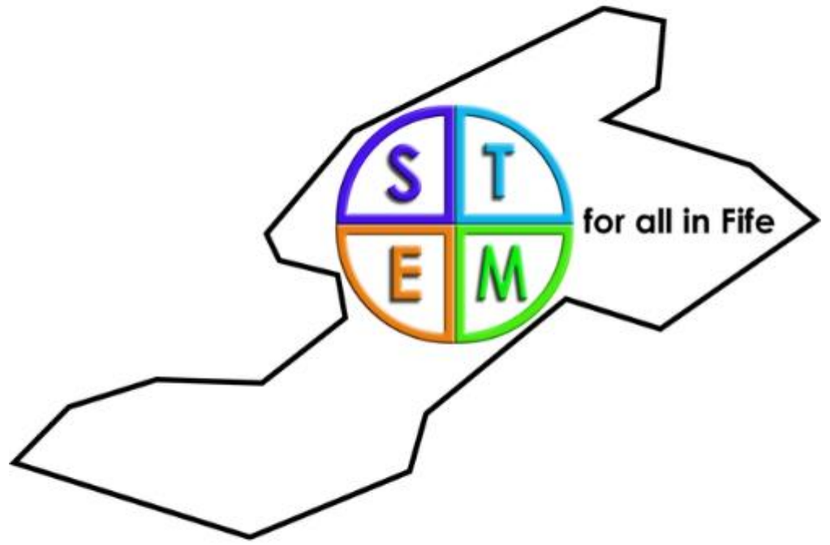
Fife Sciences Overviews



Second, Third and Fourth Level

Fife Council

GUIDANCE

The Overview provides a clear and structured framework to support practitioners in identifying key indicators of progress throughout each phase of development.

Designed to complement the Fife Progression Pathways, these materials support flexible and responsive planning, while aiding the monitoring and tracking of progress across organisers and skills.

Each CfE Level has been divided into phases to show progression within the Level.

Early		First			Second			Third			Fourth		
Phase 1 – Prerequisite	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8	Phase 9	Phase 10	Phase 11	Phase 12	Phase 13
											Used in some curricular areas only		

Benchmark statements are emboldened and embedded within each line of progression. Typically Benchmarks appear at Phase 1 (Early), 4 (First), 7 (Second),10 (Third) and 13 (Fourth) to illustrate achievement of a Level.

Effective use of this documentation is supported by:

- Engagement in professional learning around Learning, Teaching and Assessment
- A collaborative, whole school/faculty agreement on consistent use for planning and assessment of knowledge, application and skills
- School-specific systems for evaluating learning and informing professional judgement

In science, the scientific skills have been summarised to support holistic assessment approaches allowing practitioners to confidently track and evaluate learners' attainment.

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Phases 11-13**
Scientific Skills	**Inquiry and investigative skills**	With support: Begins to formulate scientific questions, make predictions, identify what needs to be changed or kept the same, and designs safe procedures for investigations. Makes careful observations and measurements using the appropriate equipment and units, keep the test fair, and follow the steps. Organises results clearly using tables, charts, and labelled diagrams, and structures simple reports or presentations. Identifies patterns and relationships in the data, explains what findings might mean in real-world contexts, recognises limitations in the investigation, and suggests improvements.		With support: Formulates scientific questions and predictions, identifies variables, anticipates risks, and applies safety measures. Collects observations and measurements accurately using appropriate equipment and units, manages controlled variables, and follows procedures. Records and organises data, identifies relationships, draws conclusions linked to predictions, relates findings to the wider world, and suggests improvements while recognising errors. Uses a range of tables, charts, and graphs; structures reports collaboratively or individually; summarises findings with headings; and uses scientific vocabulary with sources acknowledged.	With some support: Formulates scientific questions, aims and predictions, showing increasingly understanding of how to design an experiment and types of variables. Anticipates most risks and applies safety measures. Collects data (with units) using appropriate equipment and manages controlled variables using a procedure. Begins to interpret and analyse data to suggest relationships between variables, draws conclusions linked to aim and can suggest some improvements in experiment design. Presents data using a range of formats, communicates findings in a variety of ways, and acknowledges sources. Showing some confidence in using scientific terminology.		With limited support: Formulates key questions, aims and hypotheses, designs a controlled experiment with identified independent, dependent and controlled variables, and anticipates most risks and hazards and applies safety measures. Collects increasingly complex data using varied methods and equipment, manages controlled variables for validity. Interprets and analyses data to establish relationships between variables and hypotheses, draws conclusions linked to the aim and relates these to scientific knowledge. Considers alternative explanations and evaluates methodology and suggests improvements in experimental design. Presents data using an increasing range of formats, communicates effectively through reports and presentations for different audiences, and acknowledges sources appropriately. Using some scientific terminology (independent/dependent variable, precision, accuracy, validity) appropriately.	Independently: Formulates hypotheses and aims in complex contexts, designs a controlled experiment, identifying independent, dependent and controlled variables, selects appropriate ranges for the variables and measurements, and anticipates and mitigates major risks. Collects accurate measurements of complex data using suitable equipment, records data precisely with correct units and scales, and manages controlled variables for validity. Interprets and analyses data to identify trends and relationships between variables and link to hypotheses, draws justified conclusions linked to aim, considers alternative explanations, applies findings to wider contexts, and evaluates validity and reliability with justified improvements. Presents data by selecting an appropriate format for qualitative or quantitative data, structures reports for different audiences, summarises evidence from multiple sources, and acknowledges all sources appropriately. Using scientific terminology (independent/dependent variable, precision, accuracy, validity) appropriately.

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Phases 11-13**
Scientific Skills	**Scientific analytical thinking skills**	Applies scientific thinking skills to solve problems with familiar contexts. Provides solutions that start to demonstrate creative thinking through the engineering process (design, construct, test and modify).		Applies scientific analytical thinking skills and some knowledge to solve problems with less familiar (or familiar but more complex) contexts. Provides solutions using some creative thinking through the engineering process (design, construct, test and modify).	Applies scientific analytical thinking skills and a wider range of knowledge to solve problems that are becoming less familiar. Provides solutions that show increasing creative thinking through the engineering process (design, construct, test and modify).		Applies scientific analytical thinking skills and a wide range of science concepts to solve problems with a less familiar and more complex context (with increasingly independence). Provides solutions that demonstrate creative thinking through the engineering process (design, construct, test and modify).	Applies scientific thinking skills and knowledge from different areas of science to solve problems with an unfamiliar and complex context. Makes use of the engineering process in practical work to design, construct a model, test and modify the design to improve the solution.

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Phases 11-13**
Scientific Skills	**Skills and attributes of scientifically literate citizens**	Begins to develop and share evidence-based arguments that link to scientific and environmental issues. Demonstrates some understanding of the relevance of science to their future lives, careers and society.		Presents and shares a reasoned argument, based on evidence, demonstrating understanding of underlying science, engaging with the view of others. Demonstrates understanding of the relevance of science to their future lives, careers, and society. Demonstrates increased awareness of creativity, inventiveness, technology, and impact of science on society.	Discusses moral and ethical implications of a limited range of topical scientific developments, while respecting other views. Presents an informed view, using some evidence and scientific knowledge. Shows some awareness of creativity and technology use in Science, and a range of STEM careers.		Debates and discusses moral and ethical implications of some topical scientific developments, respecting other views. Presents informed view, using evidence, demonstrating understanding of underlying scientific concepts. Shows awareness of creativity and technology use in Science, and increasing range of STEM careers.	Debates and discusses moral and ethical implications of a wider range of scientific developments, respecting other views. Communicates informed, evidence-based views, with increasing complexity and sophisticated content and arguments, on topical issues demonstrating understanding of underlying scientific concepts. Shows awareness of creativity and technology use in Science, and increasing range of STEM careers.

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Benchmarks for Reference**
Planet Earth	**Biodiversity and interdependence**	Recognises variation within plants and animals – e.g., flowering vs non-flowering plants, vertebrates vs invertebrates. Observes and compares organisms based on visible characteristics to classify them logically. Begins to use and understand new terminology including habitat, ecosystem, herbivore, carnivore, omnivore, energy flow, adaptation, interdependence, extinction. Begins to interlink single food chains into simple food webs which show more than one consumer. Identifies basic plant parts and functions – roots, stems, leaves, flowers.	Begins to classify living things beyond plants and animals – micro-organisms (fungi, bacteria). Begins to use simple keys to identify particular plants and animals. Begins to identify and discuss characteristics of living things which help them survive in different environments. Begins to compare and contrast different ecosystems including living (organisms) and non-living factors (e.g., climate). Develops knowledge of more complex food webs, moving from simple chains to interconnected systems. Investigates different uses of plants and recognises the benefits to society and the environment. Recognises the use of different fertilisers (natural and artificial). Begins to explore the process of photosynthesis and respiration, linking to energy transfer.	**Classifies living things into plants (flowering and non-flowering), animals (vertebrates and invertebrates) and other groups through knowledge of their characteristics.** **Begins to construct and use simple branched keys which can be used to identify particular plants or animals.** **Identifies characteristics of living things and their environment which have contributed to the survival or extinction of a species.** **Describes how some plants and animals have adapted to their environment, for example, for drought or by using flight.** **Describes how energy flows between plants and animals in more complex food chains and webs and ecosystems, using vocabulary such as 'producers', 'consumers' and 'herbivore'.** **Relates findings from practical investigations to describe how plants have benefited society, for example, in medicine, dyes, fuels, construction, prevention of soil erosion and by influencing the balance of gases in the air.** **Collaborates with others to present a reasoned argument, based on evidence, of the risks and benefits of using fertilisers, demonstrating understanding of the underlying scientific concepts.**	With support, uses a branched biological key to identify plants and animals based on observable characteristics. Uses different sampling techniques to estimate the number of organisms living in a particular habitat. Begins to use different equipment to measure abiotic factors (e.g. temperature, light intensity). States why plants carry out photosynthesis, identifying the useful product of the reaction. Identifies more complex uses of plants. Explores nutrient cycles in the environment. Identifies different nutrients needed for successful plant growth. Identifies different agricultural processes (use of chemicals, genetic modification) used to promote plant growth and improve food production.	Uses branched and paired-statement biological keys to identify plants and animals based on observable characteristics. Identifies simple data patterns and trends, making links between the type and number of organisms in a habitat and the abiotic factors. Investigates the process of photosynthesis (e.g. testing a plant for starch) and draw a conclusion about requirements of photosynthesis. Organises and presents more complex information on the uses of plants and the benefits to society and the environment. Describes the relationship between fertilisers, nutrient levels and plant yields. Describes how different agricultural processes are used to improve food production. Investigates the impact of different agricultural processes on society and the environment.	**Identifies living things using biological keys.** **Collects and analyses increasingly complex data and information, for example, temperature and light intensity, to suggest reasons for the distribution of organisms within different habitats.** **Describes the process of photosynthesis (using the word equation) in terms of reactants (raw materials) and products.** **Applies knowledge gained from practical investigations to explain how green plants make their own food in the form of sugars and store this as starch.** **Investigates and presents information on how plants help to sustain life, for example, by providing oxygen, food, habitat, raw materials and medicines.** **Interprets data and information to establish a link between the use of fertilisers and plant yield and nutrient levels in the soil.** **Researches an agricultural method, for example, chemical fertilisers, herbicides, pesticides, organic methods, genetic modification (GM) and biological control and evaluates their impact on food production.**	**Describes how plants and animals depend on each other for food, shelter and pollination, using scientific vocabulary such as 'population', 'community' and 'species'.** **Explains the possible effects of removal or addition of species on food webs and biodiversity.** **Summarises research findings to provide examples of structural, physiological and behavioural adaptations which lead to species survival.** **Compares natural and artificial techniques to propagate plants, for example, seeds, bulbs and cuttings, and suggests commercial uses such as food production and food security.** **Explains, using experimental findings, the effect of different factors on the rate of aerobic respiration.** **Uses the word equation to describe the process of aerobic respiration.** **Describes the nitrogen cycle and explains the importance of each stage.** **Explores and explains the possible impact of the use of fertilisers, for example, algal blooms.**

		Second			Third			Fourth
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Planet Earth	**Energy sources and sustainability**	Begins to identify the common types of energy that occur in everyday appliances. Describes how energy is transferred and transformed in simple everyday tasks or appliances e.g. torch: electrical → light. Begins to explore renewable and non-renewable sources of energy and their advantages and disadvantages. Begins to explore their own energy use.	Begins to understand the difference between 'useful' and 'wasted' energy. Begins to identify 'useful' and 'wasted' energy conversions in simple, everyday energy transfers e.g. light bulb converting electrical energy to light (useful) and heat (wasted) energy. Identifies a range of renewable and non-renewable sources of energy used locally. Discusses ways to conserve energy and why it is important.	**Demonstrates understanding of the law of conservation of energy (energy can be converted from one form to another but cannot be created or destroyed).** **Identifies the common types of energy (kinetic, potential, electrical, chemical, light, sound and heat) used in energy transfers and transformations that occur in everyday appliances.** **Explains that when energy transfers and transformations take place, energy is converted into 'useful' and 'wasted' energy, for example a mechanical braking system transforms kinetic energy into heat energy which is dissipated to the atmosphere as 'waste' heat.** **Researches non-renewable sources of energy, such as fossil fuels and nuclear, and discusses how these are used in Scotland.** **Draws on increasing knowledge and understanding to suggest ways in which they can reduce their own energy use and live more sustainably.**	Plans and carries out experiments to investigate how heat is transferred by conduction, convection and radiation. Measures and calculates temperature difference between a variety of environments. Identifies common conductors and insulators of heat energy. Researches different types of renewable energy using a range of reliable and robust sources to inform their own views.	Describes heat transfer by the processes of conduction, convection and radiation. Understands how heat (thermal) energy flows from hot to cold objects. Explains the difference between temperature and heat. Identifies common ways heat energy is lost by conduction, convection and radiation from buildings. Recognises everyday examples and solutions to prevent heat loss from buildings. Discusses the impact of renewable energy sources on society and the environment.	**Applies knowledge from practical investigations to explain how heat is transferred by conduction, convection and radiation.** **Establishes a link between heat loss in buildings and the temperature difference between the inside and outside of the building.** **Applies understanding of thermal energy efficiency, conductors and insulators to explain how materials can be used in building design to reduce heat loss, for example, in double and triple glazing.** **Presents research findings on the advantages and disadvantages associated with the use of renewable energy sources and their impact on society, demonstrating an informed view based on evidence.**	**Applies knowledge and understanding from different areas of the curriculum to express an informed view of the risks and benefits of different energy sources, including at least one energy source derived from plants.** **Discusses, following research, the formation and use of fossil fuels and the need to use remaining fossil fuel resources responsibly, for example, to preserve finite supplies, limit pollution and reduce emissions of greenhouse gases.**

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Planet Earth	**Processes of the planet**	Identifies common uses of water in everyday life in different settings / environments. Explains how water supports life and the environment and predicts what might happen if water was scarce or unavailable. Identifies and describes changes of states of water (melting, freezing, boiling, evaporation and condensation) and recognises that these changes happen repeatedly in nature. Names the main stages of the water cycle and describes what happens at each stage.		**Discusses the necessity of water for life, for example, for the growth of crops, for drinking and in river formation/flow.** **Demonstrates understanding of the processes involved in the water cycle.**	Recognises the different particle arrangements in solids, liquids and gases. Compares and contrasts the properties of solids, liquids and gases, relating to particle arrangements. Identifies and describes the processes of the carbon cycle.	Describes the effect of energy gain or loss on particle motion and begins to link this to changing state. Explores human impact on the carbon cycle and how this relates to climate change. Describes the greenhouse effect.	**Describes, using particle models and diagrams, the properties of solids, liquids and gases and applies this knowledge to identify and classify unknown substances.** **Applies understanding of models of matter to explain changes of state in terms of energy being gained or lost by a substance.** **Explains how the levels of carbon dioxide in the atmosphere have increased over time, for example, through respiration of organisms, deforestation and increased combustion of fuels.** **Draws on supporting evidence, quotes and sources to demonstrate an association between carbon dioxide in the atmosphere and increasing global temperatures as a result of the greenhouse effect.**	**Calculates the pressure exerted by a force over an area using the relationship P = F / A.** **Describes, from experimental observation, the relationships between pressure, volume and temperature for a fixed mass of gas.** **Describes the steps in the carbon cycle and explains how processes such as respiration, photosynthesis and burning carbon-based fuels affect the balance of gases in the air.** **Researches the effects of changes in the balance of gases in the air and shares their scientific findings in an appropriate manner.**

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Benchmarks for Reference**
Planet Earth	**Space**	Explores our Solar System, it's planets, moons and star. Explores using models, how the planets orbit the sun. Compares and contrasts the time taken for different planets in our Solar System to orbit the sun. Models how the relative positions and motions of the sun, Earth and moon create lunar phases, eclipses, and predictable patterns within the lunar cycle.	Identifies the names of the planets in our Solar System and recognises their order from the sun, using simple facts to describe each one. Describes the basic structure of the Solar System, including the sun, planets, and the moon, and recognises how they move relative to each other (e.g. the Earth orbits the sun, and the moon orbits the Earth).	**Reports collaboratively on the key features of the planets including size, distance from the sun, length of day, length of year, temperature, materials from which they are predominantly made and the number of moons.** **Uses simple models to communicate understanding of size, scale, time and relative motion within our Solar System, including how solar & lunar eclipses occur.**	Identifies the requirements for life on Earth to exist. Explores stars and galaxies beyond our Solar System.	Researches conditions required to support life out with our Solar System. Investigates what is meant by the "Habitable Zone" and state the definition of an exoplanet.	**Presents a reasoned argument on the likelihood of life existing elsewhere in the universe including factors such as: the distance of planets from their stars, the number of stars in the universe and the availability of liquid water, nutrients and energy.**	**Describes the operation of an optical telescope, for example, reflecting or refracting telescopes, and explains the advantages of placing optical telescopes in orbit, for example, larger range due to less absorption and less atmospheric distortion.** **Researches and describes advances in techniques for viewing the universe, for example, using radio telescopes, emission spectra 40 or through gravitational wave detection.** **Discusses how discoveries made through observations have improved our knowledge of the universe and provides supporting evidence.**

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Benchmarks for Reference**
Forces, electricity and waves	**Forces**	Investigates how more than one force can act on an object at the same time. Explores how objects move through air or water and notices that their shape or size can affect how quickly they fall or travel. Relates friction and air resistance to slowing down or moving objects. Compares and contrasts the movement of different objects and begins to suggest ways to improve the efficiency of motion. Observes falling objects and links to the force of gravity. Investigates how the poles of a magnet behave, showing that like poles repel and opposite poles attract, and can use this knowledge to solve simple practical problems. Investigates how magnetic strength varies across a magnet and uses this understanding to identify the strongest parts of a magnet and applies this knowledge in simple problem-solving tasks. Explores objects that can be rubbed to make them static and notices that they can pull together or push apart. Explores placing different objects in water and notices whether they float or sink. Using prior knowledge, begins to question why certain objects float or sink in water.		**Describes friction as a force which opposes the motion of moving objects, for example, two solid surfaces rubbing against one another or a solid surface moving through air or water.** **Finds an association between air resistance (drag), the speed of the object being investigated and the surface area exposed to the air, making links to original predictions.** **Demonstrates understanding of how friction and air resistance can both be useful, for example, in braking systems, and also a problem, for example, causing moving parts to wear.** **Describes efficient movement as that which requires the least possible energy and suggests ways to improve efficiency in moving objects, for example, by streamlining.** **Measures gravitational force with a force meter or newton meter and records results using appropriate units (newtons).** **Explains how some objects may become electrically charged by rubbing two surfaces together and how the charges produce an electrostatic force.** **Investigates and demonstrates understanding that magnetic and electrostatic forces can both repel and attract.** **Describes practical applications of magnetic, electrostatic and gravitational forces, for example, magnetised needle in a compass.** **Explores the factors which affect floating, for example, the object's shape and the density of the material that the object is made of, and collates, organises and summarises findings with assistance.**	Plans and carries out experiments to explore the effect of lubrication and streamlining on friction, energy loss (as heat) and efficiency. Identifies the difference between mass and weight. Understands that gravitational field strength links mass to weight. Begins to link prior knowledge of the Solar System and gravitational field strength to make predictions about the weight of an object on various planets.		**Draws on findings from investigations to explain how lubrication, streamlining and other methods can be used to reduce friction, reducing the energy lost and improving efficiency.** **Knows that weight is a force caused by the Earth's (or other planet's) gravitational pull on an object, measured in newtons (N), and uses the formula W = mg to calculate weight.** **Predicts the effects on the weight of an object due to the gravitational field strength in different positions in the universe, for example, at different altitudes on Earth, on different planets and in deep space.**	**Measures and records data from experiments to produce speed-time graphs and interprets speed-time graphs to accurately describe motion.** **Calculates acceleration and distance travelled from a speed-time graph.** **Explains the motion of objects in situations involving constant acceleration, using Newton's Second Law, and applies knowledge to the context of transport safety, for example, braking distances, seatbelts, airbags and other design features.** **Interprets and analyses data to establish a relationship between the strength of electromagnets and, for example, the number of coils, size of current, core material or dimensions.** **Compares model electromagnets with those used in real-life applications, looking for similarities and differences.** **Shares scientific findings about the uses of super magnets, for example, in MRI machines, computer hard drives, electric and hybrid motors, audio speakers, electric guitars and race car engines.** **Calculates the density of a range of materials using the relationship Density = mass / volume.**

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Benchmarks for Reference**
Forces, electricity and waves	**Electricity**	Builds simple circuits using basic components such as bulbs, switches, bells and batteries, and recognises when a circuit is complete or incomplete.	Builds and tests simple electrical circuits using an increasing range of components such as bulbs, batteries, switches and buzzers, and can explain when a circuit is complete or incomplete. Identifies and uses the symbols to denote different circuit components. Demonstrates understanding that electrical energy can be transformed into different types of energy including light, heat, sound, and movement. Understands that batteries are a store of chemical energy and act as a source of electrical energy in a circuit.	**Designs and builds a variety of electrical circuits for differing purposes, using an increasing range of components.** **Draws circuit diagrams using appropriate symbols to denote a bulb, switch, motor, bell, buzzer, wires, cell and a battery.** **Describes how components in a circuit transfer energy into different forms.** **Applies knowledge and understanding to build simple batteries (chemical cells) and demonstrates understanding that a battery (cell) is a portable energy source which has a store of chemical energy.** **Explains the process of energy transformation from battery (cell) to electrical components.**	Using circuit diagrams, constructs simple series and parallel circuits. Conducts practical investigations to compare and contrast series and parallel circuits. Identifies everyday examples of series and parallel circuits. Demonstrates understanding that electricity involves the movement of charged particles/electrons and begins to make links to current and voltage. Uses equipment to measure and record current and voltage readings from series and parallel circuits.	Explores common metals and their different properties (reactivity, conductivity, etc.). Through experimentation, understands that a pair of metals can create a voltage difference and certain solutions allow charges to move. Measures the voltage produced by different metal/electrolyte combinations.	**Applies knowledge from practical investigations to describe the similarities and differences between series and parallel circuits and explain the advantages of parallel circuits in an everyday application.** **Investigates and explains how electricity can be produced when different metals are used as electrodes, with an electrolyte between them.** **Investigates and discusses the relationship between a range of factors (for example, the combination of metal electrodes used, the electrolyte used, the electrolyte concentration, the distance between electrodes and surface area of electrodes) and the voltage produced by a simple chemical.**	**Investigates the electrical properties of at least one fixed resistor to determine the relationship R = V / I and applies this to solve practical problems in circuits.** **Demonstrates understanding of the properties of input devices (for example, variable and light dependent resistors, thermistors and switches) and the operation of output devices (for example, bulbs, LEDs, motors and relays).** **Applies knowledge and understanding of the properties of switching devices, for example, transistors and logic gates, to design and construct an electronic circuit which solves a practical problem.** **Draws on findings from experiments to construct an electrochemical series using the voltage difference between pairs of metals.** **Demonstrates an understanding of the use of different metals in electrochemical cells for different applications.** **Researches and demonstrates awareness of the developments in cell technology, for example, in relation to fuel cells.** **Researches an application of chemical cells and its impact on society, communicating findings to others and acknowledging sources appropriately.**

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Benchmarks for Reference**
Forces, electricity and waves	**Vibrations and waves**	Describes how vibrations travel through different materials (air, solids, liquids) and begins to explain how the pitch or loudness of a sound can change depending on the size, speed, or strength of the vibration. Recognises the ear is the organ which detects sound. Explores how light behaves using simple observations (e.g., noticing shadows form when light is blocked, seeing light reflect from shiny objects, or observing distortions in curved surfaces like spoons or bottles). Investigates shadows in simple ways, noticing that shadows appear when an object blocks light and that shadows can change when the object or light source moves.	Explores how sounds can be heard in different situations (e.g., placing ear on a table, listening through a door, hearing sounds underwater) and begins to notice that sounds differ in different mediums. Notices and comments on simple differences in how well they can hear sounds in different situations (e.g., when facing away, covering ears, standing nearer or further away). Identifies the main parts of the ear and their associated functions. Explores how light can create colours in simple ways (e.g., noticing rainbows on CDs, in bubbles, or through glass prisms) and shows curiosity about where these colours come from. Notices that they can see objects only when there is light and begins to comment that it is harder to see in the dark.	**Discusses and demonstrates through experiments how sound travels differently through air, water and solids.** **Explains how hearing is limited by a range of factors, for example, age, position, and flexibility (direction) of ears.** **Demonstrates and records, through practical investigations, that light travels in straight lines, can be reflected by highly-polished surfaces and that curved faces can distort the image.** **Predicts and investigates how the position, shape and size of a shadow depend on the position of the object in relation to the light source.** **Demonstrates that white light/sunlight can be dispersed to show the colours of the visible spectrum and identifies the colours and order of the rainbow as red, orange, yellow, green, blue, indigo and violet.** **Explains that we see objects because they give out or reflect light rays that enter our eyes.** **Draws on findings from practical investigations to describe the effect that coloured filters have on white light and how they can be used to make other colours.** **Explains how we can recognise the colour of an object due the reflection and absorption of particular parts of the visible spectrum.**	Observes and records the direction of light as it passes from one material to another. Understands that light can pass through some materials but not others and can use the terms transparent, translucent and opaque. Understands that when light travels from one material to another (e.g., air → glass), it may slow down or speed up. Explores everyday examples of refraction.	Recognises light travels as a wave rather than as particles you can see moving. Understands that each colour of light has a different wavelength. Through experimentation, observes the dispersion of light through a prism and links this to developing knowledge of refraction. Understands that the visible spectrum is a tiny proportion of the full electromagnetic spectrum. Understands that electromagnetic waves differ in wavelength, frequency, and energy, but they all travel at the speed of light in a vacuum. Explores the electromagnetic spectrum and begins to relate to everyday examples.	**Demonstrates through practical investigation how refraction can cause a change of direction of light as it passes from one material to another.** **Describes the practical applications of refraction in everyday situations, for example, in corrective lenses in glasses, and in magnifying glasses and optical instruments.** **Explains how a visible spectrum is produced as light passes through a prism.** **Describes the electromagnetic spectrum as a family of waves including Gamma Rays, X-Rays, Ultraviolet, Visible Light, Infrared, Microwaves, Television and Radio.** **Researches at least one application of an electromagnetic wave beyond the visible in everyday life, giving advantages and limitations of that application.**	**Interprets sound wave traces to describe changes in amplitude and frequency.** **Compares non-visible parts of the electromagnetic spectrum, finding their common properties (speed, propagation), individual properties (range of frequencies, wavelengths) and discusses their uses.**

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Benchmarks for Reference**
Biological systems	**Body systems and cells**	Explains the functions of different parts of the skeleton in more detail, including how bones, joints and muscles work together for movement, and begins to compare human skeletons with those of other animals to identify similarities and differences. Describes how major organs work together within body systems (e.g., circulatory, respiratory, digestive, nervous) and begins to describe how lifestyle factors such as diet, exercise and hydration can support the healthy functioning of these organs. Explains how the skin works together with other body systems (e.g., the immune system and circulatory system) to protect the body and begins to describe factors that can damage or support healthy skin, such as hygiene, hydration, sun protection and injury. Independently researches, organises and presents detailed information about healthy lifestyle choices, explaining how different factors (nutrition, physical activity, sleep, substance avoidance, mental wellbeing) interact to support overall health, and evaluates the reliability of sources used. Recognises simple situations where senses help them notice danger (e.g., hearing a loud alarm, seeing a hot surface). Notices that people may use their senses differently (e.g., someone who cannot see might listen more carefully) and begins to recognise that some senses can help when another is not being used. Explains how common diseases are caused, how they spread, and identifies simple steps people can take to reduce transmission (e.g., hand-washing, vaccination, covering coughs), linking symptoms to ways the body tries to fight infection. Evaluates the effectiveness of different disease-prevention strategies (e.g., vaccination programmes, quarantine, hygiene routines, protective equipment) and explains why some methods work better for certain diseases than others, using scientific evidence to support conclusions.	Recognises that the human body is made up of different organs that have specific jobs (e.g., the heart pumps blood, the lungs help us breathe) and begins to name a few body systems (such as the circulatory or digestive system). Applies understanding of the senses to evaluate real-life safety situations, explaining which senses are most useful in different contexts (e.g., listening for alarms, smelling smoke, noticing hazards) and how using multiple senses together improves awareness and decision-making. Evaluates and explains why the senses can sometimes be misleading, drawing on evidence from investigations (e.g., how the brain interprets optical illusions, how background noise affects hearing, or how smell influences taste), and begins to discuss how humans use tools or technology to extend or enhance their senses. Notices and talks about how we need light to see and begins to observe simple changes in the eyes (e.g., pupils looking “big” in the dark or “small” in bright light). Recognises that microorganisms such as bacteria, viruses and fungi exist and can grow or spread, noticing simple examples (e.g., mould appearing on food or germs spreading by touch). Discusses microorganisms that can be helpful and are used in making certain foods (e.g., bread, cheese, yoghurt). Recognises that microorganisms can cause food to go mouldy or “go off,” and that some microorganisms live inside the body and help us stay healthy. Notices simple signs of decay in natural materials (e.g., mould on food, leaves breaking down, wood softening) and begins to understand that micro-organisms are involved.	**The expectation is that at least two of the following body systems will be studied at Second Level covering the functions of the main organs and main preventable causes of disease. See Progression Pathways for full details.** **Respiratory system** **Circulatory system** **Digestive system** **Reproductive system** **Skeletal system** **Describes how senses work individually or together to keep people safe from harm.** **Demonstrates understanding of how, if one sense is impaired, it can have an effect on the other senses, either positively or negatively.** **Describes how light enters the eye through the pupil and how the pupil changes size in dark/light conditions.** **Demonstrates understanding of how microorganisms, including bacteria, viruses and fungi, can multiply rapidly.** **Investigates and explains the action of some microorganisms used in food production, for example, yeast in bread and bacteria in yoghurt.** **Describes how some micro-organisms break down food causing it to be inedible or harmful if digested, and how others exist in the gut to break down food to aid digestion.** **Investigates, observes and records how microscopic organisms are necessary for the process of decomposition (the breaking down of dead material – decay).**	Explores at least three major organ systems, producing labelled diagrams for each and identifies the function of the system. Participates in investigations to measure different aspects of health: (e.g., pulse rate, blood pressure and recovery rate). Explores different aspects of health and conditions that can be monitored. Observes and identifies different plant and animal cells. Identifies and labels the main parts of basic plants and animal cells. Observes a variety of specialised cells and identifies specialised features. Carries out practical microbiology investigations following safety rules. Investigates a range of conditions and chemicals, observing the effect on microbial growth. Researches different micro-organisms and associated human diseases/infections. Explores and discusses different body defence mechanisms which protect against disease. Demonstrates an awareness of vaccinations and their purpose. Explores different disease which can be vaccinated against to protect individuals and populations.	Identifies and describes the key structures and functions of three major organ systems with increasing confidence. Uses both high- and low-tech instruments to measure different aspects of health: (e.g. pulse rate, blood pressure and recovery rate). Researches a condition that can be screened for in health settings. Compares and contrasts plant and animal cell structures. Describes the functions of the main plant and animal cell structures. Researches the structure and function of different specialised cells (nerve, root hair, red blood cell, sperm and egg). Recognises essential resources required for microbial growth. Describes and predicts the effect of different conditions and chemicals on microbial growth. Explores and identifies how different micro-organisms invade the body causing disease and infection. Identifies a range of human first line defences again disease and infection. Identifies and describes the structure and function of the body’s immune system. Describes how a vaccine works, making reference to the immune system.	**Learning at Third Level should take account of, and extend prior learning, both in terms of breadth and depth.** **Explores and explains the structure and function of at least three of the major organ systems, for example, Respiratory, Circulatory, Digestive, Excretory, Reproductive and Skeletal, and relates this to the basic biological processes required to sustain life.** **Uses a variety of instruments to monitor and record aspects of health, for example, pulse rate, blood pressure and recovery rate and gives examples of other aspects of health that may be monitored, for example, cholesterol and BMI.** **Researches one condition that is screened for (for example, bowel cancer, macular degeneration and diabetes) and describes the symptoms of the condition.** **Identifies the structures found in plant and animal cells and describes their functions.** **Describes the main similarities and differences between plant and animal cells.** **Researches and describes the structure and function of some specialised cells, for example, nerve, root hair, red blood cell, sperm and egg.** **Applies knowledge from investigations to describe the essential resources that micro-organisms need to grow and reproduce, for example, food, water, warm temperature and a suitable pH.** **Draws conclusions from investigations to describe how conditions and chemicals can promote and restrict growth, including temperature, antibiotics and antifungals.** **Describes how microbes (for example, bacteria and viruses) can cause disease and infection and how barriers to infection provide a first line of defence, for example, skin, mucus and stomach acids.** **Describes how the immune system protects the body against disease if the first line of defence is breached, for example, through the action of white blood cells and production of antibodies.** **Applies knowledge of body defence mechanisms to explain how vaccinations can protect individuals and populations from disease.**	**Describes the changes in the body in response to an external stimulus (for example, change in temperature) and an internal change (for example, water balance and the kidneys or the action of insulin in relation to the regulation of glucose).** **Explains the importance of these changes in relation to the normal working conditions of the body (homeostasis).** **Describes methods of learned behaviour in organisms, for example, the effect of light on the behaviour of woodlice, and explains how this behaviour contributes to their survival.** **Summarises data and information from research to explain why cell division is required for growth and repair in organisms.** **Researches and describes at least one therapeutic use of stem cells.** **Describes the properties and industrial uses of at least one microorganism, for example, the use of yeast in brewing and bacteria in yogurt production.** **Describes the properties of at least one enzyme used in industry, for example, enzymes within biological detergents and stain removers or pectinase in the breakdown of plant material to release juice.** **Formulates a reasoned argument, based on evidence and using correct scientific vocabulary, to debate moral and ethical issues of the chosen controversial biological procedure, for example, the collection and use of stem cells and DNA profiling.**

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Benchmarks for Reference**
Biological systems	**Inheritance**	Begins to explain that inherited characteristics come from genetic information passed from parents to offspring and can distinguish between inherited traits and those influenced by the environment. Recognises that offspring can look similar to their parents and notices simple inherited features (e.g., eye colour, fur pattern). Notices and talks about simple differences between people (e.g., hair colour, height, favourite things) without yet distinguishing which characteristics are inherited and which are learned or chosen. Notices and comments on a range of human characteristics (e.g., hair colour, height, favourite activities), without yet distinguishing whether these traits are inherited or learned/ chosen.	Plants: Notices and names the basic parts of common flowers (e.g., petals, stem, leaves) and begins to observe insects visiting flowers, showing early awareness that they play a role in helping plants reproduce. Recognises that plants produce male and female parts and begins to understand that pollen must reach the female part of the flower for a seed to form. Recognises that once a flower has been pollinated, the petals may fall off and a small fruit or seed pod begins to grow, showing early awareness that changes happen after pollination. Observes that seeds can begin to grow when placed in soil or on damp materials and notices early changes such as the seed swelling or a small root appearing. Animals: Notices simple differences between animals (e.g., size, number of legs, body coverings) and begins to group them based on obvious features. Recognises that different vertebrate groups have their own basic life cycle patterns (e.g., some hatch from eggs, some are born live). Identifies and describes the basic life cycle of one familiar invertebrate (such as a ladybird or butterfly). Begins to explain how genetic information is passed from parents to offspring, recognise that offspring inherit a combination of traits from both parents, and explore how some characteristics are inherited while others are influenced by environmental factors. Begins to explain that variations within families occur because offspring inherit a mix of genetic information from both parents and can distinguish inherited characteristics from those shaped by environmental factors. Understands that living things have unique features that make them identifiable (e.g., no two animals or people look exactly the same).	**Plants:** **Describes how pollination occurs when the male cell (pollen) lands on the stigma.** **Describes how fertilisation (sexual reproduction) occurs when the genetic information in the male cell fuses (joins) with the genetic information in the female cell.** **Describes how the fertilised ovule develops into a seed and how the ovary ripens to form a fruit.** **Investigates and explains how a seed germinates into a plant using water, oxygen, a food store and warmth.** **Animals:** **Identifies and compares the two distinct groups of animals – vertebrates and invertebrates.** **Researches the lifecycles of the five main types of vertebrates including fish (spawn), birds (eggs which are rigid but fragile), amphibians (spawn and metamorphosis), reptiles (leathery shelled eggs) and mammal (live young), and communicates findings using a range of media.** **Compares the lifecycles of some invertebrates, for example, ladybird and spider.** **Knows that genetics is the study of inherited characteristics and that inherited characteristics are carried on genes and can sometime skip a generation.** **Explores and categorises characteristics into inherited (eye and hair colour, height and right/left handedness) and non-inherited (native language spoken and favourite colour).** **Describes how every living thing has its own DNA fingerprint.**	Identifies the male and female animal gametes. Identifies the main structures and functions of the human reproductive systems. Explores the process of fertilisation linking knowledge of the human reproductive system. Identifies and labels the main structures within the pregnant womb. Researches different risk factors for the developing embryo in the pregnant womb. Explores and discusses how genetic information is structured and stored in living things using the terms DNA and genes. Demonstrates understanding that everyone's DNA is unique. Researches different uses of DNA profiling. Begins to discuss the ethical implications of collecting, processing, storing and owning genetic information or DNA profiles.	Relates the structure to the function of the male and female animal gametes. Demonstrates understanding that male and female gametes carry genetic information in their nuclei required to make a complete individual. Describes the main events in the process of fertilisation. Describes how the fertilised egg develops into an embryo. Understands the functions of the different structures within the pregnant womb. Identifies different substances which can cross the placenta from mother to the embryo and recognises how they can cause harm to the embryo. Understands how genetic information is organised and unique to individuals controlling specific inherited characteristics. Identifies specific uses of DNA profiling, and associated advantages and disadvantages of collecting, processing, storing and owning genetic information or DNA profiles. Uses research and discussion to form their own opinions and ideas about the ethical implications of collecting, processing, storing and owning genetic information or DNA profiles.	**Knows that a sex cell (gamete) contains half the genetic information needed to a make a complete individual.** **Explains how the nuclei of an egg and a sperm (sex cells) fuse through the process of fertilisation and how the fertilised egg divides repeatedly to form an embryo.** **Identifies the main structures within the pregnant womb (for example, placenta, amniotic fluid and umbilical cord) and describes their function.** **Gives examples of substances, including toxins, which can cross the placenta from the mother to the embryo and demonstrates understanding of the potential damage to the embryo.** **Knows that DNA is found in the nucleus of most cells and that it contains the instructions for the development and function of living things (genetic code).** **Describes a gene as a piece of DNA which controls specific characteristics in an individual and demonstrates understanding that every individual has a unique combination of genes.** **Describes DNA profiling as a way of using technology to analyse DNA to see a unique pattern for an individual and gives examples of practical applications (paternity tests and forensics).** **Presents reasoned arguments on the ethical implications of collection, processing, storage and ownership of genetic information or DNA profiles.**	**Investigates and researches the life cycles of at least two organisms and compares and contrast their related growth and development.** **Evaluates and compares data and information on sexual and asexual reproduction, for example, rate of reproduction and numbers of organisms, and explains the importance of both methods for survival of species.** **Describes how the genetic information received from parent(s) determines some of our physical characteristics and demonstrates understanding that some genes have dominant and recessive versions called 'alleles'.** **Produces a worked example to solve a simple genetic problem, for example, a monohybrid cross to show the passage of genes from parents to offspring.**

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Benchmarks for Reference**
Materials	**Properties and uses of substances**	Begins to identify and compare the properties of natural and synthetic materials (such as flexibility, durability, waterproofing, transparency, and strength) and explains how these properties make certain materials suitable for particular uses. Explores everyday examples where materials change permanently (e.g., bread to toast, steel wool rusting, paper burning) and begins to notice that these changes cannot be undone. Observes simple changes of state (e.g., ice turning to water, water disappearing from a puddle, steam from a kettle) and talks about what they see in everyday language. Begins to predict, investigate and record how different factors (such as temperature, stirring, and particle size) affect the rate at which materials dissolve and explains their findings using scientific language. Explores mixtures of different solids through hands-on play and begins to notice that some materials can be separated more easily than others (e.g., picking out large pieces by hand).	Explores simple physical changes by observing what happens when materials are heated, cooled, mixed or dissolved, noticing that they can look or feel different afterwards. Begins to investigate how materials can change (e.g., melting, freezing, dissolving, mixing), recognises which changes are reversible or irreversible, and explains how these changes affect the material's properties and potential uses. Engages in simple explorations where materials are mixed, heated or combined, noticing that some materials change in unexpected ways (e.g., fizzing tablets in water, colour changes in food, heat from hand warmers). Experiments with a range of materials and notices simple differences in how they behave (e.g., some stay in one shape, some can be poured, some spread out into the air). Explores simple mixtures of insoluble solids and begins to recognise that different tools (e.g., sieves, filters, magnets) can separate materials. Observes that some solids disappear when mixed with a liquid (dissolve) while others do not and begins to recognise that once a solid has dissolved, it cannot be removed by simple filtering. Explores what happens when solids are mixed with liquids and describes these changes using everyday language (e.g., "it disappears," "it mixes in," "it stays solid"). Describes what happens during simple dissolving investigations (e.g., which solids dissolved fastest or which solutions were easiest to mix). Explores how different conditions affect dissolving by observing simple patterns (e.g., noticing that warm water or stirring helps something dissolve faster). Carries out simple dissolving activities and begins to notice that some substances dissolve faster than others. Recognises that dissolving can happen at different speeds and begins to describe these differences based on simple observations in class investigations.	**Investigates and explains physical changes to the properties of materials which are fully and partially reversible, for example, salt dissolving in water, chocolate melting and water freezing.** **Uses scientific vocabulary such as 'melting', 'freezing', 'evaporating' and 'condensing' to describe changes of state.** **Investigates and records chemical changes to the properties of materials which are irreversible, for example, cooking, rusting and striking a match.** **Observes and identifies some of the signs of a chemical reaction, for example, production of bubbles, colour/texture change and heat given out/taken in.** **Explores and describes the characteristics of solids, liquids and gases, for example, solids retain the same volume and shape, liquids keep the same volume but the shape changes to fit the container and that gases change shape and volume to fill the container.** **Draws on findings from practical investigations to explain how a mixture of solids of different sizes can be separated using a sieve or magnet, for example, sand and peas or salt and iron filings.** **Selects the most appropriate practical technique for separating insoluble solids, for example, filtering or sieving.** **Explains why a dissolved solid cannot be separated from the solvent by filtering but can be separated by evaporation.** **Uses scientific vocabulary such as 'soluble', 'insoluble', 'dissolve' and 'solution' in context.** **Relates findings of practical investigations about dissolving to everyday experiences, for example, recycling, salt production and water purification.** **Finds an association between the quantity of substance that dissolves and a range of conditions – temperature, time, particle size, stirring and quantity of solvent.** **Investigates how a range of factors such as particle size and heat can affect the rate of dissolving.** **Relates learning about the quantity and rate of dissolving to everyday examples such as dissolving sugar in tea or salt in water (granules or big crystals, hot or cold liquid, stirred or not stirred).**	Begins to explore the Periodic Table, naming and locating common elements including metals and non-metals. Carries out investigations to compare and contrast the properties and uses of different metals and non-metals. Observes chemical reactions involving different groups of elements, noticing how reactivity is linked to their position in the Periodic Table. Carries out investigations to separate different mixtures. Carries out simple solubility investigations and begins to use the terms solute, solvent and solution in context.	Uses the Periodic Table with increasing confidence to identify different elements by their name, symbol and atomic number. Begins to locate elements in the Periodic Table in relation to their properties. Plans and carries out investigations to make common compounds. Explores naming rules for simple compounds. Begins to construct simple word equations, identifying the reactants and products. Explores reading and writing simple molecular formulae using knowledge of the periodic table. Demonstrates understanding of the relationship between solute, solvent and solution. Compares and contrasts the solubility of different solutes in different solvents. Begins to make links between changing solute and solvent quantities and the concentration of a solution, relating to everyday examples e.g. diluting juice, sugar in tea.	**Investigates and describes properties of metals and non-metals, for example, appearance, conductivity of electricity, position in the Periodic Table and their uses linked to their properties.** **Knows that elements are organised in the Periodic Table by atomic number, each with its own unique symbol, and that elements with similar chemical properties are placed together in vertical groups.** **Identifies and names the groups 'alkali metals', 'halogens' and 'noble gases' and describes their reactivity.** **Investigates and describes at least two examples of compounds with properties that are different from their constituent elements, for example, hydrogen explosion and electrolysis of water.** **Constructs names of two-element compounds which are derived from the names of the elements, from which it is formed, with a suffix of-ide.** **Constructs word equations for simple reactions, for example, carbon reacting with oxygen: carbon + oxygen carbon dioxide.** **Identifies elements present from simple molecular formulae.** **Gives examples of pure substances and mixtures from everyday life.** **Selects appropriate physical methods to separate mixtures into their components, for example, distillation, filtration and chromatography and justifies their choices.** **Investigates and describes the solubility of substances in different solvents, for example, water and acetone/propanone.** **Explains the link between the relative quantity of solute or solvent and changes in the concentration of a solution.**	**Constructs diagrams and models to illustrate the sharing of outer electrons in covalent bonds between non-metal atoms when forming molecules and to illustrate how ionic compounds exist as a crystal lattice.** **Identifies, from temperature data, the relationship between melting and boiling points and the state at room temperature for covalent and ionic compounds.** **Investigates and describes electrical conductivity for covalent and ionic compounds.** **Identifies the most likely type of bonding in a compound based on its properties, for example, melting and boiling points and electrical conductivity.** **Summarises data and information from research to explain the properties, practical application and potential impact of a novel material.** **Demonstrates understanding of conservation of mass by evaluating experimental results relating to the mass of reactants and products of at least two chemical reactions, for example, burning iron wool, making magnesium oxide or precipitation of ionic salts.**

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Benchmarks for Reference**
Materials	**Earth's materials**	Observes, describes and sorts rocks, soils and minerals using simple, visible features such as colour, texture, hardness, and grain size. Understands that different materials come from the Earth and identifies basic examples of rocks, soils, and minerals in their environment.		**Analyses and compares samples of rocks, soil and minerals and reports their characteristics and uses, using a range of media.**	Researches the rock cycle process and different types of rock. Explores and identifies different types of soils and their uses. Explores common minerals and their everyday uses. Carries out investigations to explore how a useful substance can be extracted from natural resources, e.g. dyes from plants.	Describes processes in the rock cycle linking specifically to the formation of sedimentary, igneous and metamorphic rocks. Compares and contrasts sedimentary, igneous and metamorphic rocks. Describes the formation and characteristics of loam, sand and clay soil types. Describes at least 2 characteristics of a common mineral, e.g. quartz or gypsum. Identifies useful substances that can be extracted from natural resources, e.g. metal from mineral ores, dyes from plants.	**Applies knowledge of the rock cycle to describe the formation and characteristics of sedimentary, igneous and metamorphic rocks and gives at least one example of how each is used.** **Describes the formation and characteristics of loam, sand and clay soil types, providing examples of their uses, for example, in agriculture, building and beauty products.** **Researches the formation, characteristics and uses of at least two common minerals, for example, quartz or gypsum and communicates their findings to others using a range of media.** **Investigates and describes how at least two useful substances can be extracted from natural resources, for example, metal from mineral ores, dyes from plants and oils from plants.**	**Explains how fractional distillation can be used to separate crude oil into 'fractions' (groups of compounds with similar boiling points).** **Identifies and describes the importance of at least three everyday substances that are made from hydrocarbons, for example, petrol for fuel, camping gas or plastics.**

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Benchmarks for Reference**
Materials	**Chemical changes**	Understands and describes the key stages of the water cycle—evaporation, condensation, precipitation, and collection—and recognise that water continually moves between the sea, land and air in a repeating cycle. Understands that water collected from the environment may contain impurities and that not all water is safe to drink. Knows that water can be changed by processes such as evaporation and condensation and describes the basic stages of the water cycle. Understands that water is a limited and valuable resource and know some everyday examples of how water is used in the home, school and wider environment. Recognises that wasting water has consequences and shows an awareness that people and animals depend on clean water to survive. Understands that water is essential for life and recognise everyday ways in which water is used in the home, school and community (e.g., drinking, washing, cleaning, watering plants). They are aware that water exists in different forms—liquid, solid and gas—and that it can change state. Identifies observable signs that a change has happened when materials are mixed (e.g., colour change, fizzing, temperature change, new smell) and understands that some changes are reversible while others are not. They also know and demonstrate basic classroom safety rules when handling materials and equipment. Identifies observable signs that a material has undergone a change—for example colour change, fizzing, heat being produced, or a new smell. They understand that some changes are reversible (like melting or freezing) and others are irreversible (like burning or rusting). Observes and describes simple changes when materials are mixed or heated and recognises key signs that a chemical reaction may have occurred—such as fizzing, colour change, heat production, or a new smell. Demonstrates understanding that some changes are reversible while others are not.		**Uses knowledge of the water cycle to explain how the quantity of water on the Earth has remained approximately the same.** **Investigates and discusses the methods used to purify water, for example, sedimentation, filtration, evaporation, desalination and the addition of chemicals such as chlorine.** **Researches methods used to conserve water within the home, school and globally and communicates findings to others.** **Discusses the many uses of water, for example, to support all living things, in preservation (ice) and to generate electricity.** **Collaborates with others to safely demonstrate simple chemical reactions, for example, effervescence.** **Investigates examples of everyday chemical reactions, such as burning and corrosion, and names some of the new substances which are produced.** **Uses prior knowledge to identify when a chemical reaction has occurred to produce a new substance.**	Explores and tests everyday examples of acids and alkalis. Carries out investigations and observes the colour change of an indicator when mixed with an acid, alkali or neutral substance. Observes a range of chemical reactions and notices the difference in reaction rate. Researches the role of catalysts in everyday life.	Carries out investigations to test what happens when different indicators are combined with acids or alkalis/bases. Investigates the pH of an acidic, neutral and alkaline solution, linking the colour of an indicator to the pH scale. Carries out a range of investigations looking at chemical reactions and identifies different indicators of a chemical reaction. Carries out a range of investigations into factors (particle size, concentration, temperature or catalysts) affecting reaction rate. Draws a suitable conclusion about the relationship. Defines the terms "catalyst" and "enzyme" and describes their effect on everyday reactions. Links knowledge of chemical reactions in the laboratory to reactions involving Earth's materials, e.g. combustion of fossil fuels.	**Knows that indicators, such as universal indicator, are chemicals which produce different colours when placed in acid and alkali/bases.** **Investigates and describes the colour changes of indicators when added to acid/bases.** **Investigates and describes the pH of some everyday substances.** **Identifies substances as acidic (pH of less than 7), alkaline/basic (pH greater than 7) or neutral (equal to 7).** **Investigates and describes what happens to the pH when an acid is added to an alkali/basic.** **Identifies indicators of chemical reactions such as colour change, precipitate formation, release of gas, and/or a detectable energy change.** **Finds the relationship between particle size, concentration temperature and catalysts and the rate of a reaction.** **Explains how catalysts, including enzymes, can be used to speed up chemical reactions, and provides at least two everyday examples of reactions involving a catalyst.** **Describes chemical reactions involving the Earth's materials, for example, combustion of fossil fuels, carbonate rocks reacting with acid and the formation and impact of acid rain.**	**Analyses and interprets findings from environmental sample data to identify the quantities of pollutants present.** **Gives at least one reason for the presence of a pollutant in an environmental sample and describes the environmental change which may occur as a result of the presence of the pollutant.** **Collects and analyses temperature data to identify, on at least two occasions, where a chemical reaction is either exothermic or endothermic.** **Uses data from experiments to list metals in order of reactivity, for example, involving metals reacting with oxygen (to produce oxides), metals reacting with water (to produce hydroxides) and metals reacting with a dilute acid (to produce hydrogen gas and aqueous salts).** **Constructs simple formulae equations describing reactions of metals with oxygen, water and a dilute acid.** **Investigates and describes three methods of extracting metals from their compound ores as:** **• Heating alone, for example, with silver oxide** **• Heating with carbon, for example, with copper oxide** **• Electrolysis, for example, lead bromide (possible demonstration).** **Identifies the appropriate extraction method for a metal depending on the position of the metal in the reactivity series.** **Draws on findings from investigations to explain how metals above iron in the reactivity series can be used to sacrificially protect iron from corrosion.**

		Second			Third			Fourth
		Phase 5	**Phase 6**	**Phase 7**	**Phase 8**	**Phase 9**	**Phase 10**	**Benchmarks for Reference**
Topical science	**Topical science**	Identifies how different aspects of science are relevant to their everyday lives. Finds relevant information about a range of scientists and their discoveries from more than one source, including digital media. Identifies and discusses careers in STEM, making links to scientific skills they are developing. Identifies topical scientific issues and increasingly contributes to discussions considering the moral, ethical, societal, cultural, economic and environmental aspects. Respects different opinions around topical scientific issues.		**Researches historic and contemporary scientists (ensuring gender balance) and their scientific discoveries and reports collaboratively to others using a range of methods.** **Describes the impact of scientific discovery, creativity and invention on society past and present, for example, in design, medicine and agriculture.** **Demonstrates understanding of how science impacts on every aspect of our lives.** **Relates the development of scientific skills in the classroom to an increasingly wide variety of science, technology, engineering and mathematics (STEM) careers.** **Explores items of current scientific interest within the school, local community, nationally or in the global media and collates, organises and summarises findings, with assistance.** **Shares opinions about a variety of topical scientific issues considering, for example, moral, ethical, societal, cultural, economic and environmental aspects.**	Identifies relevant and reliable sources of scientific information. Explores how scientists contribute to innovative research and development and can communicate findings clearly. Accesses information about STEM careers to inform future pathways. Explores the reasons for bias in relation to scientific issues. Identifies and considers bias across a variety of scientific sources. Through research and discussion, identifies fact from opinion linked to scientific issues. Begins to formulate and justify their own opinions about a variety of scientific issues.		**Collaborates with others to research how scientists, and those who use science in their jobs, have contributed to the development of scientific ideas.** **Communicates findings in a suitable way to give an example of how scientists contribute to innovative research and development.** **Gives examples of how skills developed through science are used in a wide variety of jobs and careers including science, technology, engineering and mathematics (STEM) careers.** **Demonstrates understanding of bias and separates fact from opinion taking into account a range of reasons for bias, for example, selective sampling and political views.** **Analyses the scientific content in media items and presents a reasoned argument on the ethical implications of the scientific issue being explored.**	**Researches and communicates developments in science, explaining how current and future applications might impact on life.** **Demonstrates increasing understanding of how the transferrable skills developed through the sciences are used in a wide variety of jobs including science, technology, engineering and mathematics (STEM) careers.** **Selects and analyses scientific content of topical interest from a range of sources, including the media.** **Identifies examples of bias in sources and justifies decisions in separating fact from opinion.** **Critically analyses a scientific issue and gives consideration to the ethical, moral, environmental, social or political implications of the scientific theme selected to develop an informed argument.**

Appendix 1: S3 Guidance – Fourth Level Benchmarks

The Benchmarks have been aligned to the traditional Secondary Subject Areas – Biology, Chemistry and Physics. Where a particular curricular organiser / sub-curricular organiser is relevant within another subject area, a code has been added to show this. Biology (**Bio**), Chemistry (**Chem**) and Physics (**Phys**).

Biology

Planet Earth – Biodiversity and interdependence

- Describes how plants and animals depend on each other for food, shelter and pollination, using scientific vocabulary such as 'population', 'community' and 'species'.
- Explains the possible effects of removal or addition of species on food webs and biodiversity.
- Summarises research findings to provide examples of structural, physiological and behavioural adaptations which lead to species survival.
- Compares natural and artificial techniques to propagate plants, for example, seeds, bulbs and cuttings, and suggests commercial uses such as food production and food security.
- Explains, using experimental findings, the effect of different factors on the rate of aerobic respiration.
- Uses the word equation to describe the process of aerobic respiration.
- Describes the nitrogen cycle and explains the importance of each stage.
- Explores and explains the possible impact of the use of fertilisers, for example, algal blooms.

Planet Earth – Energy sources and sustainability (Chem & Phys)

- Applies knowledge and understanding from different areas of the curriculum to express an informed view of the risks and benefits of different energy sources, including at least one energy source derived from plants.
- Discusses, following research, the formation and use of fossil fuels and the need to use remaining fossil fuel resources responsibly, for example, to preserve finite supplies, limit pollution and reduce emissions of greenhouse gases.

Biological systems – Body systems and cells

- Describes the changes in the body in response to an external stimulus (for example, change in temperature) and an internal change (for example, water balance and the kidneys or the action of insulin in relation to the regulation of glucose).
- Explains the importance of these changes in relation to the normal working conditions of the body (homeostasis).
- Describes methods of learned behaviour in organisms, for example, the effect of light on the behaviour of woodlice, and explains how this behaviour contributes to their survival.
- Summarises data and information from research to explain why cell division is required for growth and repair in organisms.
- Researches and describes at least one therapeutic use of stem cells.
- Describes the properties and industrial uses of at least one microorganism, for example, the use of yeast in brewing and bacteria in yogurt production.
- Describes the properties of at least one enzyme used in industry, for example, enzymes within biological detergents and stain removers or pectinase in the breakdown of plant material to release juice.
- Formulates a reasoned argument, based on evidence and using correct scientific vocabulary, to debate moral and ethical issues of the chosen controversial biological procedure, for example, the collection and use of stem cells and DNA profiling.

Biological systems – Inheritance

- Investigates and researches the life cycles of at least two organisms and compares and contrast their related growth and development.
- Evaluates and compares data and information on sexual and asexual reproduction, for example, rate of reproduction and numbers of organisms, and explains the importance of both methods for survival of species.
- Describes how the genetic information received from parent(s) determines some of our physical characteristics and demonstrates understanding that some genes have dominant and recessive versions called 'alleles'.
- Produces a worked example to solve a simple genetic problem, for example, a monohybrid cross to show the passage of genes from parents to offspring.

Chemistry

Planet Earth – Processes of the planet (Bio & Phys)

- Calculates the pressure exerted by a force over an area using the relationship P = F / A.
- Describes, from experimental observation, the relationships between pressure, volume and temperature for a fixed mass of gas.
- Describes the steps in the carbon cycle and explains how processes such as respiration, photosynthesis and burning carbon-based fuels affect the balance of gases in the air.
- Researches the effects of changes in the balance of gases in the air and shares their scientific findings in an appropriate manner.

Materials – Properties and uses of substances

- Constructs diagrams and models to illustrate the sharing of outer electrons in covalent bonds between non-metal atoms when forming molecules and to illustrate how ionic compounds exist as a crystal lattice.
- Identifies, from temperature data, the relationship between melting and boiling points and the state at room temperature for covalent and ionic compounds.
- Investigates and describes electrical conductivity for covalent and ionic compounds.
- Identifies the most likely type of bonding in a compound based on its properties, for example, melting and boiling points and electrical conductivity.
- Summarises data and information from research to explain the properties, practical application and potential impact of a novel material.
- Demonstrates understanding of conservation of mass by evaluating experimental results relating to the mass of reactants and products of at least two chemical reactions, for example, burning iron wool, making magnesium oxide or precipitation of ionic salts.

Materials – Earth's materials

- Explains how fractional distillation can be used to separate crude oil into 'fractions' (groups of compounds with similar boiling points).
- Identifies and describes the importance of at least three everyday substances that are made from hydrocarbons, for example, petrol for fuel, camping gas or plastics.

Materials – Chemical changes

- Analyses and interprets findings from environmental sample data to identify the quantities of pollutants present.
- Gives at least one reason for the presence of a pollutant in an environmental sample and describes the environmental change which may occur as a result of the presence of the pollutant.
- Collects and analyses temperature data to identify, on at least two occasions, where a chemical reaction is either exothermic or endothermic.
- Uses data from experiments to list metals in order of reactivity, for example, involving metals reacting with oxygen (to produce oxides), metals reacting with water (to produce hydroxides) and metals reacting with a dilute acid (to produce hydrogen gas and aqueous salts).
- Constructs simple formulae equations describing reactions of metals with oxygen, water and a dilute acid.
- Investigates and describes three methods of extracting metals from their compound ores as:
    - Heating alone, for example, with silver oxide
    - Heating with carbon, for example, with copper oxide
    - Electrolysis, for example, lead bromide (possible demonstration).
- Identifies the appropriate extraction method for a metal depending on the position of the metal in the reactivity series.
- Draws on findings from investigations to explain how metals above iron in the reactivity series can be used to sacrificially protect iron from corrosion.

Physics

Planet Earth – Space

- Describes the operation of an optical telescope, for example, reflecting or refracting telescopes, and explains the advantages of placing optical telescopes in orbit, for example, larger range due to less absorption and less atmospheric distortion.
- Researches and describes advances in techniques for viewing the universe, for example, using radio telescopes, emission spectra 40 or through gravitational wave detection.
- Discusses how discoveries made through observations have improved our knowledge of the universe and provides supporting evidence.

Forces, electricity and waves – Forces

- Measures and records data from experiments to produce speed-time graphs and interprets speed-time graphs to accurately describe motion.
- Calculates acceleration and distance travelled from a speed-time graph.
- Explains the motion of objects in situations involving constant acceleration, using Newton's Second Law, and applies knowledge to the context of transport safety, for example, braking distances, seatbelts, airbags and other design features.
- Interprets and analyses data to establish a relationship between the strength of electromagnets and, for example, the number of coils, size of current, core material or dimensions.
- Compares model electromagnets with those used in real-life applications, looking for similarities and differences.
- Shares scientific findings about the uses of super magnets, for example, in MRI machines, computer hard drives, electric and hybrid motors, audio speakers, electric guitars and race car engines.
- Calculates the density of a range of materials using the relationship Density = mass / volume.

Forces, electricity and waves – Electricity

- Investigates the electrical properties of at least one fixed resistor to determine the relationship R = V / I and applies this to solve practical problems in circuits.
- Demonstrates understanding of the properties of input devices (for example, variable and light dependent resistors, thermistors and switches) and the operation of output devices (for example, bulbs, LEDs, motors and relays).
- Applies knowledge and understanding of the properties of switching devices, for example, transistors and logic gates, to design and construct an electronic circuit which solves a practical problem.
- Draws on findings from experiments to construct an electrochemical series using the voltage difference between pairs of metals.
- Demonstrates an understanding of the use of different metals in electrochemical cells for different applications.
- Researches and demonstrates awareness of the developments in cell technology, for example, in relation to fuel cells.
- Researches an application of chemical cells and its impact on society, communicating findings to others and acknowledging sources appropriately.

Forces, electricity and waves – Vibrations and waves

- Interprets sound wave traces to describe changes in amplitude and frequency.
- Compares non-visible parts of the electromagnetic spectrum, finding their common properties (speed, propagation), individual properties (range of frequencies, wavelengths) and discusses their uses.

Topical science

- Researches and communicates developments in science, explaining how current and future applications might impact on life.
- Demonstrates increasing understanding of how the transferrable skills developed through the sciences are used in a wide variety of jobs including science, technology, engineering and mathematics (STEM) careers.
- Selects and analyses scientific content of topical interest from a range of sources, including the media.
- Identifies examples of bias in sources and justifies decisions in separating fact from opinion.
- Critically analyses a scientific issue and gives consideration to the ethical, moral, environmental, social or political implications of the scientific theme selected to develop an informed argument.