	Autumn 1 & 2	Spring 1 & 2	Summer 1 & 2
Content Declarative knowledge 'I know'	**<u>Unit 1</u>: Principles & Applications of Science 1** <u>Chemistry</u>: Know Periodicity and properties of elements Know structure and bonding in applications in science, including: Know the electronic structure of atoms Know electronic orbitals Know Aufbau principle Know Bohr theory Know ionic bonding Know the theories of strong electrostatic attraction between oppositely charged ions Know strong electrostatic attraction between two nuclei and the shared pair(s) of electrons between them Know the effects ionic radius and ionic charge have on the strength of ionic bonding Know about the production and uses of substances in relation to properties Know the periodic table Know periods 1, 2, 3 and 4 Know groups – s block, p block, d block Know the layout of the periodic table in relation to s, p, d notation	**<u>Unit 2</u>: Practical Scientific Procedures & Techniques. Reports 2A and 2B** Know the concepts and background of titrations and colorimetry to determine the concentration of solutions Know the laboratory equipment and its calibration Know the equipment and glassware used in titration and colorimetry and the importance and processes involved in calibration of measuring equipment Know the processes involved in the preparation and standardisation of solutions using titration Know the accurate determination of the end-point of titrations Know the practical application of colorimetry techniques Know calorimetry to study cooling curves Know the types of thermometer, appropriate use and practical application of measurements of heat Know the relationship between temperature and heat energy Know the accuracy of thermometers and temperature probes at different temperatures	**<u>Unit 2</u>: Practical Scientific Procedures & Techniques. Reports 2C and 2D** Know the theory, equipment and procedures used in chromatographic techniques Know chromatographic terminology, including, mobile and stationary phases and adsorption Know the principles of paper chromatography Know the principles of thin-layer chromatography (TLC), including the nature of a TLC plate using glass, metal or plastic sheet with solid adsorbent layer Know other types of chromatography, including, gas chromatography and ion-exchange chromatography Know that procedures and chromatogram interpretations are very different. Know about interpreting chromatograms, including, the polarity of molecules or intermolecular forces, in relation to solubility in the mobile phase; the polarity of molecules or intermolecular forces in relation to retention of molecules in the stationary phase; and size of

	Know the physical properties of elements Know the first ionisation energy Know reasons for trends in ionisation energy across Periods 2–4 and down groups 1, 2 and 7 Know electron affinity Know atomic radius Know ionic radius Know electronegativity Know the tetrahedral basis of organic chemistry Know trends – melting point and boiling point Know physical properties of metals – electrical conductivity, thermal conductivity, malleability, ductility Know the chemical properties of elements, including, products and reactivity of all Period 2 and 3 elements with oxygen Know oxidation Know reduction Know variable oxidation states of transition metal ions Know uses and applications of substances produced within students learning <u>Biology</u>: Know structure and functions of cells and tissues Know cell structure and function	Know about cooling curves, including, their construction and interpretation Know temperature as a function of time Know super cooling Know the shape of the curve and rate of cooling in relation to intermolecular forces and the state (solid or liquid) of the substance	molecules in relation to solubility and mobility Know common problems in chromatographic techniques resulting in difficulty interpreting a chromatogram, including, overloading samples, disturbing plates or paper during development or contamination of plates or paper Know the personal responsibilities that must be accepted for successful work in science Know the skills for effective and efficient scientific teamwork with others Know about developing standard practices applicable to working as a professional scientist

	Know that cell theory is a unifying concept stating that cells are a fundamental unit of structure, function and organisation in all living organisms Know the ultrastructure and function of organelles in the following cells Know prokaryote cells (bacterial cell) including the nucleoid, plasmids, 70S ribosomes, capsule, cell wall Know eukaryotic cells (plant and animal cells) including the plasma membrane, cytoplasm, nucleus, nucleolus, endoplasmic reticulum (smooth and rough), Golgi apparatus, vesicles, lysosomes, 80S ribosomes, mitochondria, centriole Know eukaryotic cells (plant-cell specific) including the cell wall, chloroplasts, vacuole, tonoplast, amyloplasts, plasmodesmata, pits Know the similarities and differences between plant and animal cell structure and function Know cell specialisation Know cell specialisation in terms of structure and function, including, palisade mesophyll cells in a leaf, sperm and egg cells in reproduction, root hair cells in plants, white blood cells and red blood cells.		

	Know tissue structure and function Know the structure and function of epithelial tissue, including, squamous as illustrated by the role of alveolar epithelium in gas exchange, including the effect of chronic obstructive pulmonary disease (COPD) in smokers Know columnar cells as illustrated by goblet cells and ciliated cells in the lungs to include their role in protecting lungs from pathogens Know the structure and function of endothelial tissue, as illustrated by blood vessels in the cardiovascular system, including the risk factors that damage endothelial cells and affect the development of atherosclerosis Know the structure and function of muscular tissue, including the microscopic structure of a skeletal muscle fibre Know the structural and physiological differences between fast- and slow-twitch muscle fibres and their relevance in sport Know the structure and function of nervous tissue, including non-myelinated and myelinated neurones Know the conduction of a nerve impulse (action potential) along an		

	axon, including changes in membrane permeability to sodium and potassium ions and the role of the myelination in saltatory conduction Know synaptic structure and the role of neurotransmitters, including acetylcholineoh Know the effects of drugs on synaptic transmission, including the use of L-Dopa in the treatment of Parkinson's disease <u>Physics</u>: Know waves used in communication Know features common to all waves including the terms: periodic time, speed, wavelength, frequency, amplitude and oscillation Know the difference between the two main types of wave Know transverse waves Know longitudinal waves Know concepts of displacement, coherence, path difference, phase difference and superposition as applied to diffraction gratings Know the industrial application of diffraction gratings, including, emission spectra and identifying gases Know the concept of stationary waves resonance		

	Know the concept of waves as applied to musical instruments Know waves in communication Know the principles of fibre optics, including, refractive index, total internal reflection and critical angles at a glass–air interface Know the use of electromagnetic waves in communication Know that all electromagnetic waves travel with the same speed in a vacuum		
Skills Procedural knowledge 'I know how to'	<u>Chemistry</u>: Know how to form ions in terms of electron loss or gain Know how to notate electronic configuration diagrams of cations and anions Know how to identify covalent bonding Know how to draw dot and cross diagrams to show electrons in simple covalent molecules, including those with multiple bonds and dative covalent (coordinate) bonds Know how to manipulate the relationship between bond lengths and bond strengths in covalent bonds Know how to identify metallic bonding Know how to identify de-localised electrons	Know how to undertake and determine the concentration of solutions using titrations and colorimetry Know how to calibrate equipment for titrations and colorimetry Know how to use pH meters and probes, including, how to calibrate according to the manufacturer's instructions Know how to use balances and weighing, including, electronic balances – rough balances (two decimal places), and analytical balances (four decimal places) Know how to check calibration with certified weights Know how to measure mass using increasingly accurate balances	Know how to undertake chromatographic techniques to identify components in mixtures Know how to undertake paper chromatography and TLC chromatography Know how to use capillary tubes to apply mixtures to paper or TLC plates Know how to choose developing solvents and vessels Know how to prepare methods for samples, including, solvent extraction, filtration, and concentration by evaporation Know how to use locating agents Know how to apply chromatography to separate components of a mixture, including plant pigments extracted

	Know how to create or identify positive metal ions Know how to identify regular layer structure Know how to identify the following intermolecular forces: Van der Waals, Dipole-dipole, and Hydrogen bonding Know how to balance equations Know how to calculate relative atomic mass Know how to work out atomic number and relative molecular mass Know how to calculate moles, molar masses and molarities Know how to manipulate the quantities used in chemical reactions, including, mass, volume of solution, concentration; reacting quantities; and percentage yields Know how to notate the electronic arrangement of elements using s, p, d notation Know how to decide the type of bonding in an element Know how to create products (including the reactivity) of metals with oxygen, water, dilute hydrochloric acid and dilute sulfuric acid Know how to position of metals in the reactivity series in relation to position in the periodic table	Know how to select suitable containers for weighing liquids and solids Know how to measure the density of water at different temperatures Know how to safely use volumetric glassware, including, bulb, graduated, automated and teat pipettes; burettes; glass and plastic filter funnels; volumetric flasks for accurate dilution Know how to use water as a standard for calibrating volumetric glassware Know how to accurately determine the end-point of titrations from the colour change of a suitable indicator and from the plots of pH versus volume Know how to use ΔpH/Δvolume versus volume Know how to calculate concentrations using molecular mass from periodic table, and using primary and secondary titrimetric standards Know how to select and use a colorimeter or visible spectrometer Know how to select the filter (colorimeter) or use fixed wavelength (spectrometer) Know how to measure and use absorbance readings	from leaves or herbs with propanone, with paper chromatography and TLC Know how to identify unknown mixtures and pure substances using chromatography, including amino acids, using paper chromatography Know how procedures and chromatogram interpretations are very different for gas chromatography and ion-exchange chromatography Know how to interpret a chromatogram with reference to polarity of molecules or intermolecular forces in relation to solubility in the mobile phase Know how to reference the polarity of molecules or intermolecular forces in relation to retention of molecules in the stationary phase Know how to reference the size of molecules in relation to solubility and mobility Know how to calculate the Rf value Know how to interpret chromatograms in terms of the number of substances present and the Rf values of components Know how to take personal responsibility for Science investigations

	Know how to work out the displacement reactions of metals/halogens <u>Biology</u>: Know how to recognise cell organelles from electron micrographs and the use of light microscopes Know how to distinguish between gram-positive and gram-negative bacterial cell walls and why each type reacts differently to some antibiotics Know how to calculate magnification and size of cells and organelles from drawings or images Know how to interpret graphical displays of a nerve impulse and electrocardiogram (ECG) recordings Know how imbalances in certain, naturally occurring brain chemicals can contribute to ill health, including dopamine in Parkinson's disease and serotonin in depression <u>Physics</u>: Know how to graphically represent wave features Know how to use the wave equation $v= f\lambda$ Know how to use applications of stationary waves resonance Know how to use the equation for calculation of speed $V=\sqrt{T/\mu}$	Know how to use the Beer-Lambert law to determine the concentration of a transition metal ion solution Know how to accurately dilute stock solutions to prepare a range of calibration standards with absorbance in the range 0 to 1 Know how to use blank solutions Know how to plot calibrations Know how to determine concentration of an unknown solution from graphical readings (on graph paper) or from the equation of a linear trend line through the origin (Microsoft Excel) Know how to undertake calorimetry to study cooling curves Know the types of thermometer and how they are used to gain accurate readings, including, electronic thermometers or temperature probes; liquid-filled thermometers Know how to check the calibration of thermometers by using ice and boiling water Know how to check the accuracy of thermometers and temperature probes at different temperatures Know how to construct and interpret cooling curves, including, the rate of cooling from the gradient of the tangent to the cooling curve; the	Know how to work to appropriate standards and protocols Know how to apply safe working practices Know how to accept responsibility for the quality of one's own work Know how to take responsibility for completing tasks and procedures as well as using judgements within defined parameters Know how to develop scientific interpersonal skills Know how to communicate and co-operate in the scientific working environment Know how to give and receive constructive feedback Know how to behave for safe and efficient working in science Know how to recognise professional problems and apply appropriate scientific methods to identify causes and achieve solutions Know how to identify, organise and use resources effectively to complete tasks Know how to maintain and enhance competence

	Know how to calculate refractive index Know how to calculate critical angles at a glass-air interface Know how to apply fibre optics to endoscopes in medicine Know how to apply fibre optics to communication, including, analogue and digital signals: analogue-to-digital conversion, and broadband Know how to use the inverse square law in relation to the intensity of a wave using I=K/r2 Know how the regions of the electromagnetic spectrum are grouped according to frequency Know how the applications of electromagnetic waves in communications are related to frequency, including, satellite communication, mobile phones, Bluetooth, infrared and Wi-Fi	determination of melting point from the shape of a curve for a substance freezing; the shape of the curve and the rate of cooling in relation to intermolecular forces and the state of matter of the substance; temperature as a function of time; and super cooling	
Strategies Conditional knowledge 'I know when to'	Use my own knowledge to explain consequences eg the breakdown of boradband or Wi-Fi Evaluate social, medical and global issues like communication or up to date medical treatments Apply understanding of specific materials and content to real life contexts	Use a range of standard procedures or valid techniques to overcome errors or make improvements in the processes of preparing and standardising solutions Use subject specific language to describe, analyse and evaluate my work	Evaluate and critically analyse the validity of current practical methodology or to choose the most reliable or suitable method for a given problem Use primary and secondary data sources and contextual knowledge to inform my own work or to judge the validity of an interpretation

		Apply understanding of scientific empiricism to unknown concentrations of solutions and identify errors and make improvements When to apply the most valid strategies to explorative or developmental work in progress Use primary and secondary data sources and contextual knowledge to inform my own work or to judge the validity of an interpretation Use my own knowledge to explain consequences eg the end point of a titration Use subject specific language to describe, analyse and evaluate my work and the work of others	Apply understanding of specific materials and techniques Demonstrate the importance of safe working practices and safe handling of substances When to apply the most valid strategies to explorative or developmental work in progress Use subject specific language to describe, analyse and evaluate my work
Key questions	Demonstrate knowledge of scientific facts, terms, definitions and scientific formulae Demonstrate understanding of scientific concepts, procedures, processes and techniques and their application Analyse, interpret and evaluate scientific information to make judgements and reach conclusions Make connections, use and integrate different scientific concepts, procedures, processes or techniques	Correctly prepare and standardise solutions for titration and colorimetry Investigate the concentration of unknown solutions, using procedures and techniques in titration and colorimetry Demonstrate skilful application of procedures and techniques in titration and colorimetry to accurately determine the concentration of solutions Evaluate the accuracy of procedures and techniques used in titration and	Correctly use chromatographic techniques to produce chromatograms Explain the use of chromatographic techniques to separate mixtures Analyse own chromatograms and relate the factors that affect the separation of mixtures to the quality of results obtained Evaluate the chromatographic techniques used in relation to outcomes and suggest improvements

	Name the groups of the periodic table Discuss properties of ionic compounds Using atomic and group number, explain why potassium has a lower melting point than calcium Write a balanced symbol equation Give the oxidation number and state for the transition metal chromium Calculate the relative formula mass of ammonium sulfate Complete the dot and cross diagram for the ammonium ion NH4 Calculate the mass of ammonia required to make g of ammonium nitrate Complete the electron configuration of lithium Write the equation to show the first ionisation energy of lithium Explain why the first ionisation energy of group 1 decreases as atomic number increases Explain the difference in the melting points of water and methane, in terms of their intermolecular forces Which cell component is only found in eukaryotic cells? Compare squamous and columnar epithelial cells	colorimetry in relation to outcomes and suggest improvements Correctly obtain data using different equipment to construct cooling curves Correctly determine the rate of cooling of substances using cooling curves Analyse the rate of cooling of substances from your data using cooling curves to draw valid conclusions Evaluate the accuracy of practical work in calorimetry in relation to the analysis of the cooling curve	Summarise key personal competencies developed in relation to scientific skills undertaken Analyse skills developed and suggest improvements to own practice Evaluate scientific skills developed in terms of potential for future progression

	Complete the definition of palisade mesophyll tissue Explain how the vacuole of palisade mesophyll tissue increases photosynthesis rate Identify the cell structures from an electron micrograph Describe synaptic function As nicotine is an agonist for acetylcholine, explain why it produces excess HCl in the stomach Calculate the total number of gram positive bacteria in a petri dish after two hours Discuss why penicillin prevents growth of gram positive but not gram negative bacteria Give the number of complete wavelengths of a stationary set of waves ona string and show the position of one antinode Identify the process causing the stationary wave Use the equation to calculate the speed of the wave Give two factors that can alter the pitch of a string on a music instrument Discuss microwave signals Explain the advantages of using microwaves to transmit satellite communications		

	Why do upload and download signals have different frequencies Define analogue signals Analyse the maximum voltage of analogue signals from the graph Describe how to change analogue to digital signals Calculate the speed of light in optical fibres of a certain refractive index Annotate a diagram to explain how optical fibres transmit light when being used as medical endoscopes		
Assessment topics	Opportunities for End of Unit tests for each of the three Sciences if time, in addition to a mock assessment for each of the three Sciences Practice papers available	Two opportunities to submit each report, with one opportunity for individual feedback IV process embedded into feedback opportunity	Two opportunities to submit each report, with one opportunity for individual feedback IV process embedded into feedback opportunity
Cross curricular links **Character education**	Maths -calculations, graph skills Chemistry –periodicity, reactions, calculations –moles /yields etc Physics –communication, medical applications Biology -cells and tissues SMSC -ethical issues surrounding communication and medicine Problem solving Critical thinking	ICT use for research and writing Literacy -coherency and writing skills; improving performance based on feedback; spag Developing a working knowledge of health & safety Developing a working knowledge of practical science Developing a critical analysis of techniques to apply to the real world Planning and organising	ICT use for research and writing l Literacy -coherency and writing skills; improving performance based on feedback; spag Developing a working knowledge of health & safety Developing a working knowledge of practical science Developing a critical analysis of techniques to apply to the real world Planning and organising

		Critical thinking, Problem solving	Critical thinking Problem solving