use of appropriate laboratory apparatus for a variety of experimental problem-solving and/or enquiry-based activities. Safety is an overriding requirement for all practical work. Schools and colleges are responsible for ensuring that appropriate safety procedures are followed whenever their students undertake practical work, and should undertake full risk assessments. Use and production of appropriate scientific diagrams to set up and record apparatus and procedures used in practical work is common to all science subjects and should be included wherever appropriate.

Biology

*Apparatus and techniques **AT 1** Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, temperature, volume of liquids and gases, and pH (links to A-level AT a). **AT 2** Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater (links to A-level AT a). **AT 3** Use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes. **AT 4** Safe and ethical use of living organisms (plants or animals) to measure physiological functions and responses to the environment (links to A-level AT h). **AT 5** Measurement of rates of reaction by a variety of methods including production of gas, uptake of water and colour change of indicator. **AT 6** Application of appropriate sampling techniques to investigate the distribution and abundance of organisms in an ecosystem via direct use in the field (links to A-level AT k). **AT 7** Use of appropriate apparatus, techniques and magnification, including microscopes, to make observations of biological specimens and produce labelled scientific drawings (links to A-level AT d and e).*

Chemistry

*Apparatus and techniques **AT 1** Use of appropriate apparatus to make and record a range of measurements accurately, including mass, time, temperature, and volume of liquids and gases (links to A-level AT a). **AT 2** Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater (links to A-level AT b). **AT 3** Use of appropriate apparatus and techniques for conducting and monitoring chemical reactions, including appropriate reagents and/or techniques for the measurement of pH in different situations (links to A-level AT a and d). **AT 4** Safe use of a range of equipment to purify and/or separate chemical mixtures including evaporation, filtration, crystallisation, chromatography and distillation (links to A-level AT d and g). **AT 5** Making and recording of appropriate observations during chemical reactions including changes in temperature and the measurement of rates of reaction by a variety of methods such as production of*

gas and colour change (links to A-level AT a and l). ***AT 6*** *Safe use and careful handling of gases, liquids and solids, including careful mixing of reagents under controlled conditions, using appropriate apparatus to explore chemical changes and/or products (links to A-level AT a and k).* ***AT 7*** *Use of appropriate apparatus and techniques to draw, set up and use electrochemical cells for separation and production of elements and compounds (links to A-level AT d and j).*

Physics

Apparatus and techniques ***AT 1*** *Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, volume and temperature. Use of such measurements to determine densities of solid and liquid objects (links to A-level AT a and b).* ***AT 2*** *Use of appropriate apparatus to measure and observe the effects of forces including the extension of springs (links to A-level AT a).* ***AT 3*** *Use of appropriate apparatus and techniques for measuring motion, including determination of speed and rate of change of speed (acceleration/deceleration) (links to A-level AT a, b and d).* ***AT 4*** *Making observations of waves in fluids and solids to identify the suitability of apparatus to measure speed/frequency/wavelength. Making observations of the effects of the interaction of electromagnetic waves with matter (links to A-level AT i and j).* ***AT 5*** *Safe use of appropriate apparatus in a range of contexts to measure energy changes/ transfers and associated values such as work done (links to A-level AT a, b). AT 6 Use of appropriate apparatus to measure current, potential difference (voltage) and resistance, and to explore the characteristics of a variety of circuit elements (links to A-level AT f).* ***AT 7*** *Use of circuit diagrams to construct and check series and parallel circuits including a variety of common circuit elements (links to A-level AT g).*

Mathematical requirements

Students will be required to demonstrate the following mathematics skills in GCSE Combined Science assessments. Questions will target maths skills at a level of demand appropriate to each subject. In Foundation Tier papers questions assessing maths requirements will not be lower than that expected at Key Stage 3 (as outlined in Mathematics programmes of study: Key Stage 3 by the DfE, document reference DFE00179-2013). In Higher Tier papers questions assessing maths requirements will not be lower than that of questions and tasks in assessments for the Foundation Tier in a GCSE Qualification in Mathematics.

1 Arithmetic and numerical computation *a Recognise and use expressions in decimal form b Recognise and use expressions in standard form c Use ratios, fractions and percentages d Make estimates of the results of simple calculations*

2 Handling data *a Use an appropriate number of significant figures b Find arithmetic means c Construct and interpret frequency tables and diagrams, bar charts and histograms d Understand the principles of sampling as applied to scientific data (biology questions only) e Understand simple probability (biology questions only) f Understand the terms mean, mode and median g Use a scatter diagram to identify a correlation between two variables (biology and physics questions only) h Make order of magnitude calculations*

3 Algebra a Understand and use the symbols*: =, <, <<, >>, >, ∝, ~ b Change the subject of an equation c Substitute numerical values into algebraic equations using appropriate units for physical quantities (chemistry and physics questions only) d Solve simple algebraic equations (biology and physics questions only)*

4 Graphs *a Translate information between graphical and numeric form b Understand that y = mx + c represents a linear relationship c Plot two variables from experimental or other data d Determine the slope and intercept of a linear graph*

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4 Graphs e Draw and use the slope of a tangent to a curve as a measure of rate of change (chemistry and physics questions only) f Understand the physical significance of area between a curve and the x-axis and measure it by counting squares as appropriate (physics questions only)

5 Geometry and trigonometry *a Use angular measures in degrees (physics questions only) b Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects (chemistry and physics questions only) c Calculate areas of triangles and rectangles, surface areas and volumes of cubes*