Curriculum Improvement Cycle
Draft Technical Framework
Sciences

November 2026

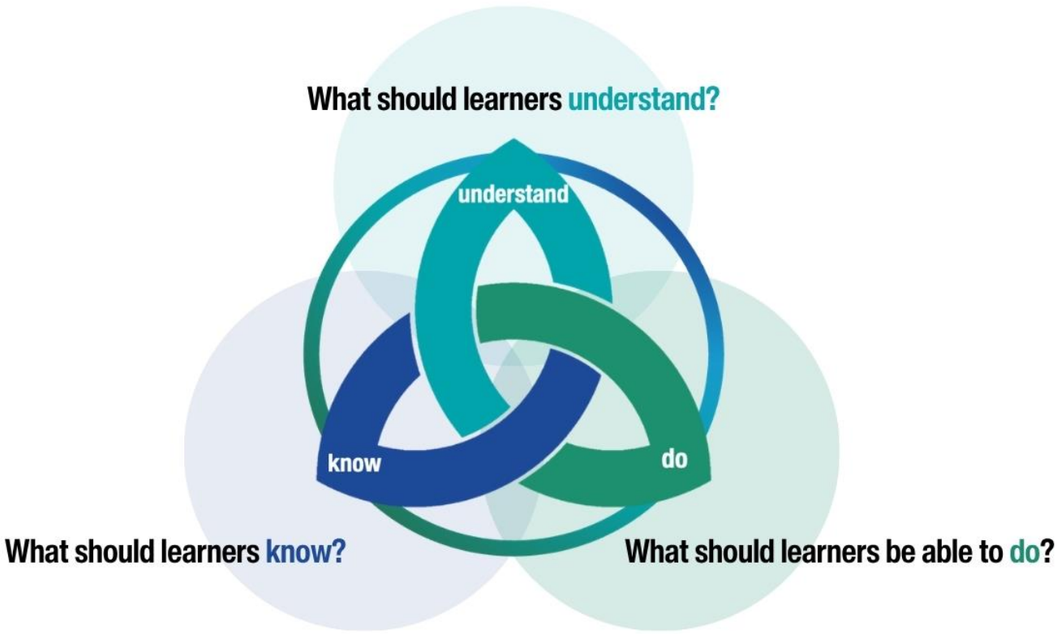
Version 1.0

These are draft materials. The content, format and style are subject to change. They are being shared as part of the co-design process and in advance of engagement and feedback time during the 2026/27 session. There is no expectation on educators, schools or settings to do anything now with these drafts. It would not be appropriate to change current planning or tracking and monitoring systems in establishments at this stage.

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The Know-Do-Understand (KDU) framework



How the KDU knots are written

Understand:
Statements that decribe the relationship between concepts.

Know:
Facts, definitions or **case studies** that learners need to know to develop the understanding above.

Do:
Skills, **processes** and **procedures** learners need to know to develop the understanding above.

Notes:
Information that helps practitioners in their planning for this KDU knot.

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Introduction

The Sciences curriculum is organised around three Big Ideas, all of which interconnect. These capture the essence of what it means to learn science in Scotland and help to develop the knowledge, skills and understanding that learners need to make sense of the world and apply their learning in real-world contexts.

Each Big Idea has strands and sub-strands associated with it which show progression from Early to Fourth level. Strands help to cluster similar conceptual understanding together. For example, in the Our Scientific Knowledge Big Idea there are four strands: The Living World, The Chemical World, The Physical World and The Connected World. These reflect the three core science disciplines (Biology, Chemistry and Physics) as well as a more integrated approach with The Connected World. Strands are presented separately to make progression clear, but learning experiences will bring different parts of the framework together. Ultimately, schools and settings will have flexibility to arrange and combine this content within their curriculum in the way that best meets the needs of their learners.

The Know, Do and Understand statements are organised into strands. Know statements set out the scientific knowledge learners develop. Do statements describe the skills, strategies and processes that learners should practice. Understand statements bring this learning together by showing the deeper understanding learners should develop and why it matters. Scientific concepts are embedded in the curriculum and help to make connections within and across the three big ideas from ages 3-18.

Learning at each level builds on what has come before. Not every strand, or sub-strand, introduces new content at every level. A blank cell in the framework means that no new learning is specified at that level; it does not mean that previous learning stops. Earlier learning can be revisited, connected and applied to support deeper understanding.

The curriculum co-design groups identified aspects of scientific learning that benefit from a progressive sequence within a CfE level, illustrating how knowledge, skills and understanding develop over time. In the Our Scientific Knowledge Big Idea, suggestions have been made as to how learning can be sequenced from Early to Second level. The learning at Early level has been sequenced into two sections under each understand statement. Whereas learning at First and Second level has been sequenced into three sections. The suggested sequencing is a guide only. Sequencing has not been done at Third and Fourth level at this stage because secondary practitioners involved in co-designing the new curriculum did not think it would be necessary. Note that not all curriculum areas have taken a sequenced approach.

In the Notes section, links have been included to support and encourage connections across science disciplines. Work is underway to strengthen connections between the Sciences and other curriculum areas (in particular alignment with mathematics). These links and connections will be made explicit in the next iteration of the curriculum drafts.

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Sciences Purpose Statement

Science education empowers all learners to explore, understand and explain the world around them through curiosity, evidence-gathering and meaningful connection to real-life contexts. Its purpose is to nurture informed, creative and responsible individuals who can use scientific knowledge and skills to shape a sustainable and equitable future.

Sciences Curriculum Big Ideas

Being Scientific: Building Our Skills	**Our Scientific Knowledge:** What We Understand So Far	**Science In Action:** Be The Change
Being scientific is about developing the skills to help us question, explore and understand the world. We begin to see ourselves in science and understand how it connects to our lives. We do this through experiences that encourage curiosity, practical enquiry, collaboration and critical thinking. We develop confidence in scientific thinking and practices by looking at evidence, testing ideas and improving explanations.	Scientific knowledge helps us to make sense of the world around us and to discover our place within it. Our understanding of the Sciences is refined over time as new evidence emerges. There are opportunities for all to make contributions to the development of scientific knowledge.	Science is not only about understanding the world – it is about improving it. Our science knowledge and skills help us come up with creative solutions to real-world problems. Evidence helps us to make informed, ethical decisions. We also recognise that scientific discoveries can bring both benefits and risks. The Sciences empower us to take action to help both people and the planet.

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Summary of Progression

Strand	Sub-strand	Sub-sub strand	Statements of understanding				
			Early Level	**First Level**	**Second Level**	**Third Level**	**Fourth Level**
Scientific Investigation	**Not applicable**	**Not applicable**	Asking questions, making observations and testing ideas can help identify what might happen.	Scientific investigations involve observations and measurements, and allow questions to be answered and new things to be discovered.	Scientific experiments can control the things that might affect the results, helping to make results more trustworthy and allowing experiments to be repeated.	Scientific investigations are planned by identifying variables, considering risks and using repeatable methods to produce reliable findings.	Scientific investigations are designed to test ideas by changing and measuring variables appropriately and controlling other relevant variables to improve the validity of findings.
Interpreting and Analysing			Changing one thing can affect another, showing how things can be connected.	Observing similarities, differences and patterns shows how things work together or affect one another.	Processing findings supports the development of conclusions, helping to support or challenge scientific ideas.	Interpreting and analysing data helps to make comparisons, show relationships and identify patterns, helping us to form conclusions and build scientific knowledge.	Scientific knowledge becomes more reliable through evaluation of evidence, recognition of limitations and critical review by others, so conclusions can be justified and refined.
Evaluation in Science			Exploring what worked, and what did not helps to improve things for next time.	Checking what was done, and the results, helps find errors and identify improvements for next time.	Evaluating scientific practice allows sources of error to be identified and addressed, supporting more accurate and reliable outcomes in future investigations.	Evaluating scientific practice involves considering the strengths and limitations of the method, results and conclusion, supporting more accurate and reliable findings in future investigations.	Evaluating and refining scientific practice helps ensure findings are valid, reliable and trustworthy, supporting continuous improvement in future investigations.
Scientific Communication and Review			Scientists engage with people to share what they discover, helping others to benefit from what has been learned.	Scientists engage with people to share findings in a range of ways, so that knowledge can be communicated and built upon by others.	Scientists share and discuss findings in a variety of ways, which often follow standard structures to allow for findings to be communicated clearly and to inform further investigations.	Scientists select appropriate graphs and units to share their findings in a consistent way, enabling evidence and findings to be communicated and accessed effectively.	Scientific thinking, knowledge and skills enable critical review so evidence, explanations and conclusions can be scrutinised and refined.

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The Connected World	**Nature and Earth's resources**	**Nature**	The environment provides living things with what they need, enabling them to stay alive.	The environment provides habitats and resources for living things, enabling them to stay alive.	Human activity can have an impact on the environment, affecting the ways living things and biodiversity are supported.	The environment consists of a variety of ecosystems, and scientific monitoring helps identify environmental change to enable nature-focused solutions.	Environmental and climate conditions shape different biomes, supporting life on Earth.
		Food and interdependence	Plants and animals provide food for many living things, enabling them to stay alive.	Living things depend on one another for food, enabling them to stay alive.	All living things are interdependent, with plants forming the base of food chains to support survival.	Soil health, climate and pollinators play an essential role in the survival of living things, including plant growth, food web stability and food security.	When resources are limited, living things must compete to get what they need, enabling them to survive.
		Materials and their properties	Materials have different properties, enabling them to be used for different purposes.	Materials have different properties which determines how they are used and recycled.	Materials vary in their properties and availability, affecting how they are used, conserved and managed responsibly.	Metals and plastics are materials that are chosen for particular uses, taking account of their impacts on people, other living things and the environment.	Metals have different chemical properties and react in different ways, making them suited to different uses and applications in society.
	Energy in society	**Energy sources and security**	Electricity is needed to power devices used in everyday life, with its safe use helping to protect us.	Electricity powers our devices, homes and transport, supporting many aspects of daily life.	Society meets its energy needs through the use of renewable and non-renewable energy sources, with electricity transferring energy to support many aspects of daily life.	Electricity is produced, transferred, stored and managed in different ways to meet changing demand, so societies can maintain reliable and sustainable energy supplies.	Meeting future energy needs requires balancing energy sources, storage and demand, so societies can make informed decisions about reliable, sustainable and secure energy supplies.
		Energy and climate change	The use of energy resources can harm the environment, so should be used with care.	Energy resources support daily life but can harm the environment, so using less helps protect our planet.	The burning of fossil fuels contributes to global warming, so reducing the use of these energy resources can help limit climate change.	Using less energy sources from non-renewable sources and using alternatives such as renewable energy sources can reduce greenhouse gas emissions, supporting the journey to net zero.	Scientific evidence helps to inform decisions about how to reduce greenhouse gas emissions and respond to the impacts of climate change on communities around the world.
	Space	**Not applicable**	The sky changes from light to dark, creating day and night.	Repeating patterns can be observed in the sky and across the seasons, helping to develop understanding of Earth and its place in space.	The movement of objects in the Solar System explains repeating patterns observed from Earth, supporting understanding of what	Gravitational forces cause objects in space to move in predictable orbits and patterns, helping to explain observations of the Solar	Scientific discoveries and technologies deepen understanding of the changing Universe and enable continued exploration of space,

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					makes Earth suitable for life.	System and wider Universe.	leading to new knowledge and possibilities.
	Health and disease	**Not applicable**	Some germs can affect health and medicines can be used to prevent and treat infections.	Some germs can affect health, and good hygiene and medicines can be used to prevent the spread of, and treat, infections.	Some microorganisms can affect the health of living organisms, and vaccines help prevent infections while antibiotics treat bacterial infections and can reduce their spread.	Public health strategies, such as vaccination and responsible antibiotic use, reduce the transmission of infectious diseases and help limit antimicrobial resistance, protecting individuals and populations.	Vaccination prepares the immune system to recognise and respond rapidly to specific pathogens, reducing the spread and impact of infectious diseases.
The Living World	**Survival of living things**	**Concept of life**	Living things grow and change and have needs that must be met for them to stay alive.	Living things have needs that must be met for them to grow and survive, although plants and animals meet these needs in different ways to live successfully.	Living things share characteristics and processes that distinguish them from non-living things, helping us identify, classify and understand living organisms.	Living things are made of cells whose structures enable them to carry out the functions needed for life	Living things depend on cellular processes for growth, maintenance and survival, making these processes essential for life.
		Genetic variation	Living things have similarities and differences that help us recognise and compare them.	Living things have similarities and differences that can be used to group and identify them.	Living things can be classified into groups based on features which can affect their survival in different environments.	Genetic information can vary and be inherited, creating differences and adaptations between organisms that can affect their chances of survival.	Genetic information is organised in DNA, genes and chromosomes, providing instructions that influence an organism's characteristics and how it functions.
	Systems for survival	**Animal bodies and skeletons**	Humans and other animals have body parts that help them live and grow.	Skeletons support and protect the body and enable movement, helping animals survive and carry out essential life activities.			
		Nervous system and the senses	Humans have senses which enable them to be aware of their surroundings, helping them stay safe.	Humans and other animals use their senses to find out about their surroundings, helping them respond to changes and stay safe.	The brain processes information from the senses, enabling organisms to respond to their environment and stay safe.	The brain and nerves work together in the central nervous system to process sensory information, enabling coordinated responses to changes in the environment.	

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		Digestive, respiratory and circulatory systems	Different parts of the body have different jobs that help the body stay alive and healthy.	The heart and lungs are organs with different jobs that work together to keep the body alive.	Body systems are made up of organs that work together to carry out essential functions and keep the body alive.	The digestive, respiratory and circulatory systems depend on each other to provide the conditions needed for life.	Digestion and respiration rely on the circulatory system to transport substances to and from cells, enabling energy release.
		Reproductive systems in humans and other animals		Humans and other animals can reproduce, allowing their species to continue over time.	Puberty involves changes that mature the human body and make reproduction possible.	Sexual reproduction produces genetic variation within a population, which can help species survive and adapt to changing environments.	Human fertility is affected by biological, environmental and lifestyle factors, which can affect the ability to reproduce.
		Plant systems	Plants have different parts that help them grow and stay alive.	Different parts of a plant (plant organs) have different jobs that help the plant grow, survive and reproduce.	Plants have different processes to help the plant function, stay alive and reproduce.	Plant root and shoot systems depend on each other to transport substances needed for photosynthesis, growth and survival.	
The Chemical World	**Physical changes**	**States of matter**	Water can change forms, explaining changes we observe in the world.	Solids and liquids can change forms through the processes of melting and freezing, helping to explain how substances behave at different temperatures.	Matter exists in three main states and can change state when temperature changes, helping to explain how matter behaves under different conditions.	Matter is made of tiny particles called atoms, and the way these particles are arranged determines the properties and behaviour of different states of matter, influencing how materials can be used.	
		Mixtures	Substances can be mixed, and doing so often changes their properties.	Substances can be separated based on their properties, allowing them to be sorted and used effectively.	Some solids dissolve more easily than others, and this property affects how substances interact and how mixtures can be separated.	A solution forms when a solute dissolves in a solvent, and differences in solubility help to explain how substances interact and how mixtures can be separated into useful components.	Mixtures of liquids can be separated by distillation based on differences in their boiling points, allowing useful substances to be collected for specific purposes.

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	Chemical changes	**Chemical reactions**		Some chemicals are useful while others can be harmful, highlighting the importance of handling materials safely.	Chemical reactions produce new substances and are often accompanied by observable signs, helping to explain changes in everyday life.	In a chemical reaction, reactants are transformed into products (which have different properties from the reactants), enabling the creation of new substances that can be useful for specific purposes.	Chemical reactions involve energy transfers, and understanding these energy changes helps explain how reactions occur and how the energy released or absorbed can be used for specific purposes.
		Rates of reaction			Chemical reactions can occur at different rates, and the rate of a reaction affects how quickly changes happen in the environment.	The rate of a chemical reaction can be controlled, allowing reactions to be carried out safely and efficiently.	
		Acids and bases				pH measures how acidic or alkaline a substance is, and understanding pH helps identify substances, predict their behaviour, determine their uses and ensure they are handled safely.	Acids and bases react in a neutralisation reaction to form new substances, and the products of these reactions have many useful applications in industry and everyday life.
	Elements and compounds	**Elements and the periodic table**				The periodic table organises all known elements in a logical way, and the patterns it contains help understand the properties and relationships of the building blocks that make up the world.	Atoms are made of subatomic particles which helps explain how atoms interact.
		Compounds				Elements combine chemically to form compounds, creating the vast range of substances in the Universe, and the names of compounds help identify their composition and properties.	Scientists use chemical formulae to communicate information about substances, helping to describe, identify and understand how the wide variety of substances in the Universe are made.

The Physical world	**Electricity**	**Electrical circuits**				Electrical circuits are systems in which components work together, allowing charge to flow when the circuit pathway is complete.	The behaviour of electrical circuits depends on the relationship between potential difference, current and resistance, allowing circuits to be designed and controlled for different purposes.
		Static electricity and electromagnetism				Electric charge can create interactions at a distance, and moving charge can create magnetic effects that can be used in everyday technologies.	
	Forces	**Motion**	Things move in different ways, allowing movement to be observed, described and compared.	Changes in how objects move allow similarities and differences in their movement to be recognised and compared.	The motion of an object can be described in terms of distance covered in a time, which allows movement to be measured.	Speed is a measure of how fast an object travels and can be determined using distance and time, helping us compare and predict motion.	Acceleration is the rate of change of speed and can be represented on a speed-time graph to analyse and interpret other aspects of motion.
		Forces and interactions	Pushes and pulls can change what things do, helping us make sense of changes we see around us.	Forces affect how objects move and change shape, making many everyday activities possible.	Forces act between objects through contact or at a distance, allowing for a variety of practical uses in everyday life.	Forces can be measured and represented, allowing us to explain the motion of objects and the interaction of forces.	Motion due to interacting forces is governed by physical laws, which allow us to model and predict motion.
	Waves	**Sound**	Sounds can be made in different ways and allow people to identify and respond to things around them.	Sounds are produced by vibrations, meaning they can change as they travel further from the source, and as they travel through different materials.	Sound travels through materials differently, resulting in them being absorbed, reflected or changed by different surfaces and environments.	Sound is a wave that has properties such as pitch, loudness, frequency and amplitude which make sound useful for different purposes.	The speed and distance that sound travels depend on the medium it travels through, helping us predict its behaviour and use sound safely in different situations.
		Light	Light helps people and animals to see the world, helping them to live, move and stay safe.	Light comes from different sources and travels from the source to the viewer, allowing people and animals to see objects.	Light travels in straight lines and can be reflected, absorbed or transmitted when it meets materials.	Light can be reflected or absorbed by materials in predictable ways, helping us explain what we see and how reflection is used in everyday technologies.	Light changes direction in predictable ways as it passes between different materials, helping us explain how lenses and light technologies work.

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		Wave properties				Waves transfer energy from one place to another and play an important role in processes such as hearing and sight.	Waves properties such as wavelength, frequency and amplitude can be measured, and these properties allow for different practical applications.
		Electromagnetic radiation				Visible light is part of a wider electromagnetic spectrum, with the different types of radiation within the spectrum having a wide variety of uses in everyday life.	Electromagnetic waves have different wavelengths and frequencies, and this explains their uses and effects.
Taking Scientific Action	**Not applicable**	**Not applicable**	Exploring and asking questions about the world around us helps identify ways to use science to make things better for people and other living things.	Using scientific knowledge and skills helps to identify actions that can make a positive difference in the school or wider community.	Using scientific evidence to solve problems helps make positive changes for people, other living things and the environment, and shows how solutions can be improved.	Applying scientific evidence helps to make informed decisions, recognise the consequences of actions and improve solutions to everyday problems.	Critically applying scientific knowledge, skills and evidence supports responsible action, informed decision-making and evaluation of impact, helping to contribute to positive change.
Science Around Me			Science is part of everyday life and helps people make things better for others.	Science uses the scientific knowledge and skills of people from diverse cultures and communities to innovate and improve everyday lives.	Science uses the ideas and innovations of people from diverse cultures and communities to improve people's lives, other living things and the environment, in the past, now and in the future.	Responsible scientific innovation develops through the collaboration of people from diverse cultures and communities, helping to create jobs and new industries in Scotland.	Breaking down barriers in science enables diverse participation and responsible innovation that considers future, ethical, social, political, environmental and economic impacts on global society.
Informed and Responsible Decision-making			Scientific knowledge can change when new evidence is discovered, helping to develop better explanations for observations.	Scientific evidence is based on observations and information, helping to distinguish between fact and opinion.	Scientific evidence can be evaluated, helping to make responsible decisions and informed choices.	Scientific evidence can be evaluated and compared, helping to identify misinformation, disinformation and bias to justify decisions.	Scientific evidence can be critically evaluated, helping people and society to make informed and responsible decisions to address scientific and societal issues.

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Know-Do-Understand Strands

Being Scientific: Building Our Skills

Strands	Scientific Investigation		Interpreting and Analysing		Evaluation in Science		Scientific Communication and Review	
Early Level	**Understand:** Asking questions, making observations and testing ideas can help identify what might happen.		**Understand:** Changing one thing can affect another, showing how things can be connected.		**Understand:** Exploring what worked, and what didn't, helps to improve things for next time.		**Understand:** Scientists engage with people to share what they discover, helping others to benefit from what has been learned.	
	Know: Being curious and asking questions is important in science and everyday life.	**Do:** Ask questions and make observations relating to science. Share ideas about what might happen and test ideas. Consider risks and hazards to make safe choices.	**Know:** **Systems thinking** Changing one thing can affect something else (cause and effect).	**Do:** **Systems thinking** Notice what happens when something changes.	**Know:** Trying things out and seeing what worked, and what didn't, means improvements can be made for next time.	**Do:** Make changes based on what was discovered.	**Know:** Scientists engage with people to share what they discover.	**Do:** Share what is discovered in a range of ways.
	Includes, but not limited to • Being curious includes asking questions, testing ideas, investigating and observing. **Notes** • A hazard is something that can cause harm. • A risk is the chance that someone could be hurt.		**Includes, but not limited to** • Systems thinking supports the overarching concept Systems and cycles. • At Early Level, learners begin systems thinking by noticing simple cause and effect. Learners are not expected to use the terms 'system' or 'systems thinking'. • Examples of cause and effect: jumping in puddle creates a splash; warm sunshine can dry clothes.		**Includes, but not limited to** • Suggesting improvements is a way for learners to develop creative thinking and problem solving and begin to develop the skills required for evaluation.		**Includes, but not limited to** • Ideas can be shared through talking, signs, drawings, movement, play, symbols etc. **Notes** • Sharing what is discovered – this refers to what has been discovered by learners themselves through their learning.	

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<table>
<tr><td rowspan="3">First Level</td><td colspan="2">Understand: Scientific investigations involve observations and measurements and allow questions to be answered and new things to be discovered.</td><td colspan="2">Understand: Observing similarities, differences and patterns shows how things work together or affect one another.</td><td colspan="2">Understand: Checking what was done, and the results, helps find errors and identify improvements for next time.</td><td colspan="2">Understand: Scientists engage with people to share findings in a range of ways, so that knowledge can be communicated and built upon by others.</td></tr>
<tr><td>Know:
A prediction is an idea about what might happen next.

An investigation is a process used to help find answers to questions.

Observations and measurements help to show what is happening.</td><td>Do:
Make predictions about what might happen.

Carry out practical hands-on science investigations safely using appropriate steps and equipment.

Identify likelihood of risks and take precautions.

Make observations and measurements.

Use scientific vocabulary: prediction, scientific investigation.</td><td>Know:
Processing information
Information can show similarities, differences and patterns which help explain what happened.

Systems thinking
Systems are made up of connected parts that work together.</td><td>Do:
Processing information
Identify similarities, differences and patterns to explain what happened.

Systems thinking
Identify the parts of a simple system and how they work together.</td><td>Know:
Scientific practices should be checked for accuracy to identify possible mistakes.</td><td>Do:
Compare different ways of carrying out scientific activities and suggest improvements.</td><td>Know:
Scientists engage with people to share findings and to generate knowledge.</td><td>Do:
Share findings in a range of ways.

Use simple models or drawings to explain ideas.</td></tr>
<tr><td colspan="2">Includes, but not limited to
• A hazard is something that can cause harm in an activity.
• A risk is how likely it is that the hazard will cause harm.</td><td colspan="2">Includes, but not limited to
• There are many different types of systems. These feature in content in Our Scientific Knowledge, for example:
- A plant-growing system includes plant, water, sunlight, soil.
- A body system has different organs to keep us alive.
- Solar system including the Sun and planets.
Notes
• A system is a group of connected parts that work together to achieve a specific purpose.</td><td colspan="2">Includes, but not limited to
• Making improvements is a way for learners to develop creative thinking and problem solving and begin to develop the skills required for evaluation.</td><td colspan="2">Includes, but not limited to
• Sharing findings in a range of ways might include: drawings, tally tables or pictographs.</td></tr>
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<tr><td rowspan="3">Second Level</td><td colspan="2">Understand: Scientific experiments can control the things that might affect the results, helping to make results more trustworthy and allowing experiments to be repeated.</td><td colspan="2">Understand: Processing findings supports the development of conclusions, helping to support or challenge scientific ideas.</td><td colspan="2">Understand: Evaluating scientific practice allows sources of error to be identified and addressed, supporting more accurate and reliable outcomes in future investigations.</td><td colspan="2">Understand: Scientists share and discuss findings in a variety of ways, which often follow standard structures to allow for findings to be communicated clearly and to inform further investigations.</td></tr>
<tr><td>Know:
An aim sets out what has to be investigated.

In science, a hypothesis is a testable idea about what might happen and why.

A fair test is a scientific experiment where one thing (variable) is changed, other things are kept the same, and what happens is observed or measured (result).

A method describes the steps taken in an experiment so that it is fair and can be repeated.</td><td>Do:
Identify what makes something a fair test within science investigations.

Formulate hypotheses, based on what is already known or observed.

Identify risks and hazards and use appropriate safety measures.

Carry out practical hands-on science investigations using a scientific method.

Make accurate observations and measurements using standard units.

Use scientific vocabulary: aim, method, hypothesis, fair test.</td><td>Know:
Processing information
Where appropriate, a mean average can be calculated from a set of numerical results to help identify a typical result.

A conclusion states what was found out in an investigation and answers the aim of the investigation.

Findings can support or challenge scientific ideas.

Systems thinking
The parts of a system depend on one another. Changes to one part can affect other parts and the way the whole system works.</td><td>Do:
Processing information
Calculate mean averages from data and findings.

Use evidence to form conclusions.

Use scientific vocabulary: system, conclusion.

Systems thinking
Identify connections within a system and how a change to one part can affect other parts.</td><td>Know:
Evaluating scientific practice involves checking methods and results to identify improvements for future investigations.</td><td>Do:
Evaluate scientific practice and suggest improvements.

Use scientific vocabulary: evaluate.</td><td>Know:
Scientists engage with people to share and discuss findings. This is done through a variety of methods and helps to advance knowledge.

Scientific reports follow a common structure, for example title, aim, method, results, conclusion) so findings can be communicated clearly.

Tables and graphs follow rules (conventions) to present data clearly, making information easy to understand and share.

Referencing helps track the scientific evidence used.</td><td>Do:
Share scientific findings in a variety of ways.

Construct tables and graphs using headings, scales and units.

Reference sources of scientific evidence.

Draw and label diagrams for the method using scientific vocabulary.</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Changes can include temperature, time, distance.
• Standard units include metres (m) for distance, seconds (s) for time and degrees Celsius (°C) for temperature.

Excludes
• At Second Level, learners are only expected to know the purpose of an aim in an investigation. Writing aims independently is introduced at Third Level.
• The term ‘variables’ may be used in discussions with learners where appropriate, however, it is introduced more formally at Third Level.

Notes</td><td colspan="2">Includes, but not limited to
• Examples of factors affecting systems:
- removal of a species from the environment
- force of friction affecting the motion of objects
- light, water, temperature affecting plant growth
- temperature, stirring, size of particles affecting time taken for a substance to dissolve

Notes
•The word ‘mean’ has a difference scientific meaning to its everyday use.</td><td colspan="2">Includes, but not limited to
• Evaluating scientific practice can be done by checking:
- the method was followed
- the equipment was working correctly
- the data collected and/or the source was reliable
- if there was human error
- if it was a fair test whether any external factors affected results, for example, noise, weather</td><td colspan="2">Includes, but not limited to
• Ways scientists share findings include:
- writing, posters, books, reports, emails, websites, digital platforms
- speaking: discussion, debate, presentations, videos, social media
- visual representations: models, tables, charts, graphs, labelled diagrams
• Referencing at this level may include: title of resource, name of author, type of resource.(webpage, book, newspaper) and page number if relevant.

Notes
• Line graphs are taught at Second Level in Mathematics and applied at Third Level in Sciences.
• Models are simplified representations that help us explain, test or predict how something works, for</td></tr>
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<table>
<tr><td></td><td colspan="2">• A testable question is one that can be answered by collecting and using evidence, such as observations or measurements.
• A hazard is a source of potential harm.
• A risk is the likelihood of harm from that hazard.</td><td colspan="2"></td><td colspan="2"></td><td colspan="2">example, model of the Solar System or human body.
• Diagrams are visual representations with labels that help us identify, describe or show relationships between parts of something, for example, plant parts.
• Table and scale have different scientific meanings to their everyday use.</td></tr>
<tr><td rowspan="2">Third Level</td><td colspan="2">Understand: Scientific investigations are planned by identifying variables, considering risks and using repeatable methods to produce reliable findings.</td><td colspan="2">Understand: Interpreting and analysing data helps to make comparisons, show relationships and identify patterns, helping us to form conclusions and build scientific knowledge.</td><td colspan="2">Understand: Evaluating scientific practice involves considering the strengths and limitations of the method, results, and conclusion, supporting more accurate and reliable findings in future investigations.</td><td colspan="2">Understand: Scientists select appropriate graphs, and units to share their findings in a consistent way, enabling evidence and findings to be communicated and accessed effectively.</td></tr>
<tr><td>Know:
Science investigations can have risks associated with them, which can be anticipated and planned for.

A variable is something in an experiment that can change.

A control variable is something that is kept the same to ensure a fair test.

A method describes the variables and steps taken in an experiment in enough detail so it can be repeated.

Repeating an investigation increases the reliability of the results.</td><td>Do:
Plan an investigation including forming an aim and hypothesis.

Identify hazards, assess risks and take steps to reduce or control the risks.

Carry out practical hands-on science investigations safely.

Collect data by making accurate observations and measurements using standard units.

Use scientific vocabulary: variable.</td><td>Know:
Processing information
Processing data helps to make comparisons, show relationships and spot patterns and trends in results.

A trend can show whether data is increasing, decreasing or remaining unchanged.

Scientific conclusions relate to the aim and are based on the interpretation of data gathered during an investigation.

Scientific knowledge may change over time as new evidence emerges.

Systems thinking
Systems involve interacting parts that affect one another and can change over time.</td><td>Do:
Processing information
Process data using the most appropriate method.

Identify trends, patterns and relationships in data.

Use evidence to form conclusions in relation to the aim.

Use scientific vocabulary: trends, patterns, relationship.

Systems thinking
Analyse connections within a system and predict how a change could affect other parts or the whole system.</td><td>Know:
Scientific findings can be evaluated by identifying strengths and limitations of the method, data and conclusions.

Reliability means getting similar results when an investigation is repeated in the same way.</td><td>Do:
Evaluate strengths and limitations of scientific methods, data and conclusions.

Justify suggested improvements.

Use scientific vocabulary: reliability.</td><td>Know:
Engagement between scientists and the public helps share knowledge and ideas, supports collaboration and contributes to addressing societal challenges.

Scientific reports follow a common structure, for example, title, aim, hypothesis, method, results, conclusion and evaluation, so findings can be clearly communicated and understood.

Scientific measurements are recorded as data using appropriate units, allowing results to be compared and interpreted.

Graphs are chosen based on the scientific data recorded, so that information is represented clearly and can be analysed and interpreted.

References acknowledge sources of information and can help assess reliability.</td><td>Do:
Communicate scientific findings for different audiences and purposes.

Record and present scientific data using appropriate scientific units.

Select and construct appropriate tables and graphs to communicate findings.

Write a scientific report using an appropriate structure.

Reference sources of information accurately.</td></tr>
</table>

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<table>
<tr><td></td><td colspan="2">Excludes
• Dependent and independent variables are introduced at Fourth Level. However, these can also be introduced at Third Level where more appropriate for the learners or context.

Notes
• A scientific investigation is a systematic process used to answer questions by collecting, analysing and interpreting evidence from practical work or existing data.
• A hazard is anything with the potential to cause harm.
• A risk is the likelihood and possible impact of harm from a hazard.
• The word ‘variable’ has a different scientific meaning to its everyday use, for example, if the weather is variable.</td><td colspan="2">Includes, but not limited to
• Systems that can be referenced include those featuring in content in Our Scientific Knowledge.
• Examples of feedback loops in systems:
- sounds become louder when a microphone is near a speaker
- rising global temperatures melt Arctic ice. Less ice means less sunlight is reflected back into space, so more heat is absorbed by the Earth. This causes temperatures to rise further, leading to even more ice melting

Notes
• Scientific conclusions – where data is conflicting – ‘no conclusion drawn’ is a suitable conclusion.</td><td colspan="2"></td><td colspan="2">Includes, but not limited to
• Types of graphs at this level: bar charts, line graphs and scatter graphs.
• Referencing at this level may include multiple sources each with title of resource, name of author, type of resource (webpage, book, newspaper), and page number if relevant. Also important to highlight that even if something is referenced it still needs to be assessed for reliability etc.</td></tr>
<tr><td rowspan="2">Fourth Level</td><td colspan="2">Understand: Scientific investigations are designed to test ideas by changing and measuring variables appropriately and controlling other relevant variables to improve the validity of findings.</td><td colspan="2">Understand: Scientific knowledge becomes more reliable through evaluation of evidence, recognition of limitations, and critical review by others, so conclusions can be justified and refined.</td><td colspan="2">Understand: Evaluating and refining scientific practice helps ensure findings are valid, reliable and trustworthy, supporting continuous improvement in future investigations.</td><td colspan="2">Understand: Scientific thinking, knowledge and skills enable critical review so evidence, explanations and conclusions can be scrutinised and refined.</td></tr>
<tr><td>Know:
The independent variable is what is changed in a scientific investigation.

The dependent variable is what is measured in a scientific investigation to see the effect of that change.

Using controlled variables improves the validity of an investigation.

Scientific investigations use different methods; there is no single fixed approach.

The scientific process is a systematic</td><td>Do:
Identify and change the independent variable and observe the effect on the dependent variable.

Design a scientific method independently.

Select appropriate equipment for an experiment.

Carry out practical hands-on science investigations safely, taking account of risks and hazards.

Use scientific vocabulary: dependent variable, independent variable.</td><td>Know:
Processing information
An anomalous result is a result that is different from the others and does not fit the pattern or trend of the data.

In scientific investigations, unexpected results are not assumed to be inaccurate and are considered carefully.

Scientific conclusions relate to the aim and hypothesis and are based on the interpretation of data gathered during an investigation.

Systems thinking
Interactions within systems can cause feedback, delays and thresholds (tipping</td><td>Do:
Processing information
Identify the relationship between independent and dependent variables.

Identify anomalous results.

Use evidence to form conclusions in relation to the aim and hypothesis.

Use scientific vocabulary: anomalous.

Systems thinking
Analyse relationships within systems and use feedback, delays and thresholds to explain or predict how a system may change.

Apply systems thinking to scientific and environmental contexts.</td><td>Know:
Methods can be refined to increase reliability and validity and improve the impact of the findings.

Scientific practice can be evaluated in terms of ethics, respect and equity.

Validity in science refers to the extent to which a method, experiment or measurement accurately addresses the aim of an investigation.</td><td>Do:
Evaluate and justify improvements to scientific methods to increase reliability and validity of findings.

Evaluate scientific practice in terms of respect, ethics and equity.

Use scientific vocabulary: validity.</td><td>Know:
Scientific knowledge develops through evidence, explanations and conclusions being scrutinised, discussed and reviewed by the scientific community.</td><td>Do:
Check, review and feedback on other people’s scientific findings.

Refine scientific reports and findings based on feedback.</td></tr>
</table>

	approach to investigation that involves asking questions, gathering and analysing evidence, testing hypotheses, communicating and reviewing findings.		points). These can affect how the whole system changes over time and may lead to unintended outcomes. Feedback: when a change in a system leads to further change. Delay: when the effect of a change takes time to happen. Threshold or tipping point: a point where a further change can cause a much bigger change in the system.					
	Includes, but not limited to • When a dependent variable cannot be measured directly, an observable change can be used as an indicator, for example, using the number of bubbles produced per minute to estimate the rate of photosynthesis. • A hazard is a source or situation with the potential to cause harm. • Risk depends on the likelihood and severity of harm occurring, taking account of exposure to the hazard, for example, using a Bunsen burner to heat water: - hazard: open flame and hot equipment - likelihood: low when used correctly - severity: high because burns can be serious - **e**xposure: limited through safe working distances and appropriate safety procedures - risk: low to moderate because exposure and likelihood are reduced		**Includes, but not limited to** • Examples of system interactions and features: - system (plant, nutrients and environment). Interaction (adding fertiliser increases plant growth). Threshold or tipping point (too much fertiliser damages plant or soil). Delay (effects on soil may take time). Unintended outcome (runoff causes algal growth in nearby water) - system (Earth's climate). Interactions (ice reflects sunlight; water absorbs it). Feedback loop (warming melts ice; less reflection of sunlight; more warming). Delay (climate changes occur over long timescales). Threshold or tipping point (loss of large ice-sheets becomes irreversible). Unintended outcome (acceleration of warming beyond initial cause). **Notes** • Systems thinking involves understanding how the parts of a system interact and influence one another, and how these interactions affect the behaviour of the system as a whole.		**Excludes** • Discussing relevance of a practical activity is covered at Senior Phase. At this level, only the relevance of sources is covered. **Notes** • Links to Science in Action: Taking scientific action.		**Includes, but not limited to** • Other people's scientific findings could be from other learners within the class or year. **Excludes** • At this level, scientific findings exclude research papers. **Notes** • Checking and feeding back on accuracy of scientific reporting and findings as detailed at Third and Fourth Level. • Evaluate = How good is it? • Critically evaluate = How good is it? What evidence supports that? What are its limitations, and how convincing is the evidence?	

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Our Scientific Knowledge: What We Understand So Far

<table>
<tr><td>Strand</td><td colspan="4">The Connected World</td></tr>
<tr><td></td><td colspan="4">Nature and Earth’s resources</td></tr>
<tr><td></td><td colspan="2">Nature</td><td colspan="2">Food and interdependence</td><td colspan="2">Materials and their properties</td></tr>
<tr><td rowspan="5">Early Level</td><td colspan="2">Understand: The environment provides living things with what they need, enabling them to stay alive.</td><td colspan="2">Understand: Plants and animals provide food for many living things, enabling them to stay alive.</td><td colspan="2">Understand: Materials have different properties, enabling them to be used for different purposes.</td></tr>
<tr><td>Know:
The environment
Plants, humans and other animals can live in different places.

Water is used by animals and humans for drinking and keeping clean.

Air is needed to breathe.</td><td>Do:
Explore and observe different places where plants, humans and other animals live.

Explore and observe how living things use their environment to meet their needs.</td><td>Know:
Food sources
Plants and animals are sources of food for humans and other animals.</td><td>Do:
Identify plants and animals that provide food for humans and other animals.</td><td>Know:
Properties and uses of materials
Different materials are suitable for different uses.

If an object moves towards the bottom of water, it means it sinks. If it stays on the top of water, it floats.</td><td>Do:
Explore and select materials to make models and solve problems.

Observe whether materials float or sink.</td></tr>
<tr><td colspan="2">Excludes
• The word ‘habitat’ may be used to describe where humans and other animals live, but the definition of the term is not required until First Level.

Notes
• Link to Our Scientific Knowledge: The Living World - Concept of life.
- Needs of living things.
• Link to Science in Action: Taking Scientific Action.
- Caring for places and living things.</td><td colspan="2">Includes, but not limited to
• Discuss that not all plants are safe to eat. Caution should be taken to avoid touching or picking unknown plants in nature.</td><td colspan="2">Includes, but not limited to
• Materials may include, paper, wood, plastic, water or sand.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:
Food sources
Plants and animals that are eaten usually come from farms and the sea.</td><td>Do:
Identify the different places our food comes from.</td><td>Know:
Properties and uses of materials
Materials are all around and have different properties.</td><td>Do:
Sort materials into different groups.

Use everyday vocabulary to describe materials.</td></tr>
<tr><td colspan="2"></td><td colspan="2">Includes, but not limited to
• Different places our food comes from might include: farms, sea, lakes, rivers, gardens or allotments. Our food might have been grown in different countries because the climate is more suitable.</td><td colspan="2">Includes, but not limited to
• Properties of materials include: colour, texture, shape, hardness, heavy, light, waterproofness, floats or sinks.
• Learners noticing which materials float and sink.</td></tr>
</table>

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<table>
<tr><td rowspan="8">First Level</td><td colspan="2">Understand: The environment provides habitats and resources for living things, enabling them to stay alive.</td><td colspan="2">Understand: Living things depend on one another for food, enabling them to stay alive.</td><td colspan="2">Understand: Materials have different properties which determines how they are used and recycled.</td></tr>
<tr><td>Know:
The environment
The environment includes all the living and non-living things in the surroundings.</td><td>Do:
Explore and observe the local environment.</td><td>Know:</td><td>Do:</td><td>Know:
Properties and uses of materials
The properties of a material determine its use.</td><td>Do:
Sort materials into different groups.

Select and justify materials for different uses based on their properties.</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Living things – plants, animals and humans.
• Non-living things – air, water, and rocks.</td><td colspan="2"></td><td colspan="2">Includes, but not limited to
Observable properties of materials include: shape, texture, colour, heaviness, hardness, whether it floats or sinks.

Notes
• Progression from Early Level is that some materials may have multiple properties, making sorting more complex.</td></tr>
<tr><td>Know:
The environment
Habitats are part of an environment.

A habitat is a place where a living thing lives.

Habitats can provide living things with the resources they need.</td><td>Do:
Identify and compare different habitats and the resources they provide.

Use scientific vocabulary: habitat.</td><td>Know:
Food sources
Seasons affect which plants grow and when they grow.</td><td>Do:
Identify plants grown for food in different seasons.</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Different habitats include desert, tree, pond.</td><td colspan="2">Includes, but not limited to
• Seasonal plants, in Scotland, include new potatoes (spring), strawberries (summer), carrots (autumn) and leeks (winter). This will be different in other parts of the world.</td><td colspan="2"></td></tr>
<tr><td>Know:
The environment
Human activity affects habitats.</td><td>Do:
Identify how human activity can positively and negatively affect habitats.</td><td>Know:
Interdependence
Humans and other animals depend on living things for food to allow them to move and grow.

Herbivores are animals that eat plants.

Carnivores are animals that eat other animals.

Omnivores are animals that eat both plant and other animals.</td><td>Do:
Identify the ways that living things depend on each other for food and survival.

Use scientific vocabulary: herbivore, omnivore and carnivore.</td><td>Know:
Responsible use of materials
Materials can be reused and recycled to reduce waste and pollution.</td><td>Do:
Sort materials into groups based on their recyclable properties.</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Human activities can have positive impacts (such as creating a bug hotel) or negative impacts (such as littering) on the environment.</td><td colspan="2">Notes
• Humans and other animals need to eat other living things – this may lead to discussion about food chains, but learners don’t need to know this until Second Level.</td><td colspan="2">Notes
• Link to Science in Action: Taking scientific action.
- Sorting of waste materials for recycling</td></tr>
</table>

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<table>
<tr><td></td><td colspan="2">Notes
• Link to Our Scientific Knowledge: The Living World - Concept of life.
– Needs of living things.
• Link to Science in Action: Taking Scientific Action.
- Caring for places and living things.</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="4">Second Level</td><td colspan="2">Understand: Human activity can have an impact on the environment, affecting the ways living things and biodiversity are supported.</td><td colspan="2">Understand: All living things are interdependent, with plants forming the base of food chains to support survival.</td><td colspan="2">Understand: Materials vary in their properties and availability, affecting how they are used, conserved and managed responsibly.</td></tr>
<tr><td>Know:
The environment
Living things need habitats and resources, and at times those resources can be limited.

Biodiversity is the variety of life on Earth.

Human activity affects biodiversity.</td><td>Do:
Analyse the positive and negative impacts of human activity on biodiversity.

Evaluate possible solutions to reduce environmental impact.

Use scientific vocabulary: biodiversity.</td><td>Know:
Food sources
Climate change is altering seasonal patterns and increasing some types of extreme weather. This is affecting plant growth and food production.</td><td>Do:
Compare the growth of plants in different environments.</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Different environments include school grounds, woodland, coastal etc.

Notes
• Progression from First Level on human activity:
- climate change and human activities, such as pollution of land, water and air, can have negative impacts on the environment and decrease biodiversity
- human activities can have positive impacts on the environment and increase biodiversity such as planting wildflowers
• Link to Our Scientific Knowledge: The Living World - Concept of life; The connected world - Energy and climate change.
• Link to Science in Action: Taking scientific action.
- Caring for places and living things.</td><td colspan="2">Includes, but not limited to
• Extreme and unusual weather patterns include floods, droughts and cold snaps.</td><td colspan="2"></td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:
Food sources
Plants grown for food are called crops and they can grow in different environments, not just soil.

Fertilisers provide nutrients that plants need for healthy growth. Food security is when people have access to enough safe and nutritious food to meet their needs.

Human activities can affect food security by changing the availability of, or access to, food.</td><td>Do:
Identify how human actions impact on food availability.

Interpret and construct simple food chains.

Use scientific vocabulary: food security, fertilisers, interdependence, producer, consumer, predator, prey.</td><td>Know:</td><td>Do:</td></tr>
</table>

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			Interdependence Interdependence refers to the way living things rely on each other for survival. Animals and plants are linked through simple food chains. Food chains represent the feeding relationship between organisms. Plants are producers because they make their own food and form the start of food chains. Humans and other animals get their food by eating other organisms and are referred to as consumers. Energy is transferred from plants to animals when animals eat plants. A predator is an animal that hunts and eats other animals to survive. Prey are animals that are hunted and eaten by predators. An animal can be a predator, prey, or both, depending on its place in a food chain.			
			Includes, but not limited to • Plants can be grown in polytunnels, green houses and artificial environments. • Predict what might happen to other organisms in a food chain if the number of one type of organism changes. • Positive impacts such as sustainable farming, reducing waste, farming technology and innovation etc. • Negative impacts such as pollution (contaminating soil and water), climate change, misuse of water resources, overfishing, deforestation etc. **Notes** • Link to Our Scientific Knowledge: The Connected World - Energy and climate change. • Link to Science in Action: Taking Scientific Action. • The word ‘consumer’ has a different scientific meaning to its everyday use. • The word ‘prey’ sounds like ‘pray’ but has a different scientific meaning.		

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<table>
<tr>
<td></td>
<td>Know:</td>
<td>Do:</td>
<td>Know:</td>
<td>Do:</td>
<td>Know:
Properties and uses of materials
Materials can bend, stretch, compress or break when forces are applied.

Some materials are used because they float or sink.

Floating and sinking depends on material and shape.

Some materials help keep heat in or out and are used in buildings and clothing.

Materials which let heat pass through them easily are called conductors.

Materials which do not let heat pass through easily are called insulators.

Responsible use of materials
Some materials are at risk of running out.

Ways to reduce the use of raw materials include rethinking, reducing, re-using/re-purposing, repairing and recycling.</td>
<td>Do:
Evaluate and justify which materials are best suited for specific uses, based on their properties.

Justify responsible choices about the use and reuse of materials.

Evaluate the environmental impact of material use and disposal.

Use scientific vocabulary: float, sink, conductor, insulator.</td>
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<tr>
<td></td>
<td colspan="2"></td>
<td colspan="2"></td>
<td colspan="2">Includes
• At this level, properties of materials could extend to flexibility, elasticity, waterproofness, strength, durability, biodegradability.

Notes
• Materials can become at risk of running out either because they are scarce or being used up quickly. Examples include copper, coal, oil.
• Ways to reduce the use of materials introduces some principles of the circular economy, but this vocabulary is not required. Composting may also be discussed.
• ‘Sink’ has a different scientific meaning to its everyday use.</td>
</tr>
</table>

	Understand: The environment consists of a variety of ecosystems, and scientific monitoring helps identify environmental change to enable nature-focused solutions.		**Understand:** Soil health, climate and pollinators play an essential role in the survival of living things, including plant growth, food web stability and food security.		**Understand:** Metals and plastics are materials that are chosen for particular uses, taking account of their impacts on people, other living things and the environment.	
	Know: **The environment** An ecosystem is made up of living things that interact with each other and with the non-living parts of their environment. The environment provides the conditions that support a variety of ecosystems. Monitoring the health of the environment helps to identify changes and actions that are needed to protect and improve ecosystems and human health. Human activities can cause changes in ecosystems that affect the living things within them.	**Do:** Identify different ecosystems and their key features. Select and use appropriate techniques to investigate an ecosystem. Identify how human activity affects ecosystems and evaluate the relative impacts of nature-focused solutions. Use scientific vocabulary: ecosystem.	**Know:** **Food sources** Horticulture is the practice of growing plants. Healthy soil is vital to ecosystems. Soil conditions such as pH and moisture, support plant growth, while decomposers recycle nutrients, ensuring plants can thrive and sustain food webs. Fertilisers can be natural or manufactured and contain nitrogen, phosphorous and/or potassium, which are important plant nutrients. **Interdependence** Food webs represent interconnecting food chains, with arrows indicating the direction of energy transfer between organisms. Photosynthetic organisms capture energy from the Sun and form the base of food webs as primary producers. Changes in the number of one type of organism can affect the numbers of other organisms and the availability of food within a food web.	**Do:** Evaluate and justify how natural processes and human activities affect food production and the environment. Predict the effects of changes in the number of organism(s) on a food web. Use scientific vocabulary: horticulture, decomposers, pollination, photosynthetic.	**Know:** **Properties and uses of materials** Some metals are found uncombined in the Earth's crust. These are known as native metals. Most metals are found combined with other elements in compounds known as ores, and have to be extracted for use. Heating occurs when energy is transferred from a warmer object or place to a cooler one because of a difference in temperature. Metal elements are usually good conductors of heat and electricity, where non-metals are usually not. Both have useful applications in everyday life. Energy can be transferred from warmer to cooler areas by conduction, convection and radiation. In solids, energy can be transferred from warmer to cooler regions by conduction. In liquids and gases, energy can be transferred from warmer to cooler regions by convection, through the movement of the liquid or gas. Energy can be transferred by radiation without the need for a material medium. Density describes how much mass there is in a given volume. Density depends on how closely particles are packed together. Objects float when they are less dense than the liquid they are in. Many plastics are durable and biodegrade very slowly, so they can	**Do:** Investigate and compare conductivity in different materials. Evaluate and justify which materials are most suitable for energy efficiency. Compare the density of objects and liquids in relation to floating and sinking. Identify which objects will float or sink in different liquids. Make informed decisions about the use of and impact of plastics and metals. Use scientific vocabulary: ore, conduction, convection, radiation.
Third Level						

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					persist in the environment and form microplastics. New materials with particular properties have been developed to meet specific needs and challenges. **Responsible use of materials** Extracting metals provides materials that society depends on, but it can harm the environment and affect communities. Plastics pose environmental, health and social challenges. Decisions about using materials require evaluation of environmental, social and ethical impacts.	
	Includes, but not limited to • Ecosystems can be large such as oceans or rainforests, or small, such as a garden or rock pool. • Non-living parts of an ecosystem include environmental factors such as light intensity, temperature, pH, soil moisture. • Environmental monitoring techniques include measuring light, pH and moisture, and sampling organisms using quadrats and pitfall traps. **Excludes** • The wider physical and chemical components of the environment (beyond ecosystems) are not covered at this level. **Notes** • Progression from Second Level on human activity: - climate change and human activities, such as deforestation and burning fossil fuels, can negatively impact on ecosystems. - human activities such as conservation efforts and effective policies can positively support ecosystems, helping to protect and increase biodiversity • Link to Our Scientific Knowledge: The Living World – Digestive, respiratory and circulatory systems. • Link to Science in Action: Taking Scientific Action.		**Includes, but not limited to** • Regenerative farming improves soil and restores the environment using natural and sustainable practices such as crop rotation. **Excludes** The learning below does not need to be covered at this level. • The role of nitrogen, potassium and phosphorus in plant growth. • The process of eutrophication. • The study of pesticides and plant diseases. **Notes** • The term 'transfer of energy' should be used instead of 'energy flow' for scientific accuracy. • Human actions impacting on food security might include: - positive: regenerating land, polyculture growing, agroforestry - negative: over-tilling of the soil, overuse of pesticides which harm pollinators, overuse of fertilisers • Link to Our Scientific Knowledge: The Chemical World – Elements • Link to Science in Action: Informed and Responsible Decision making - Ethical food production and sustainable living		**Includes, but not limited to** • Examples of applications based on conductivity include: building insulation, cooking utensils, insulation in wires. • Density, mass, volume, floating and sinking in familiar liquids. **Notes** • Radiation is not to be confused with radioactivity. • Link to Science in action: science around me. - New materials such as Kevlar (strong), biopol (soluble), composite materials (carbon fibre and plywood), and high-performance sportswear, amongst others, can be explored in the contexts of performance, cost, sustainability and ethics.	
Fourth Level	**Understand:** Environmental and climate conditions shape different biomes, supporting life on Earth.		**Understand:** When resources are limited, living things must compete to get what they need, enabling them to survive.		**Understand:** Metals have different chemical properties and react in different ways, making them suited to different uses and applications in society.	
	Know: **The environment** A community consists of different species living and interacting in the same area.	**Do:** Identify and compare the key features of different biomes. Identify how human activity affects biomes and investigate nature-focused solutions.	**Know:** **Competition** A population is a group of organisms of the same species living in the same area.	**Do:** Evaluate and justify the impact of competition on a food web. Use scientific vocabulary: competition, population.	**Know:** **Properties and uses of metals** Metals can be arranged in order of reactivity according to their reactions with water, acids and oxygen.	**Do:** Compare reactions of metals to observe the property of reactivity. Construct word equations to describe the reactions of metals.

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	A biome is a large region of the Earth that can be distinguished from other biomes by: - the characteristic environmental factors that affect it, such as climate - the particular animal community (fauna) and plant community (flora) that it supports Human activities can change conditions within biomes, affecting the biodiversity they support.	Use scientific vocabulary: biome, fauna, flora, community.	Competition occurs when organisms require the same limited resources, such as food, water, space or light. Competition can affect the survival and reproduction of organisms, leading to changes in population sizes and interactions within food webs.		Some metals react with water to produce a metal hydroxide and hydrogen gas. Some metals react with acids to produce a salt and hydrogen gas. Some metals react with oxygen to produce metal oxides. The reactivity of metals has many practical applications in everyday life. The reactivity of metals determines how they can be extracted from their ores. - unreactive metals can be extracted from their ores by heating - moderately reactive metals can be extracted from their ores by heating with carbon - reactive metals have to be extracted from their ores by electrolysis	Relate extraction methods to metal reactivity. Apply knowledge of reactivity of metals to justify the selection and use of metals as solutions to everyday problems. Use scientific vocabulary: metal hydroxide, metal oxide, reactivity, extraction.
	Includes, but not limited to • Different biomes include aquatic (freshwater and marine) and terrestrial (desert, forest and tundra). **Notes** • The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action and for details. • Progression from Third Level: - climate change and human activities, such as overfishing and urbanisation, can negatively affect biomes - human activities such as nature restoration, as with coral reef and peatlands, can positively impact on biomes • Link to Our Scientific Knowledge: The Connected World - Energy and climate change. • Link to Science in Action: Taking Scientific Action. - learners could, for example, apply learning of ecosystems and biomes to monitor and enhance a natural environment or location		**Includes, but not limited to** • Plants compete for light, water, nutrients and space. **Notes** • The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action and for details. • The word ‘competition’ has a different scientific meaning to its everyday use. • Link to Science in Action: Taking scientific action. - learners could for example apply learning about food production in practical real-life contexts		**Includes, but not limited to** • Comparison of metal reactivity by reaction with water, acid and oxygen. **Excludes** • Formula equations for reactions of metals, as this does not need to be covered at this level. **Notes** • The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action and for details. • The reactivity of metals can be used in solutions to everyday problems such as: - choosing more reactive metals to make batteries more efficient - using less reactive metals in buildings so they don’t rust or corrode quickly - using copper in wires because it is relatively unreactive and safe • The word ‘reactivity’ has a different scientific meaning to its everyday use.	

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<table>
<tr><td>Strand</td><td colspan="4">The Connected World</td></tr>
<tr><td>Sub-strand</td><td colspan="4">Energy in society</td></tr>
<tr><td></td><td colspan="2">Energy sources and security</td><td colspan="2">Energy and climate change</td></tr>
<tr><td rowspan="8">Early Level</td><td colspan="2">Understand: Electricity is needed to power devices used in everyday life, with its safe use helping to protect us.</td><td colspan="2">Understand: The use of energy resources can harm the environment, so should be used with care.</td></tr>
<tr><td>Know:
Safety and use
Electrical things need to be used safely.

Electricity can hurt people if it is not used safely.

Only plugs should be put into sockets.</td><td>Do:
Use electrical devices safely.

Observe what happens when an object powered by electricity is used.</td><td>Know:
Climate change
There are things we can do to save energy.</td><td>Do:
Follow routines to conserve energy.</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Focus on encouraging safe and unsafe behaviour around electricity, sockets and batteries.
• May involve turning electrical devices on and off and using devices to observe what happens such as blenders, torches, toys or hairdryers.

Notes
• Link to Our Scientific Knowledge: The Living World - Concept of life.</td><td colspan="2">Includes, but not limited to
• Routines to save energy include turning off taps, devices and lights.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:
Climate change
Using less energy resources helps care for the environment.</td><td>Do:
Observe and identify ways energy resources can be wasted and saved.

Recognise how using less energy helps care for the environment.</td></tr>
<tr><td colspan="2"></td><td colspan="2">Includes , but not limited to
• Noticing when energy resources are being wasted, such as lights on in empty rooms or heating on with windows open.</td></tr>
<tr><td rowspan="2">First Level</td><td colspan="2">Understand: Electricity powers our devices, homes and transport, supporting many aspects of daily life.</td><td colspan="2">Understand: Energy resources support daily life but can harm the environment, so using less helps protect our planet.</td></tr>
<tr><td>Know:
Electricity
Electricity transfers energy from one place to another, to make things work.

Electricity can come from the mains via sockets or stored in batteries.

Batteries store energy that powers devices when required.</td><td>Do:
Identify safe ways to use plugs, sockets and electrical devices.

Observe how electricity makes things light up, move or make sound.</td><td>Know:</td><td>Do:</td></tr>
</table>

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<table>
<tr><td rowspan="11"></td><td colspan="2">Electricity can make things light up, move, make sound or become warmer.</td><td colspan="2"></td></tr>
<tr><td colspan="2">Includes, but not limited to
• Electricity stays within safe pathways in plugs, sockets and wires.
• Focus on observable electrical effects only.
• Electricity can make things light up, move or make sound: could cover small devices, everyday appliances or transport.</td><td colspan="2"></td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Know:
Electricity
Electricity provides energy that can make everyday things work, for example, enabling them to produce heat, light, sound or movement.

Wires carry electricity inside devices. Damaged or exposed wires can cause electric shock.

Wires have a protective coating (usually plastic or rubber) around them to prevent against electric shock.</td><td>Do:
Match electrical devices to the effects they produce, such as heat, light, sound or movement.

Identify wires and their protective coverings in familiar electrical devices.

Recognise potential electrical hazards, such as damaged or exposed wires.</td><td>Know:
Climate change
People can make choices to minimise the use of energy resources and protect the environment.</td><td>Do:
Identify and apply ways to reduce unnecessary use of energy resources.

Compare how different activities use energy resources.</td></tr>
<tr><td colspan="2">Notes
• Electricity can make some devices warmer. However, for safety reasons, hot electrical devices should not be touched to test their temperature.
• Damaged or exposed electrical wires should not be touched or used when connected to an electrical supply.</td><td colspan="2">Includes, but not limited to
• Examples of choices made to minimise the use of energy resources would be turning off devices, using public transport etc.

Notes
• Link to Our Scientific Knowledge: the connected world - Nature.
• At this level, learners may talk about ‘using energy’. Avoid suggesting that energy itself is used up. Where appropriate, make clear that it is energy resources, such as fuels, that can be used up.
• Link to Science in Action: Taking Scientific Action.
- reduce the use of energy resources</td></tr>
<tr><td rowspan="5">Second Level</td><td colspan="4">Understand: Society meets its energy needs through the use of renewable and non-renewable energy sources, with electricity transferring energy to support many aspects of daily life.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Know:
Energy sources
A fuel is a source of stored energy that can be used when needed.</td><td>Do:
Classify energy sources as renewable or non-renewable.

Compare the advantages and disadvantages of different energy sources.</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="4"></td></tr>
</table>

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Renewable energy comes from sources that are naturally replaced and can be used again and again.

Non-renewable energy comes from sources that take a very long time to form and will eventually run out.

Meeting society's energy needs has led to the burning of fossil fuels, which are non-renewable and took millions of years to form.
Electricity can be produced using a range of renewable energy sources.
The use of energy resources in homes, schools and transport can be measured.

Compare information about the use of energy resources in everyday life.

Use scientific vocabulary: finite, renewable, non-renewable, fuel, fossil fuel

Includes, but not limited to
- Non-renewable fossil fuels include coal, oil and gas.
- Range of ways to generate electricity: renewable sources such as wind, solar, hydroelectric, geothermal, wave/tidal and biomass.

Notes
- Link to Being Scientific: Interpreting and Analysing.
  - comparing information about energy use might include discussion about smart meter data, appliance ratings, transport comparisons, school energy audits

Know:

Do:

Know:

Climate change
The Earth's natural Greenhouse Effect helps keep the Earth warm enough for life to survive, but changes to this natural balance can affect the Earth's climate.

Burning fossil fuels releases more greenhouse gases into the atmosphere, which leads to an increase in the Earth's temperature. This is called global warming.

Global warming leads to climate change, causing weather, seasons and climate systems to change. This has consequences for nature and communities both locally and globally.

Do:
Evaluate how different energy sources contribute to climate change.

Identify the impact of human activity on climate systems over time.

Use scientific vocabulary: Greenhouse Effect, greenhouse gases, climate change.

Includes, but not limited to
- Impacts of climate change include extreme weather (storms, flooding, droughts), loss of habitats, decline in food security.

Excludes
- Specific naming of greenhouse gases (such as carbon dioxide, methane) is not expected at this level but may naturally occur during discussion.

Notes
- Link to Being Scientific: Interpreting and Analysing.
  - identify impact of human activity may include interpreting evidence such as temperature change data, polar ice cap sizes, number of extreme weather events

<table>
<tr><td rowspan="3">Third Level</td><td colspan="2">Understand: Electricity is produced, transferred, stored and managed in different ways to meet changing demand, so societies can maintain reliable and sustainable energy supplies.</td><td colspan="2">Understand: Using less energy sources from non-renewable sources and using alternatives such as renewable energy sources can reduce greenhouse gas emissions, supporting the journey to net zero.</td></tr>
<tr><td>Know:
Energy sources
Electricity is produced when energy from fuels or renewable sources is used to turn turbines. Electricity can also be produced by photovoltaic cells.

Turbines spin the moving parts of a generator, producing electricity.

Energy cannot be created or destroyed. It can be transferred between energy stores within a system or to the surroundings.

A battery contains chemicals that store energy and can supply an electrical current when connected in a complete circuit.

The National Grid is supplied by a changing mix of energy sources, allowing electricity supply and demand to be balanced.

Micro-renewables are small-scale systems that produce electricity locally for nearby users.

Energy security is having access to a reliable supply of energy to meet current and future societal needs.

Electricity
Electricity use is often measured in kilowatt-hours (kW h).

Some electrical appliances can have energy efficiency ratings.

Technology can help people monitor and manage electricity use.</td><td>Do:
Identify the energy efficiency of common electrical appliances.

Analyse energy bills and compare tariffs.

Identify ways to reduce electricity use.

Evaluate the advantages and limitations of different energy sources in relation to reliability, sustainability and environmental impact.

Use scientific vocabulary: turbines, generators, photovoltaic cells, energy security.</td><td>Know:
Climate change
The land and the oceans on Earth absorb energy from the Sun and emit infrared radiation. Some of the radiation is absorbed and re-emitted by greenhouse gases in the Earth’s atmosphere.

Human activities are increasing the amount of greenhouse gases in the atmosphere, causing more infrared radiation from the Earth to be absorbed and re-emitted.

The increasing amounts of greenhouse gases in the atmosphere are slowing the rate at which energy is transferred into space, causing the Earth to warm and contributing to changes in weather patterns and climate.

Combustion is the scientific term for burning – a chemical reaction in which a substance reacts with oxygen.

Fossil fuels are carbon-based compounds.

The reaction of carbon-based compounds with oxygen produces carbon dioxide, which is one of the greenhouse gases.

Some natural environments are important carbon stores (maintains constant amount of carbon) and carbon sinks (takes in more carbon than it emits).

Using renewable energy reduces greenhouse gas emissions compared to the use of fossil fuels.

Journey to net zero
Reducing greenhouse gas emissions requires changes to the way society operates and uses energy resources.

Net zero is when the level of greenhouse gases absorbed and released into the environment is equal.</td><td>Do:
Compare renewable and non-renewable sources used to generate electricity.

Evaluate evidence to make informed decisions about the most effective actions to reduce greenhouse gas emissions.

Use scientific vocabulary: combustion, peatlands, renewable energy, fossil fuels, infrared radiation, emit.</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Technologies used to monitor electricity consumption include smart meters and apps.
• Micro-renewables include solar panels, small wind turbines and micro-hydro.
• Heat pumps are classed as micro-renewables because they draw on energy from natural sources such as air or the ground, although they require electricity to operate.</td><td colspan="2">Includes, but not limited to
• Possible sources of energy to compare include fossil fuels, nuclear, wind, solar, hydroelectric, geothermal, wave/tidal, hydrogen, biomass.
• Comparing non-renewable and renewable resources might include evaluating environmental impact and sustainability of materials.</td></tr>
</table>

<table>
<tr>
<td></td>
<td colspan="2">Notes
• The word ‘energy’ is widely encountered in society, for example, ‘I have loads of energy’. This can result in it being understood and applied in ways that are not completely scientific.
• It is best to avoid referring to different ‘forms’ or ‘types’ of energy. It is better to refer to the ‘transfer’ of energy, or ‘energy stores’, rather than the ‘transformation’ of energy from one ‘form’ to another.
• Electricity consumption may be explored using real or simulated energy data, including kilowatt-hours (kWh) and appliance ratings.
• Link to Our Scientific Knowledge: The Physical World - Electricity.
- building circuits using electrical components</td>
<td colspan="2">• Natural environments that are important carbon stores include wetlands (including peatlands), forests, oceans and coastal ecosystems, such as seagrass meadows.

Excludes
• Description of fossil fuels as hydrocarbons, or specific naming and drawing of these, does not need to be covered at this level.

Notes
• Nuclear energy is currently classified as a non-renewable energy source because it relies on finite fuels such as uranium. However, electricity produced by nuclear power produces very low greenhouse gas emissions.
• Link to Our Scientific Knowledge: The Connected World - Energy sources and security.
- linking the science of climate change to responsible use of energy resources</td>
</tr>
<tr>
<td rowspan="3">Fourth Level</td>
<td colspan="2">Understand: Meeting future energy needs requires balancing energy sources, storage and demand, so societies can make informed decisions about reliable, sustainable and secure energy supplies.</td>
<td colspan="2">Understand: Scientific evidence helps to inform decisions about how to reduce greenhouse gas emissions and respond to the impacts of climate change on communities around the world.</td>
</tr>
<tr>
<td>Know:
Energy security
Innovative energy storage methods are important for expanding the use of renewable energy, as they allow energy to be stored when it is produced and used later when demand is high or supply is low.

Future energy security depends on reducing overall energy demand, as well as ensuring an appropriate balance of available energy sources and sufficient storage to meet needs.

Countries around the world experience different challenges and develop different solutions to meet the energy needs of their populations in a sustainable way.</td>
<td>Do:
Justify why energy security is important for a variety of communities and societies.</td>
<td>Know:
Climate change
Levels of carbon dioxide in the atmosphere depend on the balance of processes that release and remove carbon dioxide.

Methane is a powerful greenhouse gas produced by agriculture, waste decomposition and fossil fuel extraction.

Journey to net zero
Climate change is a local and global issue requiring collective action which is informed by scientific evidence.</td>
<td>Do:
Use evidence and data to identify how human activities affect greenhouse gas levels and contribute to climate change.

Use scientific vocabulary: methane, decomposition.</td>
</tr>
<tr>
<td colspan="2">Includes, but not limited to
• Energy storage innovations include fast-charging Lithium batteries, battery walls to store solar energy generated in homes, and large-scale energy storage used in power stations.
• Energy security challenges may include resource availability, climate change, conflict, infrastructure limitations and increasing demand.

Notes
• The application of knowledge and skills through real-life contexts will be a significant focus at Fourth Level. See Science in Action Big Idea for details.
• Learners should engage critically with evidence and contemporary case studies related to energy security and sustainability.
• Smart grid technologies can be used to integrate renewable energy sources and balance supply and demand across the electricity network.
• Link to Our Scientific Knowledge: The Connected World - Energy and climate change.
• Link to Science in Action: Taking Scientific Action.</td>
<td colspan="2">Notes
• The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action and details.
• Link to Our Scientific Knowledge: The Connected World - Energy sources and security.
- Linking the science of climate change to responsible use of energy resources.
• Link to Science in Action: Taking Scientific Action.
- learners could for example apply learning and work collaboratively to take positive scientific action on a climate change issue</td>
</tr>
</table>

<table>
<tr><td>Strand</td><td colspan="2">The Connected World</td></tr>
<tr><td></td><td colspan="2">Space</td></tr>
<tr><td rowspan="5">Early Level</td><td colspan="2">Understand: The sky changes from light to dark, creating day and night.</td></tr>
<tr><td>Know:
Solar system
The Sun gives us light and warmth.

The Moon can be observed in the sky during the day and at night.

Stars and galaxies
Stars can be seen when the sky is dark.</td><td>Do:
Observe changes in the sky at different times of the day.

Use everyday vocabulary such as Sun, Moon, stars, day and night to describe changes in the sky.</td></tr>
<tr><td colspan="2">Excludes
• The turning of the Earth causes the sky to appear light and dark, creating day and night – this is covered at First Level.

Notes
• Observing stars might not always be possible or practical but can be discussed.
• Link to Our Scientific Knowledge: the physical world - Light.
- observing the world around us</td></tr>
<tr><td>Know:
Solar system
The Moon appears to change shape.

The sky is mostly light during the day and dark at night.

The Sun is in the sky during the daytime, even when it is cloudy.

Exploring space
People can travel into space to explore.</td><td>Do:
Observe the sky at different times and identify the Sun and Moon.</td></tr>
<tr><td colspan="2">Notes
• The sky is mostly light during the day and dark during the night. The word ‘mostly’ is used because of seasonal changes – in the winter learners may arrive to settings during the day when it is still dark, and in the summer, they may go to bed at night but it is still light.
• Link to Our Scientific Knowledge: The Physical World - Light.
- observing the world around us</td></tr>
<tr><td rowspan="4">First Level</td><td colspan="2">Understand: Repeating patterns can be observed in the sky and across the seasons, helping to develop understanding of Earth and its place in space.</td></tr>
<tr><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Know:
Solar System
Planet Earth is shaped like a sphere.

The Earth spins once every day (24 hours), causing day and night.</td><td>Do:
Observe changes in the sky and seasonal change.

Relate the Earth’s movements to the length of a day, the seasons and a year.</td></tr>
</table>

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<table>
<tr><td></td><td>Observations of the Sun, daylight and weather can be used to identify seasonal patterns.

It is unsafe to look directly at the Sun because it can damage the eyes.

The Solar System is made up of the Sun, eight planets and other objects that move around the Sun.

Some planets can be observed in the night sky without a telescope.

The moon goes through eight major phases.

Stars and galaxies
Stars appear as small points of light in the sky, often in recognisable patterns.

The Sun is one of many stars in our Milky Way galaxy.

Conditions for life
The Sun provides the light and warmth needed by living things.

Exploring space
Humans use technology to observe and explore space to learn about Earth, the Solar System and beyond.</td><td>Use scientific vocabulary: seasons, Earth, planets, Solar System, galaxies, Milky Way.</td></tr>
<tr><td></td><td colspan="2">Includes, but not limited to
• Relating the Earth’s movements might include discussion about days being shorter in winter, longer in summer, how long it takes to orbit the Sun (a year), differences in northern and southern hemisphere, the Equator.

Notes
• The planets in the Solar System are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune.
• Other objects in the solar system include asteroids, meteors and moons.
• Changes in the sky can include day, night, sunrise and sunset and in the appearance of the Moon.
• The eight major phases of the Moon: new Moon, waxing crescent, first quarter, waxing gibbous, full moon, waning gibbous, last quarter, waning crescent.
• The Sun only appears to move across the day because the Earth is turning, not because the Sun itself is moving.
• Learners are not expected to memorise all moon phases in sequence at First Level.</td></tr>
<tr><td></td><td>Know:</td><td>Do:</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td>Second Level</td><td colspan="2">Understand: The movement of objects in the Solar System explains repeating patterns observed from Earth, supporting understanding of what makes Earth suitable for life.</td></tr>
<tr><td></td><td>Know:
Solar System
An orbit is the path an object follows around another object in space.

The Earth orbits the Sun once each year.

The Moon orbits the Earth approximately every 27 days.

Some planets in the Solar System are rocky, and some are gas or ice giants.

Stars and galaxies
Space is the vast region beyond Earth’s atmosphere where planets, stars, and galaxies exist.</td><td>Do:
Identify and compare the planets and features of the Solar System.

Identify some constellations.

Identify the ways the Sun sustains life on Earth.

Use scientific vocabulary: orbit, rocky, ice and gas giant planets, space, constellations.</td></tr>
</table>

A star is a very large, hot object in space that produces its own light and heat. Planets are large, rounded objects that orbit a star. Constellations are recognised patterns of stars that appear to form shapes when viewed from Earth, even though the stars are not actually close together in space. **Conditions for life** Planet Earth has the ideal conditions needed to support life. The Sun provides the energy that drives weather on Earth and makes life possible. **Exploring space** Satellites are used to communicate, navigate and monitor Earth. Space exploration helps us learn more about Earth and space. Conditions in space can affect the health of humans working in space	
Notes • Rocky planets (Mercury, Venus, Earth and Mars). • Gas planets (Jupiter, Saturn) and Ice planets (Uranus and Neptune) are the furthest planets from the Sun and are much bigger than the rocky planets. • Leap year – The Earth takes about 365¼ days to orbit the Sun, so an extra day (29 February) is added every four years. • It takes about 27.3 days for the Moon to orbit the Earth – not 28 days as commonly thought. • Stars in the same constellation may be very far apart in space and are different distances from Earth. • Link to Science in Action: Science Around Me. - Observing the night sky has been important to many cultures over time.	
Know:	**Do:**
Know:	**Do:**

<table>
<tr><td rowspan="2">Third Level</td><td colspan="2">Understand: Gravitational forces cause objects in space to move in predictable orbits and patterns, helping to explain observations of the Solar System and wider Universe.</td></tr>
<tr><td>Know:
Solar System and the Universe
Lunar and solar eclipses are caused by the relative positions of the Earth, Moon and Sun.

Seasons are caused by the Earth's tilted axis as it orbits the Sun, which changes the angle and duration of sunlight throughout the year.

Gravitational forces pull objects towards each other, keeping the Earth and Moon in orbit and affecting tides on Earth.

A galaxy is a large group of stars, gas and dust held together by gravitational forces.

The Universe is vast and contains billions of galaxies and is expanding.

Earth lies within the Sun's habitable 'Goldilocks' Zone, where temperatures can allow liquid water to exist. The atmosphere of Earth contains breathable gases, enabling life.

Exploring space
Satellites and space technologies are used for a variety of purposes including environmental and climate monitoring, research and astronomy.

Space exploration and technology can have environmental impacts and raise ethical questions.</td><td>Do:
Interpret and compare information collected using satellites and space technologies.

Identify and evaluate how space technologies are used to monitor Earth, weather, climate and environmental change.

Compare and evaluate the challenges of living and working in space.

Use scientific vocabulary: gravity, orbit, lunar, solar, eclipse, satellite, Goldilocks Zone, Universe.</td></tr>
<tr><td colspan="3">Includes, but not limited to
• Space technologies include satellites, probes, telescopes and spacecraft and space stations.

Notes
• Scientists study organisms called extremophiles, which can survive in extreme conditions such as high temperature, pressure or low oxygen, to help understand if and where life might exist beyond Earth.
• Different planetary conditions and atmospheres can be explored when discussing the ‘Goldilocks’ Zone.
• Living in low gravity can affect muscles, bones and body systems.
• Satellites may be explored in relation to communication, navigation, weather forecasting and environmental monitoring.
• Link to Science in Action: Science Around Me.
- connection of innovation in science and technologies with how this aids people and communities on planet Earth
• Link to Our Scientific Knowledge: The Physical World - Forces.
- connection related to understanding of gravity</td></tr>
<tr><td rowspan="2">Fourth Level</td><td colspan="2">Understand: Scientific discoveries and technologies deepen understanding of the changing Universe and enable continued exploration of space, leading to new knowledge and possibilities.</td></tr>
<tr><td>Know:
Solar System and the Universe
A black hole is a region of space that can form when a very massive star collapses, creating a gravitational field so strong that nothing, not even light, can escape.

The Universe began from a very hot, dense state and has been expanding over time. This is known as The Big Bang Theory.

Exploring space
Space travel and habitation requires innovation and scientific solutions.</td><td>Do:
Analyse evidence from space research and Earth observation to identify patterns, changes and impacts.

Evaluate the environmental, social and ethical impacts of advances in space science and technologies.

Use scientific vocabulary: black hole, The Big Bang Theory.</td></tr>
</table>

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	Includes, but not limited to • This content at Fourth Level provides a light-touch introduction to vocabulary and concepts that learners may encounter in everyday life, media and popular culture. **Notes** • The application of knowledge and skills through everyday contexts is a significant focus at Fourth Level. See Science in Action for details. • Discoveries and images from space can inspire wonder and curiosity about the Universe. • Links can be made to environmental, ethical and economic considerations related to space innovation and exploration. • Link to Science in Action: Science Around Me - connection of innovation in science and technologies with space exploration beyond Earth.

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<table>
<tr><td>Strand</td><td colspan="2">The Connected World</td></tr>
<tr><td></td><td colspan="2">Health and disease</td></tr>
<tr><td rowspan="5">Early Level</td><td colspan="2">Understand: Some germs can affect health, and medicines can be used to prevent and treat infections.</td></tr>
<tr><td>Know:
Health and disease
Bodies can stay healthy or become unwell.

Medicine can help us stay healthy and safe.</td><td>Do:
Identify signs of being unwell.

Use scientific vocabulary: medicine.</td></tr>
<tr><td colspan="2">Notes
• Recognising signs such as being tired, warm or needing rest may indicate feeling unwell.
• Medicine might include vaccinations – relevant as many children are being vaccinated at this age.</td></tr>
<tr><td>Know:
Health and disease
Germs are tiny living things that can be found everywhere and can make humans and other animals feel unwell.</td><td>Do:
Identify ways of keeping our bodies healthy and safe from germs.

Use scientific vocabulary: germs.</td></tr>
<tr><td colspan="2">Excludes
• Knowledge of microorganisms is not required.

Notes
• Getting dirty doesn’t necessarily mean being exposed to germs and getting unwell.</td></tr>
<tr><td rowspan="5">First Level</td><td colspan="2">Understand: Some germs can affect health, and good hygiene and medicines can be used to prevent the spread of, and treat, infections.</td></tr>
<tr><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td></td><td>Know:
Health and disease
Germs can spread between living things, and some can cause disease.

An infection can happen when harmful germs enter the body and multiply.

Some infections can cause disease and make a person feel unwell.

Good hygiene can reduce the spread of some infections and diseases. This includes washing hands and covering the mouth and nose when coughing or sneezing.

Medicines can come in different forms.</td><td>Do:
Recognise the symptoms of different diseases and potential prevention methods.</td></tr>
</table>

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<table>
<tr><td></td><td colspan="2">Includes, but not limited to
• Recognising symptoms of common infectious diseases such as common cold, flu and chickenpox.

Excludes
• Vaccinations may be discussed as part of disease prevention, but this is not essential knowledge until Second Level.

Notes
• Medicines come in forms such as liquids, pills or nasal sprays.
• Good hygiene can reduce the spread of some infectious diseases, including colds and flu. However, it cannot prevent all infectious diseases from spreading.</td></tr>
<tr><td rowspan="6">Second Level</td><td colspan="2">Understand: Some microorganisms can affect the health of living organisms, and vaccines help prevent infections while antibiotics treat bacterial infections and can reduce their spread.</td></tr>
<tr><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Know:
Health and disease
Germs are microorganisms.

Most microorganisms, including bacteria, can only be seen using a microscope.

Microorganisms can affect the health of plants, humans and other animals, and some can cause infectious diseases.

Some bacteria are helpful, while others can cause disease.

Infectious diseases, such as chickenpox, flu and the common cold, are passed on by spreading.

Some are common and easily transmitted, while others are less common but more serious.

Non-infectious diseases, such as diabetes, cancer and asthma, are not passed on by spreading.

Vaccinations can prevent the spread of some diseases by helping the body to fight against them.

Antibiotics are medicines used to treat infections caused by bacteria; they do not work against viruses.

Allergies
A food allergy is when the body reacts unusually to specific foods. Although allergic reactions are often mild, they can be very serious.

Other common allergies include hay fever (where the body reacts to pollen), pets (where the body reacts to skin and fur), insect stings and medication.</td><td>Do:
Identify a variety of infectious and non-infectious diseases.

Identify the ways in which infectious diseases can spread.

Investigate common childhood antibiotics and vaccines and the diseases they help to treat and prevent.

Use scientific vocabulary: microorganism, bacteria, virus, vaccination.</td></tr>
</table>

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<table>
<tr><td></td><td colspan="2">Includes, but not limited to
• Investigation of vaccines might include common childhood vaccines such as the flu vaccine.
• Investigation of antibiotics might include common antibiotics such as penicillin.
• Antibiotics don’t work on viruses like the common cold or flu but do work on bacterial infections like tonsilitis.
• Recognise infectious diseases such as common cold, flu, malaria, chickenpox. Non-infectious disease can include diabetes, cancer, asthma, heart disease.

Excludes
• Detailed information about vaccines and how they work.
• Practical investigation involving antibiotics and vaccines.

Notes
• Microorganisms play an important role in keeping organisms and the environment healthy; they are not all disease-causing.
• Microorganisms are not animals or plants but are their own separate group.
• There is no expectation that microscopes must be used, but they can be if they are available and relevant.
• Learning about diseases may need to be handled sensitively depending on the class context.
• Link to Our Scientific Knowledge: The Living World – Concept of life; Genetic variation.</td></tr>
<tr><td rowspan="2">Third Level</td><td colspan="2">Understand: Public health strategies, such as vaccination and responsible antibiotic use, reduce the transmission of infectious diseases and help limit antimicrobial resistance, protecting individuals and populations.</td></tr>
<tr><td>Know:
Health and disease
Infectious diseases in plants, humans and other animals can be caused by pathogens.

A pathogen is a microorganism or other infectious agent that can cause disease.

A pandemic occurs when an infectious disease spreads across many countries or large parts of the world.

Vaccination programmes aim to increase immunity in the population, reducing outbreaks and preventing future pandemics.

Immunity means the body has resistance to a particular infectious disease.

Herd immunity occurs when enough people are immune to a disease (through vaccination or prior infection). This reduces the spread of a disease and helps to protect vulnerable individuals.

Vaccine hesitancy is the delay in acceptance or refusal of vaccines despite the availability of vaccination services.

Antimicrobial resistance (AMR)
Antimicrobial resistance occurs when microorganisms (such as bacteria, viruses, fungi and parasites) change over time and no longer respond to medicines, making infections harder to treat and increasing the risk of disease spread.

Misuse and overuse of antibiotics can lead to antimicrobial resistance.

Public health messages around antibiotics.
- don't share antibiotics with others: taking leftover antibiotics can be dangerous and could make the problem of antibiotic resistance worse
- wash your hands regularly: help stop the spread of antibiotic-resistant infection
- follow your vet’s instructions when giving your pets antibiotics: protect animals from the threat of antibiotic resistance</td><td>Do:
Identify different diseases caused by pathogens.

Evaluate the potential impact of vaccine hesitancy.

Evaluate the impact of antimicrobial resistance.

Use scientific vocabulary: pathogens, immunity, antibiotics, antibiotic resistance, antimicrobial, herd immunity, fungi, parasites.</td></tr>
</table>

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<table>
<tr><td></td><td>
- take unused medicines back to the pharmacy: throwing antibiotics in bins, sinks, or toilets can harm the environment
- prevent pollution, reduce resistance: keeping pollutants such as medicines and disinfectants out of the environment can help slow the spread of antimicrobial resistance
</td><td></td></tr>
<tr><td></td><td colspan="2">
Excludes
• Knowledge of viruses, fungi and parasites are not required.

Notes
• Disease-causing microorganisms are also known as pathogens.
• Medicine (drug)-resistant microorganisms can be found naturally in people, animals, food and in the environment.
• Link to Our Scientific Knowledge: The Living World - Concept of life; Genetic variation.
</td></tr>
<tr><td rowspan="3">Fourth Level</td><td colspan="2">Understand: Vaccination prepares the immune system to recognise and respond rapidly to specific pathogens, reducing the spread and impact of infectious diseases.</td></tr>
<tr><td>
Know:
Vaccination
Vaccines introduce inactivated weakened, or parts of pathogens to stimulate an immune response and develop immunity.

Vaccines stimulate the body’s immune system to develop protection against specific diseases without causing the illness itself.

After vaccination, the immune system creates memory cells.

If an individual is exposed to the same pathogen in the future, the memory cells will produce a faster response, reducing the chance of the individual becoming unwell.

Booster vaccines may be required over the course of an individual’s life as antibody and memory cell levels can decrease over time.
</td><td>
Do:
Observe the growth of microbial cultures.

Demonstrate an awareness of current affairs regarding vaccination programmes and disease outbreaks, both nationally and globally.
</td></tr>
<tr><td colspan="2">
Notes
• The application of knowledge and skills through everyday contexts is a significant focus at Fourth Level. See Science in action Big Idea and for details.
• Link to Our Scientific Knowledge: The Living World - Concept of life; Genetic variation; Digestive, respiratory and circulatory systems.
</td></tr>
</table>

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The Living World

<table>
<tr><td>Strand</td><td colspan="4">The Living World</td></tr>
<tr><td>Sub-strand</td><td colspan="4">Survival of living things</td></tr>
<tr><td></td><td colspan="2">Concept of life</td><td colspan="2">Genetic variation</td></tr>
<tr><td rowspan="4">Early Level</td><td colspan="2">Understand: Living things grow and change and have needs that must be met for them to stay alive.</td><td colspan="2">Understand: Living things have similarities and differences that help us recognise and compare them.</td></tr>
<tr><td>Know:
Living, non-living and once-living
Living things can grow and change over time.

Life cycles
Living things go through a series of stages as they grow (life cycles).</td><td>Do:
Explore the different stages (life cycles) living things go through as they grow.</td><td>Know:
Variation
Living things look different.</td><td>Do:
Observe and describe similarities and differences between plants, humans and other animals.</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Life cycles of living things such as butterflies, chicks, frogs and plants.
• Opportunities to observe growth, for example, seedlings, caterpillars, chicks, bulbs and seeds.

Excludes
• At this level, learners are not expected to use the term ‘life cycles”.

Notes
• Any observation of animal life cycle should be done in an ethical manner.</td><td colspan="2">Includes, but not limited to
• Human variation such as hair colour and height.
• Animal variation such as fur patterns and number of legs.
• Plant variation such as leaf shape and colour.</td></tr>
<tr><td>Know:
Living, non-living and once-living
Most livings things need food, water and air to stay alive.</td><td>Do:
Identify and compare living, non-living and once-living things.

Use scientific vocabulary: extinct.</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Plants are alive.

Notes
• Non-living things, such as rocks, are not dead because they have never been alive.
• Once-living describes something that was alive in the past but is not alive now, such as dinosaurs or wood.
• Link to Our Scientific Knowledge: The Connected World - Nature.</td><td colspan="2"></td></tr>
</table>

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<table>
<tr><td rowspan="8">First Level</td><td colspan="2">Understand: Living things have needs that must be met for them to grow and survive, although plants and animals meet these needs in different ways to live successfully.</td><td colspan="2">Understand: Living things have similarities and differences that can be used to group and identify them.</td></tr>
<tr><td>Know:
Needs
Humans and other animals have needs to help them grow and stay alive, including food, water and air.</td><td>Do:
Identify the needs of humans and other animals.</td><td>Know:
Variation
Variation exists between plants, humans and other animals.

Plants, humans and other animals have physical similarities and differences between them, such as eye colour or leaf shape.</td><td>Do:
Observe and compare similarities and differences within groups of plants and within groups of humans and other animals.

Use scientific vocabulary: variation.</td></tr>
<tr><td colspan="2">Includes
• Humans are animals.
• Opportunities to care for living things.</td><td colspan="2"></td></tr>
<tr><td>Know:
Needs
Plants have needs to help them grow and stay alive including air, water, light, nutrients and a suitable temperature.</td><td>Do:
Identify the needs of plants.</td><td>Know:
Classification
Biological classification sorts living things into groups based on similar characteristics.</td><td>Do:
Classify living things using observable characteristics and justify the groupings.

Use scientific vocabulary: classification.</td></tr>
<tr><td colspan="2">Notes
• Opportunities to care for living things.
• Link to Our Scientific Knowledge: The Connected World - Nature; Food and interdependence.</td><td colspan="2">Notes
Excludes
• Classifying animals into vertebrate and invertebrate groups is not required at this level.</td></tr>
<tr><td>Know:
Needs
If the needs of living things are not met then it can affect whether plants, humans and other animals can survive and thrive.</td><td>Do:
Compare the needs of living things.

Justify how different conditions affect the needs of plant, humans and other animals.</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2">Notes</td><td colspan="2">Notes</td></tr>
<tr><td rowspan="4">Second Level</td><td colspan="2">Understand: Living things share characteristics and processes that distinguish them from non-living things, helping us identify, classify and understand living organisms.</td><td colspan="2">Understand: Living things can be classified into groups based on features which can affect their survival in different environments.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Know:
Living things
The term ‘organism’ is used to describe living things, such as plants, animals, and microorganisms.</td><td>Do:
Identify the seven characteristics of living things.

Apply knowledge of seven characteristics of living things to classify living, non-living and once-living things.</td><td>Know:
Classification
Animals can be divided into vertebrate and invertebrate groups.

Vertebrates are animals with a backbone, such as mammals and reptiles.</td><td>Do:
Classify living things based on characteristics and justify the groupings.

Use scientific vocabulary: vertebrate and invertebrate.</td></tr>
</table>

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<table>
<tr><td rowspan="6"></td><td>Microorganisms are tiny living organisms, such as bacteria and viruses, that are found almost everywhere on Earth.

Characteristics of living things
• There are seven characteristics that determine if something is living.
- movement: organisms can move or show movement
- respiration: organisms release energy from their food
- sensitivity: organisms detect and respond to changes in their environment
- growth: organisms grow and develop over time
- reproduction: organisms can produce offspring of the same kind
- excretion: organisms remove waste products that are produced
- nutrition: processes by which living things obtain and use essential nutrients</td><td>Use scientific vocabulary: organism, movement, respiration, sensitivity, growth, reproduction, excretion, nutrition.</td><td>Vertebrate animals can be classed as:
- mammals
- birds
- amphibians
- fish
- reptiles

Invertebrates are animals without a backbone, such as crustaceans, molluscs and insects.</td><td></td></tr>
<tr><td colspan="2">Includes, but not limited to
• Not everything that moves or responds is alive such as vehicles, machines and robots.
• Plants do not move from place to place but they grow and respond to stimuli such as light.
• Microorganisms such as fungi and bacteria.

Excludes
• The mechanism of how respiration works does not need to be covered at this level.

Notes
• The mnemonic MRS GREN can be used to remember the seven characteristics of living things.
• Link to Our Scientific Knowledge – The Living World - Plant systems; The Connected World – Health and disease.</td><td colspan="2">Includes, but not limited to
• Classify organisms into vertebrate and invertebrate groups, and further classify vertebrates into mammals, birds, amphibians, fish and reptiles.

Notes
• Characteristics of the main vertebrate groups:
- mammals: hair/fur, live young, produce milk
- birds: feathers, beaks
- fish: gills, fins
- amphibians: moist skin
- reptiles: dry scaly skin
• Link to Our Scientific Knowledge: The Connected World - Nature.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="3">Third Level</td><td colspan="2">Understand: Living things are made of cells whose structures enable them to carry out the functions needed for life</td><td colspan="2">Understand: Genetic information can vary and be inherited, creating differences and adaptations between organisms that can affect their chances of survival.</td></tr>
<tr><td>Know:
Cells
Cells are the basic building blocks of life and vary in structure and complexity.

A specialised cell is a cell that has a specific structure and function to perform a particular job.</td><td>Do:
Use a microscope to observe a prepared slide.

Prepare a slide using plant material.

Identify the main parts of plant and animal cells.</td><td>Know:
Genetic variation and inheritance
DNA is the structure that carries the genetic information.

This genetic information determines characteristics such as eye colour and leaf shape.

Variation in genetic information can lead to adaptations that affect an organism’s chance of survival.</td><td>Do:
Recognise and identify DNA in diagrams and models.

Extract and observe DNA from a plant source.

Identify adaptations in organisms.</td></tr>
<tr><td colspan="4"></td></tr>
</table>

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<table>
<tr><td></td><td>Bacteria and yeast are examples of living organisms that are made up of only one cell (unicellular).

Plants, humans and other animals are made up of many different types of cells (multicellular).

Typical animal and plant cells contain a nucleus, cytoplasm and a cell membrane.

A typical plant cell also includes a cell wall and chloroplasts.

The nucleus stores most of the genetic information (DNA) and helps control cell activities.

Chloroplasts are the site of photosynthesis.</td><td>Identify cell structures and relate these to associated cell functions and processes, where appropriate.

Use scientific vocabulary: cells, nucleus, chloroplasts, cytoplasm, cell membrane, cell wall.</td><td>Inheritance is the process by which this genetic information is passed from parents to offspring.

Offspring are organisms produced by parents.

Adaptation
An adaptation is an inherited characteristic that makes an organism well suited to its environment.</td><td>Identify the ways in which adaptations increase an organism's chance of survival in its environment.

Use scientific vocabulary: DNA, inheritance, offspring, adaptation.</td></tr>
<tr><td></td><td colspan="2">Includes, but not limited to
• Further exploration of cell structures might include:
- the cytoplasm is the site of chemical reactions
- the cell membrane controls the movement of substances in to and out of the cell
- the cell wall provides strength, support and structure to a plant cell

Excludes
• Other cells structures that contain DNA.

Notes
• The words ‘DNA’ and ‘genetic information’ are defined in the Genetic variation sub-strand – the use of them here is related to applying them to the context of cell structure.
• Rest of DNA is found in chloroplasts and mitochondria.
• The word ‘cell’ has a different scientific meaning to its everyday use.
• Link to Our Scientific Knowledge: The Living World - Genetic variation; Plant systems: The Connected World – Food production.</td><td colspan="2">Excludes
• The structure of DNA does not need to be covered at this level.

Notes
• Link to Our Scientific Knowledge: The Living World - Reproductive system in humans and other animals.</td></tr>
<tr><td>Fourth Level</td><td colspan="2">Understand: Living things depend on cellular processes for growth, maintenance and survival, making these processes essential for life.</td><td colspan="2">Understand: Genetic information is organised in DNA, genes and chromosomes, providing instructions that influence an organism’s characteristics and how it functions.</td></tr>
<tr><td></td><td>Know:
Cellular processes
A cellular process, such as aerobic respiration, photosynthesis or cell division, is a series of biochemical reactions that take place within a cell to maintain its survival, growth and normal functioning.</td><td>Do:
Identify cellular processes and relate these to survival, growth and normal functioning in animal and plant systems.</td><td>Know:
Structure and organisation of genetic material
The four DNA bases are adenine, thymine, cytosine and guanine.

Adenine pairs with thymine, and cytosine pairs with guanine.

DNA is made of two strands twisted into a double helix, with each strand containing a unique sequence of bases.

Genes are sections of DNA that provide instructions for characteristics and how an organism functions.

Chromosomes are structures found in the nucleus that contain many genes.</td><td>Do:
Use models to describe the structure of DNA and how it is organised within an animal or plant cell.

Use scientific vocabulary: adenine, thymine, guanine, cytosine, double helix, bases, genes and chromosomes.</td></tr>
</table>

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	Excludes The learning below does not need to be covered in depth at this level. • Cell division. • Cellular respiration. **Notes** • Link to Our Scientific Knowledge: the living world - Plant systems (Third Level); Digestion, respiratory and circulatory system • Link to Science in action: science around me; Informed and responsible decision making. • The application of knowledge and skills through everyday contexts is a significant focus at Fourth Level. See Science in Action for details.	**Includes, but not limited to** • Explore the innovations and ethical considerations of genetic applications. **Notes** • The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action for details.

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<tr><td>Strand</td><td colspan="4">The Living World</td></tr>
<tr><td>Sub strand</td><td colspan="4">Systems for survival</td></tr>
<tr><td></td><td colspan="2">Animal bodies and skeletons</td><td colspan="2">Nervous system and the senses</td></tr>
<tr><td rowspan="6">Early Level</td><td colspan="2">Understand: Humans and other animals have different body parts that help them live and move.</td><td colspan="2">Understand: Humans have senses which enable them to be aware of their surroundings, helping them stay safe.</td></tr>
<tr><td>Know:
Body parts
Humans are made up of different parts.</td><td>Do:
Identify human body parts.</td><td>Know:
Senses
Humans have senses.

The senses allow humans to be aware of what is happening around them.

Eyes are for sight.

Ears are used for hearing.

The nose is used for smell.

The tongue is used for taste.

The skin is used for touch.</td><td>Do:
Use senses to explore items or environment.</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Include diverse representations of human bodies in terms of skin colour, hair texture, physical disability, religious clothing.</td><td colspan="2">Includes, but not limited to
• Model language: “I can hear…”, “I can smell…”.

Notes
• Research suggests that humans have more senses than the traditional five.</td></tr>
<tr><td>Know:
Body parts
Humans and other animals are made up of different parts.</td><td>Do:
Identify animal body parts.

Compare body parts of different animals.</td><td>Know:
Senses
Humans and other animals have senses.</td><td>Do:
Compare how humans and other animals use senses to survive.</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Animal body parts such as beaks, paws, wings, fins, shells.</td><td colspan="2">Notes
• Not all animals sense the world in the same way: bees see colours differently, dogs can notice smells people cannot, bats have good hearing, moles cannot see.</td></tr>
<tr><td rowspan="2">First Level</td><td colspan="2">Understand: Skeletons support and protect the body and enable movement, helping animals survive and carry out essential life activities.</td><td colspan="2">Understand: Humans and other animals use their senses to find out about their surroundings, helping them respond to changes and stay safe.</td></tr>
<tr><td>Know:
Skeleton
Humans and some other animals have a skeleton.

The skeleton is made up of bones.

Bones are living parts of the body that can grow and repair themselves.</td><td>Do:
Identify and justify the main functions of a skeleton.

Compare skeletons of different animals.

Use scientific vocabulary: skeleton.</td><td>Know:
Senses
Sensory abilities can vary between humans and other animals and can also change over time.

Humans and other animals can use more than one sense at a time to gather information about their environment.</td><td>Do:
Compare how senses help humans and other animals respond to their environment.</td></tr>
</table>

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<table>
<tr><td rowspan="5"></td><td colspan="2">Include, but not limited to
• Comparing skeletons of different animals (X-rays, models).

Excludes
• Names of bones do not need to be covered at this level.

Notes
• Support – the skeleton gives the body structure and shape.
• Protection – the skeleton protects vital organs such as:
- the skull protects the brain
- the ribcage protects the heart and lungs
• Movement – the skeleton works with muscles to allow the body to move.</td><td colspan="2">Includes, but not limited to
• Some animals have enhanced senses such as dogs, owls.
• If one sense is impaired, people can use information from their other senses to help them. Aids can also support some senses, for example, glasses and hearing aids.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="5">Second Level</td><td colspan="2">Understand:</td><td colspan="2">Understand: The brain processes information from the senses, enabling organisms to respond to their environment and stay safe.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:
Processing sensory information
Senses work individually or together to help us understand what is happening around us and to keep us safe from harm.

The brain is an organ that receives and processes information from the sense organs.

The brain processes information from the senses and sends messages to different parts of the body to produce a response, such as movement.

Reaction time is the time it takes to respond to something detected by the senses.</td><td>Do:
Identify and measure reaction time.

Relate sensory information to body responses.

Use scientific vocabulary: brain.</td></tr>
<tr><td colspan="2"></td><td colspan="2">Includes, but not limited to
• Reaction time can be affected by factors such as tiredness.</td></tr>
</table>

<table>
<tr><td></td><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="4">Third Level</td><td colspan="2">Understand:</td><td colspan="2">Understand: The brain and nerves work together in the central nervous system to process sensory information, enabling coordinated responses to changes in the environment.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:
Processing sensory information
Sense organs detect stimuli from the environment and convert this information into electrical impulses that travel along nerves to the brain.

The brain processes this information and sends electrical impulses back along nerves to parts of the body, enabling a response to stimuli.

The central nervous system (CNS) comprises the brain and spinal cord.</td><td>Do:
Use models to describe how sensory information is processed in the central nervous system.

Use models to describe how sensory information is processed in the central nervous system.

Use scientific vocabulary: stimuli, electrical impulses, nerves, central nervous system.</td></tr>
<tr><td colspan="2"></td><td colspan="2">Includes, but not limited to
• Study of how information from the eye, ear or skin is detected and processed.

Excludes
• Areas of the brain do not need to be covered at this level.
• Reflex arcs and reflex actions do not need to be covered at this level.

Notes
• Link to The Physical World: Electricity.</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="3">Fourth Level</td><td colspan="2">Understand:</td><td colspan="2">Understand:</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2">Notes
• The application of knowledge and skills through everyday contexts is a significant focus at Fourth Level. See Science in Action Big Idea for details.</td></tr>
</table>

<table>
<tr><td>Strand</td><td colspan="5">The Living World</td></tr>
<tr><td>Sub-strand</td><td colspan="5">Systems for survival</td></tr>
<tr><td></td><td colspan="2">Digestive, respiratory and circulatory systems</td><td colspan="2">Reproductive systems in humans and other animals</td><td>Plant systems</td></tr>
<tr><td rowspan="6">Early Level</td><td colspan="2">Understand: Different parts of the body have different jobs that help the body stay alive and healthy.</td><td colspan="2">Understand:</td><td>Understand: Plants have different parts that help them grow and stay alive.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td><td>Know:
Plant parts
Plants are made up of different parts.</td><td>Do:
Identify different parts of a plant.</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2">Includes, but not limited to
• Plant parts such as roots, stem, leaves, flowers, fruit and seeds.

Notes
• Link to Our Scientific Knowledge: The Living World – Concept of life.
• Link to Our Scientific Knowledge: The Connected World - Food and interdependence.</td></tr>
<tr><td>Know:
Body parts
Teeth play an important role in eating such as biting and chewing food.

The lungs help you breathe.

The heart pumps blood around the body.</td><td>Do:
Identify how teeth, lungs and heart help the body to work.

Observe and describe changes in breathing and heartbeat.</td><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Link tooth loss to growing up.
• Teeth are the start of the digestive system.
• Compare teeth based on their size and shape.
• Through practical exercise, observe and describe changes in breathing and heartbeat.

Excludes
• Names of teeth such as incisors and molars do not need to be covered at this level.</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="3">First Level</td><td colspan="2">Understand: The heart and lungs are organs with different jobs that work together to keep the body alive.</td><td colspan="2">Understand: Humans and other animals can reproduce, allowing their species to continue over time.</td><td>Understand: Different parts of a plant (plant organs) have different jobs that help the plant grow, survive and reproduce.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
</table>

	Know: **Organs** The heart and lungs are internal organs. The lungs take in air when we breathe in and out through the nose and mouth. Breathing rate is the number of breaths taken in one minute. Breathing rate can change in different situations.	**Do:** Observe, compare and identify reasons for changes in breathing rates in different situations.	**Know:** **Organs** Humans and other animals can reproduce to make new life. Some animals have their young in different ways such as giving birth to live young or laying eggs. The external human reproductive organ in females is the vulva. The external human reproductive organs in males are the penis and the testicles (testes).	**Do:** Explore how some animals have their young in different ways. Identify the external reproductive organs of a human male and female. Use scientific vocabulary: penis, vulva, reproduce, testicles, testes.	**Know:** **Organs** Plant parts, such as flowers and leaves, are also known as organs. These organs work together to help the plant carry out important life processes such as making food and transporting substances like water. Roots hold the plant in the ground and take in water and minerals from where the plant is growing. The root system is made up of roots and root hairs. Stems hold the plant up and move water and food to other parts. Leaves make food for the plant. Flowers help the plant make seeds to grow new plants. The shoot system is made up of stems, leaves and flowers. A seed contains a young plant and a food store to help it start growing. Fruits protect the seed.	**Do:** Identify the roles of different parts of a plant. Use scientific vocabulary: flowers, leaves, roots, stem, seeds, fruit.
	Includes, but not limited to • Measuring breathing rate before and after exercise.		**Includes, but not limited to** • Explore how some animals have their young in different ways such as giving birth to live young or laying eggs. • The testicles (plural: testes) are contained within the scrotum and are considered external reproductive organs. **Excludes** The learning below does not need to be covered at this level. • Internal human female reproductive organs such as the vagina, uterus and ovaries. • Sexual reproduction (Third Level content). This content is focused on knowing self and the young that animals produce, not the process of reproduction. **Notes** • The science of external human reproductive organs may have been covered at Early Level through Health and Wellbeing and Relationships, Sexual Health and Parenthood (RSHP) education through a child protection lens.		**Includes, but not limited to** • Through practical work, grow a flowering plant from a seed. • Most plants grow from seeds in soil. • Seeds do not need light to grow. • Plants can grow under artificial light. **Notes** • For consistency with animal systems, the term ‘organ’ is being introduced at First Level. • The word ‘leaves’ has a different scientific meaning to its everyday use. • Link to Our Scientific Knowledge: The Living World - Concept of life. • Link to Our Scientific Knowledge: The Connected World - Food and interdependence.	

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	Know: **Organs** The heart pumps blood around the body in blood vessels. Heart rate is the number of heart beats taken in one minute. Breathing rate and heart rate can change in different situations.	**Do:** Observe, compare and identify reasons for changes to heart rates in different situations.	**Know:**	**Do:**	**Know:**	**Do:**
	Notes • Measuring heart rate before and after exercise.					

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<table>
<tr><td rowspan="6">Second Level</td><td colspan="2">Understand: Body systems are made up of organs that work together to carry out essential functions and keep the body alive.</td><td colspan="2">Understand: Puberty involves changes that mature the human body and make reproduction possible.</td><td colspan="2">Understand: Plants have different processes to help the plant function, stay alive and reproduce.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td><td>Know:
Plant processes
Pollen is a fine powder produced by flowers that is needed for plants to reproduce.

Pollination is the transfer of pollen from one flower to another flower, or within the same flower, so that seeds can be produced.

Pollination is essential for plants to produce fruit and set seed.

Pollination can occur with the help of wind or animals, including insects such as bees.</td><td>Do:
Identify the different methods of plant pollination.

Use scientific vocabulary: pollen, pollination.</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2">Notes
• Link to Our Scientific Knowledge: The Connected World - Food production.</td></tr>
<tr><td>Know:
Body systems
Body systems are groups of organs that work together to perform specific functions.

The digestive, respiratory and circulatory systems work together to keep the body functioning and alive.

Some of the main organs involved in digesting foods are:
- mouth
- oesophagus
- stomach
- small intestine
- large intestine
- rectum
- anus

The main organs involved in the respiratory system are the:
- nose and mouth
- trachea (windpipe)
- lungs</td><td>Do:
Use models to describe the digestion, respiration and circulation systems.

Use scientific vocabulary: digestive, respiratory, circulatory, oesophagus, intestine, trachea, vessels.</td><td>Know:
Puberty
Puberty is the stage of physiological development during which the body undergoes changes and becomes sexually mature and capable of reproduction.</td><td>Do:
Identify changes that happen in both males and females during puberty.</td><td>Know:</td><td>Do:</td></tr>
</table>

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	The main organs involved in the circulatory system are the: - heart - blood vessels					
	Notes • Breathing and respiration are not the same process. Respiration is a cellular process that is introduced at Fourth Level. Oxygen is breathed in and used by cells for respiration.		**Excludes** • Sexual reproduction is Third Level content. At Second Level, the focus is on understanding the physical changes that occur during puberty. **Notes** • 'Physiological' relates to the physical, chemical and biological functions of living things.			
	Know:	**Do:**	**Know:** **Menstruation** The internal human reproductive organs in females include: - ovary (plural: ovaries) - oviduct(s) - uterus - vagina Menstruation is the process by which the uterus lining is shed and leaves the body as part of the menstrual cycle. This takes place approximately every 28 days and is commonly known as a 'period'.	**Do:** Identify the internal reproductive organs of a human female. Use scientific vocabulary: ovary, oviduct, uterus, vagina, menstruation.	**Know:**	**Do:**
			Excludes • Sexual reproduction is Third Level content. At Second Level, the focus is on understanding the physical changes that occur during puberty. **Notes** • 'Physiological' relates to the physical, chemical and biological functions of living things. • Oviducts may also be called fallopian tubes in humans.			
Third Level	**Understand:** The digestive, respiratory and circulatory systems depend on each other to provide the conditions needed for life.		**Understand:** Sexual reproduction produces genetic variation within a population, which can help species survive and adapt to changing environments.		**Understand:** Plant root and shoot systems depend on each other to transport substances needed for photosynthesis, growth and survival.	
	Know: **Body systems** Body systems play a role in transporting, absorbing and exchanging materials such as oxygen and nutrients to keep the body functioning.	**Do:** Identify ways in which the circulatory, respiratory and digestive systems work together.	**Know:** **Sexual reproduction** Hormones are chemical messengers carried in the bloodstream that affect different parts of the body. Sex hormones differ for males and females.	**Do:** Use scientific vocabulary: hormones, reproduction, fertilisation, foetus, embryo, zygote, gestation, pregnancy.	**Know:** **Plant processes** Photosynthesis is the process by which plants make their own food, and this occurs in the chloroplasts of cells. During photosynthesis, carbon dioxide and water react to produce glucose and oxygen in when light is present.	**Do:** Identify the requirements for photosynthesis (limiting factors). Use a simple word equation to describe the process of photosynthesis.

	The digestive, respiratory and circulatory systems depend on each other. In the digestive system, nutrients are absorbed in the small intestine, and water is absorbed in the large intestine with both passing into the bloodstream. In the respiratory system, the lungs are the site of gas exchange. During breathing air, oxygen is absorbed into the bloodstream, and carbon dioxide is removed from the bloodstream in the lungs. The circulatory system transports blood, delivering oxygen and nutrients to cells through arteries and carrying waste products, such as carbon dioxide, away through veins for removal.		Sexual reproduction is the biological process in which new life is formed from two parents. In females, eggs (sex cells) are produced in the ovaries, and travel to the uterus via the oviducts. In males, sperm (sex cells) are produced in the testes. During sexual reproduction, sperm are ejaculated into the vagina and swim through the reproductive system to the egg. Fertilisation occurs when the nucleus of a sperm fuses with the nucleus of an egg to form a zygote and takes place in the oviduct. The zygote divides repeatedly to form a ball of cells called an embryo. The embryo travels to the uterus and implants in the uterus lining where it develops further. After about eight weeks, the developing embryo is called a foetus because its main body structures have formed. The placenta is an organ that develops in the uterus during pregnancy and allows oxygen and nutrients to pass from the female's blood to the foetus, while removing waste products such as carbon dioxide. During pregnancy, menstruation typically stops because hormonal changes maintain the uterus lining to support foetal development. Gestation is the period during which offspring develop inside a female's body before birth. Birth is the process by which a foetus leaves the female’s body		The rate of photosynthesis can be affected by light intensity, temperature and carbon dioxide concentration. The root system and shoot system work together to transport water to the leaves for photosynthesis. After photosynthesis, glucose is transported from the leaves in the shoot system to other parts of the plant, including the root system, where it is used for respiration, growth and repair or stored as starch.	Use scientific vocabulary: photosynthesis, glucose, chloroplasts, starch.

			through the uterus and vagina, followed by the delivery of the placenta.			
	Excludes • The process of cellular respiration does not need to be covered at this level. **Notes** • Air is composed of approximately 78% nitrogen, 21% oxygen, and other gases (including carbon dioxide). • Blood is carried in blood vessels and is made up of: - plasma - red blood cells - white blood cells - platelets • Link to Our Scientific Knowledge: The Connected World - Health and disease.		**Includes, but not limited to** • Hormones affect many systems and are not exclusive to the reproductive system. • A zygote is the term given to a fertilised egg. • Harmful substances such as alcohol can also cross the placenta. • The testicles (plural: testes) are contained within the scrotum and are considered external reproductive organs. **Excludes** • The endocrine system, and the names of specific hormones associated with the reproductive system, do not need to be covered at this level.		**Includes, but not limited to** • Other organisms, such as algae, can also photosynthesise, whereas fungi cannot photosynthesise. **Notes** • Chloroplasts contain the green pigment chlorophyll that absorbs light. • Link to Our Scientific Knowledge: The Connected World - Food and interdependence; The Living World - Concept of life.	
Fourth Level	**Understand:** Digestion and respiration rely on the circulatory system to transport substances to and from cells, enabling energy release.		**Understand:** Human fertility is affected by biological, environmental and lifestyle factors, which can affect the ability to reproduce.		**Understand:**	
	Know: **Cellular processes** Digestion is the process of breaking food down into small, soluble substances that can be absorbed by the body. In cellular respiration, oxygen and glucose react to produce carbon dioxide and water. The circulatory system transports essential substances, such as oxygen and nutrients, to and from cells so that cellular processes can occur.	**Do:** Identify the importance of the circulatory, respiratory and digestive systems work together to support cellular processes.	**Know:** **Fertility** Fertility is the ability of humans and other animals to produce offspring. In humans and other animals, fertility can be affected by factors such as age, health, lifestyle, environment and genetics. Menopause is the stage when the menstruation cycle stops permanently and pregnancy can no longer occur.	**Do:** Use scientific vocabulary: fertility, menopause.	**Know:**	**Do:**
	Notes • Link to Our Scientific Knowledge: the living world - Concept of life. • The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action Big Idea for details.		**Includes, but not limited to** • Explore the innovations and ethical considerations of fertility treatments. **Notes** • Link to Science in Action: Science around me; Informed and responsible decision making. The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action Big Idea for details.			

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The Chemical World

<table>
<tr><td>Strand</td><td colspan="4">The Chemical World</td></tr>
<tr><td>Sub-strand</td><td colspan="4">Physical changes</td></tr>
<tr><td></td><td colspan="2">States of matter</td><td colspan="2">Mixtures</td></tr>
<tr><td rowspan="8">Early Level</td><td colspan="2">Understand: Water can change forms, explaining changes we observe in the world.</td><td colspan="2">Understand: Substances can be mixed, and doing so often changes their properties.</td></tr>
<tr><td>Know:
Changes of state
Water has different forms.</td><td>Do:
Explore different forms of water.</td><td>Know:
Making mixtures
Materials can be mixed.</td><td>Do:
Mix materials and observe changes.</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Use of the words: ice, steam.

Excludes
• Water vapour (steam) may be discussed by some learners but is not essential knowledge at this level.

Notes
• Link to Our Scientific Knowledge: The Living World - Concept of life; The connected world - Nature.</td><td colspan="2">Includes, but not limited to
• Substances might include sand, soil, cornflour, leaves, water, paint.
• Mixtures can be solid-solid, liquid-liquid or solid-liquid.
• Making play dough, salads or potions are examples of mixing.
• ‘Baking’ such as making rice crispy cakes is considered mixing as no chemical reaction is taking place.

Excludes
• Some learners might use terms like dissolving or solutions, but this is not essential knowledge at this level.
• Baking a cake in the oven - this is a chemical reaction, not an example of mixing (which is a physical change).

Notes
• Some learners may separate materials through play.
• Link to Our Scientific Knowledge: The Connected World – Materials and their properties.</td></tr>
<tr><td>Know:
Changes of state
Water has different forms including liquid and solid (ice).</td><td>Do:
Use scientific vocabulary: water, ice.</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2">Includes, but not limited to
• The focus is on water but the concept of substances changing form could extend to other contexts, for example, foods melting or freezing.
• Use of the words: ice, steam.

Excludes
• Water vapour (steam) may be discussed by some learners but is not essential knowledge at this level.
• Learner use of the word ‘state’ at this level.

Notes
• Link to Science in Action: Taking Scientific Action; Science Around Me.
– how can we stop ice cream melting so quickly? How can we stop drinking water for animals freezing in the winter?</td><td colspan="2"></td></tr>
</table>

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First Level

Understand: Solids and liquids can change forms through the processes of melting and freezing helping to explain how substances behave at different temperatures.

Know:

Changes of state

Liquids can become solids by cooling. This is known as freezing.

Solids can become liquids by heating. This is known as melting.

Temperature is a measure of how hot or cold something is.

Do:

Observe changes in state.

Use scientific vocabulary: melting, freezing, solid, liquid.

Includes, but not limited to

- Melting and freezing of water and other substances, for example, foods.

Excludes

- Learners would not be expected to use the word 'state'.
- The word 'temperature' to describe why changes of state happen.
- The more abstract concept of boiling, evaporation and gases which cannot be seen is covered at Second Level.

Notes

- When puddles dry, it is a misconception that they disappear. Correct understanding: the water is changing to water vapour in the air; it has not disappeared.
- Link to Science in Action: Taking Scientific Action; Science Around Me.
  - how can we stop ice cream melting so quickly? How can we stop water freezing in the winter so animals can still drink it?

Understand: Substances can be separated based on their properties, allowing them to be sorted and used effectively.

Know:

Separating mixtures

Sieving separates solids of different sizes.

Sieving can separate some solids from liquids.

Do:

Separate mixtures using the appropriate equipment.

Use scientific vocabulary: mixture, separate.

Excludes

- Filtering – sieving is sufficient at this level.

Know:

Separating mixtures

Magnetic solids can be separated from non-magnetic solids using magnets.

Do:

Separate mixtures using the appropriate equipment.
Use scientific vocabulary: mixture, separate, magnetic.

Notes

- Link to Science in action: taking scientific action; Science around me.
  - Exploring the use of magnets in everyday life for recycling.
- Link to Our Scientific Knowledge: The Connected World – Materials and their properties; The Physical World - Static electricity and electromagnetism.

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<table>
<tr><td rowspan="3">Second Level</td><td colspan="2">Understand: Matter exists in three main states and can change state when temperature changes, helping to explain how matter behaves under different conditions.</td><td colspan="2">Understand: Some solids dissolve more easily than others, and this property affects how substances interact and how mixtures can be separated.</td></tr>
<tr><td>Know:
Matter
Everything is made of matter.

Matter exists in three main states: solids, liquids, or gases.

Properties of matter
Solids have a fixed shape and volume, which means they keep their shape.

Liquids have a fixed volume but no fixed shape.

Gases have no fixed shape or volume. They spread out to fill any space available.

Changes of state
Matter can change state by heating or cooling. This is a physical change.

When energy is transferred to or from an object, its temperature can increase or decrease.

A liquid can change into a gas by evaporation or boiling. Evaporation can happen at temperatures below the boiling point. Boiling happens when a liquid reaches its boiling point.

Gases can become liquids by cooling. This is known as condensation.

Changes of state are physical changes and are reversible.</td><td>Do:
Observe changes in state and explain what causes them.

Measure changes in temperature.

Compare how different materials behave when they are moved, poured or shaped.

Use scientific vocabulary: matter, state, solid, liquid, gas, boiling, evaporation, condensation, reversible.</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="3">Includes, but not limited to
• Water is the most familiar example of a substance that changes state, but the concept extends to other substances.
• Activities to demonstrate changes of state.
• Measuring temperature changes using a thermometer (Link to Being scientific: scientific investigation)
• The water cycle may be used as a context.

Excludes
• Particle model, specific melting and boiling points, explanations of what happens during boiling.

Notes
• The term ‘water vapour’ is most accurate but ‘steam’ may be used to support understanding.
• Condensation is not the water seen on windows but the process which causes the water to collect.
• Evaporation doesn’t only occur when water is boiling, for example, puddles evaporate even though the temperature of the water is much lower than boiling point.
• The word ‘matter’ has a different scientific meaning to its everyday use.</td><td colspan="2"></td></tr>
</table>

<table>
<tr><td colspan="2">• Link to Our Scientific Knowledge: The Connected World – Materials and their properties.
• Link to Science in Action: Taking Scientific Action; Science Around Me.
– investigate substances that have properties of both solids and liquids. How can boiling help keep things sterile? What helps clothes dry quicker? How is salt made?</td><td colspan="2"></td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:
Making mixtures (solutions)
When a solid dissolves in a liquid, a mixture called a solution forms.

When a solution forms, the solid which dissolves in the liquid is said to be soluble.

A solid which does not dissolve in a liquid is said to be insoluble.

Different factors can affect the time taken for a substance to dissolve.

Separating mixtures
If a solid doesn’t dissolve it can be separated from a liquid by filtering.</td><td>Do:
Classify substances as soluble or insoluble.

Investigate factors that affect the time taken for substances to dissolve.

Separate solids from liquids using filtration.

Use scientific vocabulary: solution, soluble, insoluble, dissolving, filtering.</td></tr>
<tr><td colspan="2"></td><td colspan="2">Includes, but not limited to
• Different substances to test for solubility might include: sand, sugar, salt, flour, baking soda.
• Variables to change when dissolving substances could include: temperature, stirring, mass of substance, size of particles, for example, sugar cubes vs sugar granules.

Excludes
• The following learning does not need to be covered at this level:
- rate at which something dissolves
- separating or observing mixtures of two liquids
• Evaporation as a separation technique is covered at Third Level.

Notes
• ‘Sugar melts in tea’ is a common misconception. When a substance has dissolved it hasn’t disappeared or melted – one substance has spread amongst the other.
• The word ‘solution’ has a different scientific meaning to its everyday use.
• Link to Our Scientific Knowledge: The Connected World – Materials and their properties.
• Link to Science in Action: Taking Scientific Action; Science Around Me.
- Exploring filtration in everyday life, for example, waste management, water purification, swimming pools, fish tanks.</td></tr>
</table>

<table>
<tr><td rowspan="2">Third Level</td><td colspan="2">Understand: Matter is made of tiny particles called atoms, and the way these particles are arranged determines the properties and behaviour of different states of matter, influencing how materials can be used.</td><td colspan="2">Understand: A solution forms when a solute dissolves in a solvent, and differences in solubility help to explain how substances interact and how mixtures can be separated into useful components.</td></tr>
<tr>
<td>Know:
Model of matter
Matter is anything that has mass and takes up space.

All matter is made of particles called atoms, which are the building blocks of all things and are held together by attractive forces.

The particle model explains the different properties of solids, liquids and gases.

Expansion happens because particles move further apart.

Contraction happens because particles move closer together.

Properties of matter
Particles in solids are packed tightly together and can barely vibrate, which is why solids have a fixed shape and volume.

Particles in liquids are close together but can move around, which allows liquids to flow.

Particles in gases are far apart and move very quickly, which is why gases have no fixed volume or shape.

Diffusion is the movement of a substance from an area of high concentration to an area of lower concentration. Diffusion occurs in liquids and gases due to the spaces between particles. This happens when their particles collide randomly and spread out.

Changes of state
Particles gain energy when heated, which overcomes the attractive forces between them. This explains the changes of state that occur during condensation, evaporation, freezing, melting.

Temperature is related to the movement of particles in a substance.

The specific temperature at which a solid becomes a liquid is known as its melting point. For water this occurs at 0°C.</td>
<td>Do:
Use a particle model to illustrate the properties of matter and changes in state and expansion and contraction.

Use scientific vocabulary: particles, atoms, attractive forces, expansion, contraction, vibrate, melting point, boiling point.</td>
<td>Know:
Making mixtures (solutions)
When a solution forms between a solid and a liquid, the solid is referred to as the solute and the liquid is referred to as the solvent.

Concentration is a measure of the quantity of solute dissolved in a given volume of solvent.

The greater the quantity of solute in a solution, the higher the concentration.

Water is a common solvent used to make solutions.

Substances which are insoluble in water may dissolve in other solvents.

A saturated solution is one in which no more solute will dissolve.

Solubility is a measure of a substance’s ability to dissolve. The solubility of most solids increases with temperature.

Separating mixtures
Mixtures can be separated using different techniques based on their solubility.

Insoluble solids can be separated from liquids by filtering.

Soluble solids can be separated from liquids by evaporation.</td>
<td>Do:
Investigate how temperature affects solubility.

Select the appropriate technique to separate mixtures.

Use scientific vocabulary: solute, solvent, solubility, concentration, saturated.</td>
</tr>
</table>

<table>
<tr><td></td><td colspan="2">The specific temperature at which a liquid becomes a gas is known as its boiling point. For water this occurs at 100°C.</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Includes, but not limited to
• Energy transfer and temperature.
• Particle models might include drawing diagrams to show the arrangement of particles on solids, liquids and gases.
• Melting and boiling points of water at normal atmospheric pressure.

Excludes
• Structure of the atom.
• Energy types or terminology related to measurement of energy.
• Specific types of attractive forces/ chemical bonds.
• Sublimation.

Notes
• The difference between evaporation and boiling can be explained in terms of temperature, energy and speed.
• Evaporation can happen at any temperature, requires less energy and happens slowly.
• Boiling happens at a fixed temperature (boiling point), requires more energy and happens fast.
• The word ‘matter’ has a different scientific meaning to its everyday use.
• Use diffusion to reinforce models of matter, that is, the reason it can diffuse in liquids or gases.
• Link to Our Scientific Knowledge: The Connected World – Materials and their properties.
• Link to Science in Action: Taking Scientific Action; Science Around Me.
– innovations in footwear materials to be durable, flexible, properties of liquids help cooling systems in industry, compression of gases for transport and use of fuels.</td><td colspan="2">Includes, but not limited to
• Variables to change when dissolving might include changing the type of solvent, temperature, mass of solute, particle size.
• Use of appropriate scientific apparatus to carry out separating techniques.

Excludes
• Supersaturation does not need to be covered at this level.
• Concentration can be measured in grams per litre (gl^{-1}) but this is not essential knowledge at this level.

Notes
• A mixture is where two or more substances are mixed but not chemically joined.
• The words ‘mixture’, ‘solution’, ‘saturated’ and ‘concentration’ have a different scientific meaning to their everyday use.
• Link to Our Scientific Knowledge: The Chemical World - Acids and bases; The Connected World – Materials and their properties. Nature; Energy and climate change; Food and interdependence.
• Link to Science in Action: Taking Scientific Action; Science Around Me.
– finding the right solvents for medicines and/or vitamin supplements; Ensuring the active ingredients in skincare can be absorbed by skin.</td></tr>
<tr><td rowspan="3">Fourth Level</td><td colspan="2">Understand:</td><td colspan="2">Understand: Mixtures of liquids can be separated by distillation based on differences in their boiling points, allowing useful substances to be collected for specific purposes.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:
Separating mixtures
Different liquids have different boiling points.

This can be used to separate mixtures containing two liquids in a process known as distillation.</td><td>Do:
Relate the properties of solutions to their concentration.

Select the appropriate technique to separate liquids.

Use scientific vocabulary: distillation.</td></tr>
<tr><td colspan="2">Notes
The application of knowledge and skills through everyday contexts is a significant focus at Fourth Level. See Science in Action for details.</td><td colspan="2">Includes, but not limited to
• Properties of solutions might include colour intensity.
• Research into the disposing of chemicals might relate to concentration and its associated hazards.

Notes
• Link to Our Scientific Knowledge: the chemical world - Acids and bases; The connected world – Materials and their properties. Nature; Energy and climate change; Food and interdependence.
• Link to Science in Action: Taking scientific action; Science around me.
- exploring applications of distillation in everyday life
• The application of knowledge and skills through everyday contexts is a significant focus at Fourth Level. See Science in action for details.</td></tr>
</table>

Strand	The Chemical World					
Sub-strand	Chemical changes					
	Chemical reactions		**Rates of reaction**		**Acids and bases**	
Early Level	**Understand:**		**Understand:**		**Understand:**	
	Know:	**Do:**	**Know:**	**Do:**	**Know:**	**Do:**
	Know:	**Do:**	**Know:**	**Do:**	**Know:**	**Do:**
First Level	**Understand:** Some chemicals are useful while others can be harmful, highlighting the importance of handling materials safely.		**Understand:**		**Understand:**	
	Know: **Safe use of chemicals** Some chemicals are dangerous and should be handled with care. These are usually marked with a red diamond warning symbol.	**Do:** Identify common everyday chemicals and observe hazard warnings.	**Know:**	**Do:**	**Know:**	**Do:**
	Notes • Red diamond warning signs appear on safety labels of common household chemicals.					
	Know:	**Do:**	**Know:**	**Do:**	**Know:**	**Do:**
	Know: **Safe use of chemicals** Everything in the world is made of chemicals. Many chemicals are useful and help make things smell, taste, look and work the way they do. Different chemicals have different hazards associated with them.	**Do:** Explore everyday uses of chemicals and associated hazards.	**Know:**	**Do:**	**Know:**	**Do:**

<table>
<tr><td></td><td colspan="2">Includes, but not limited to
• Common everyday chemicals might include bleach, vinegar, medicines, washing powder, nail-polish remover, alcohol gel, e-liquid.

Notes
• Link to Science in Action: Taking scientific action; Science around me.
- chemicals are added to make things smell, for example, perfumes and fragrances, cleaning products
- chemicals are added to make things taste, for example, food flavourings, preservatives
- chemicals are added to make things look good, for example, colours and dyes.
- chemicals are added to make things work, for example, batteries, electronics, soap, detergent.</td><td></td><td colspan="2"></td></tr>
<tr><td rowspan="8">Second Level</td><td colspan="2">Understand: Chemical reactions produce new substances and are often accompanied by observable signs, helping to explain changes in everyday life.</td><td colspan="2">Understand: Chemical reactions can occur at different rates, and the rate of a reaction affects how quickly changes happen in the environment.</td><td colspan="2">Understand:</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
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<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Know:
Signs of a chemical reaction
In a chemical reaction, one or more new substances are formed. Chemical reactions can be difficult to reverse.

Signs that a chemical reaction may have taken place include a change in appearance, gas being produced or a change in temperature.

An example of a chemical reaction is burning. For something to burn, oxygen, fuel and heat are required.

Putting out a fire requires different approaches depending on the type of fire.</td><td>Do:
Observe and identify signs of a chemical reaction.

Identify hazards associated with different substances by their symbols.

Differentiate between physical and chemical changes.

Identify the ways in which different fire extinguishers work to put out fires.

Use scientific vocabulary: new substance, irreversible.</td><td>Know:
Rate of chemical reactions
Chemical reactions can be observed or measured.

Everyday chemical reactions can happen quickly or slowly.

How quickly a chemical reaction takes place is called the rate.

Different factors can affect the rate of a reaction.</td><td>Do:
Measure the time a reaction takes using observable signs.

Identify how different variables can affect the rate of reaction.

Use scientific vocabulary: rate, variables.</td><td>Know:</td><td>Do:</td></tr>
</table>

<table>
<tr><td></td><td colspan="2">Includes, but not limited to
• Chemical reactions might include baking soda and vinegar, cooking, striking a match, burning or rusting.
• Common hazard symbols include flammable, irritant, corrosive and harmful to environment.

Excludes
• Use of fire extinguishers – the content refers to knowing which fire extinguishers can be used safely with which type of fires and is likely to involve a matching activity.

Notes
• An example of a physical change would be melting or freezing, while a chemical change results in a new substance, for example, baking a cake.
• Bubbles when water is boiling is a physical change, not a sign of a gas forming (which is a chemical change).
• Only iron can rust - no other metals form rust. It is known as corrosion in other metals.
• Link to Our Scientific Knowledge: The Living World - Systems for survival.
• Link to Science in Action: Taking Scientific Action; Science Around Me.
- which batteries last the longest?
- what are the best fuels to use in the home?
- how can chemical reactions be used to power rockets?</td><td colspan="2">Includes, but not limited to
• Variables affecting reaction rate include temperature, particle size and concentration of reactants – these could be investigated practically.

Excludes
• While the variables above can be explored, there is no expectation for learners to know these, or why they affect reaction rate.

Notes
• Rate of reaction is: the speed at which what you start with (reactants) are converted into what you end up with (products) in a chemical reaction.
• An example of a fast reaction would be an explosion. An example of a slow reaction would be rusting.
• Link to Science in Action: Taking Scientific Action; Science Around Me.
- how can rust be prevented outdoors?
- how can you make your dinner more quickly?</td><td colspan="2"></td></tr>
<tr><td>Third Level</td><td colspan="2">Understand: In a chemical reaction, reactants are transformed into products (which have different properties from the reactants), enabling the creation of new substances that can be useful for specific purposes.</td><td colspan="2">Understand: The rate of a chemical reaction can be controlled, allowing reactions to be carried out safely and efficiently.</td><td colspan="2">Understand: pH measures how acidic or alkaline a substance is, and understanding pH helps identify substances, predict their behaviour, determine their uses and ensure they are handled safely.</td></tr>
<tr><td></td><td>Know:
Signs of a chemical reaction
Evidence that new substances have been formed include formation of a solid, an energy change, the production of a gas, or a colour change.

The new substances formed can be elements or compounds.

Reactants and products
Reactants are the substances present at the start of a chemical reaction.
Products are the new substances formed during the reaction.</td><td>Do:
Observe and identify the signs of a range of different types of chemical reactions.

Construct word equations for reactions.

Use scientific vocabulary: element, compound, reactants, products, word equation.</td><td>Know:
Controlling the rate of reaction
The rate of a chemical reaction can be controlled by changing the temperature, concentration, surface area of reactants, or by adding a catalyst.

A catalyst is a substance that speeds up a chemical reaction without being used up.

Factors that increase the rate of reaction:
- increasing temperature
- increasing concentration
- increasing surface area (making particles smaller)
- adding a catalyst</td><td>Do:
Compare how different variables affect reaction rates.

Relate how reactions are controlled in everyday life to changes in variables.

Use scientific vocabulary: temperature, concentration, surface area, catalyst.</td><td>Know:
pH scale
An indicator can be used to tell if something is an acid, alkali or neutral.

The colour of the indicator shows whether something is an acid, alkali or neutral.

Some acids and alkalis have specific hazards associated with them shown by symbols.

The pH scale can be used to measure how acidic or alkaline a substance is.</td><td>Do:
Identify hazards associated with different substances by the symbols and take necessary precautions to mitigate these risks.

Determine the pH value of a range of substances.

Identify where neutralisation reactions are helpful in everyday life.

Use scientific vocabulary: acid, alkali, neutral, pH, neutralisation, dilution.</td></tr>
</table>

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	The change from reactants to products during a chemical reaction can be written as a word equation.				An indicator can be used to estimate the pH of an acid or alkali. Substances with a pH less than 7 are acidic, and the lower the value, the more acidic. Substances with a pH greater than 7 are alkaline, and the higher the value, the more alkaline. Substances with a pH of 7 are neutral. Neutralisation is where an acid and an alkali react to form a substance that moves towards pH7. Adding water to an acid or alkali results in the pH moving closer to 7. This is known as dilution.	
	Includes, but not limited to • Chemical reactions may include precipitation (solid forming), combustion, neutralisation. • Construct word equations involving two elements combining to form a compound e.g. iron + sulfur à iron sulfide. **Excludes** • Explanations of the different types of chemical reactions and why they occur. • Structure of the atom, chemical bonding. **Notes** • The words ‘element’ and ‘compound’ are defined in the Elements and compounds sub-strand. The use of them here is related to applying them to the context of a chemical reaction. • The words ‘products’ and ‘compound’ have a different scientific meaning to their everyday use. • Atoms are not destroyed or created during a chemical reaction – they simply rearrange themselves. • Link to Our Scientific Knowledge: The Connected World - Materials and their properties. Nature; Energy sources and security; Energy and climate change. • Link to Our Scientific Knowledge: The Chemical World - Acids and bases. • Link to Science in Action: Taking Scientific Action. - how can chemical reactions help keep water safe and clean to drink? How can chemical reactions help remove pollutants from waterways or the ground?		**Excludes** • Equilibrium, pressure is not essential knowledge at this level. **Notes** • Controlling reactions in everyday life might include: - chopping potatoes smaller to help them cook faster - keeping milk in the fridge to slow down spoiling - using yeast to make bread • The word ‘concentration’ has a different scientific meaning to its everyday use. • Comparing how different variables affect reaction rates should involve practical investigation. • Link to Our Scientific Knowledge: The Connected World - Energy sources and security. - hydrogen reaction with oxygen is explosive, hydrogen for use as a fuel has associated dangers • Link to Science in Action: Taking Scientific Action; Science Around Me. • Exploring how and why reactions are controlled in industrial processes.		**Includes, but not limited to** • Both everyday acids and alkalis as well as laboratory acids and alkalis. • Everyday examples of neutralisation: fizzy drinks are acidic; toothpaste is alkali to prevent tooth decay; indigestion tablets are alkali to remedy excess acid produced in stomach etc. • Hazards associated with acids and alkalis – corrosive, irritant, harmful to the environment. • Ways to mitigate the hazards include wearing eye protection, gloves; washing with plenty of water if in contact with skin. **Notes** • The word ‘neutral’ has a different scientific meaning to its everyday use. • Link to Our Scientific Knowledge: The Connected World – Materials and their properties. Nature; Energy sources and security; Energy and climate change. • Link to Science in Action: Taking Scientific Action; Science Around Me. - what are the best ways to get rid of indigestion? - how can we stop acid rain? - what’s the best way to help people if they get a bee or a wasp sting?	

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<table>
<tr><td rowspan="3">Fourth Level</td><td colspan="2">Understand: Chemical reactions involve energy transfers, and understanding these energy changes helps explain how reactions occur, and how the energy released or absorbed can be used for specific purposes.</td><td colspan="2">Understand:</td><td colspan="2">Understand: Acids and bases react in a neutralisation reaction to form new substances, and the products of these reactions have many useful applications in industry and everyday life.</td></tr>
<tr><td>Know:
Signs of a chemical reaction
Chemical reactions involve energy changes.

In an exothermic reaction, energy is released (transferred) to the surroundings.

In an endothermic reaction, energy is absorbed (transferred) from the surroundings.</td><td>Do:
Classify reactions as exothermic or endothermic based on evidence of energy transfer.

Use scientific vocabulary: exothermic, endothermic.</td><td>Know:</td><td>Do:</td><td>Know:
Bases
A base is a substance which neutralises an acid.

Bases include metal oxides, metal hydroxides and metal carbonates.

Soluble metal oxides produce alkaline solutions.

Soluble non-metal oxides produce acidic solutions.

Neutralisation reactions
Acids and bases react to form water and a salt in neutralisation reactions.

When a metal carbonate is the base, carbon dioxide is also produced.

The name of the salt is determined by the acid and base used.

The salts produced in neutralisation reactions have a wide range of uses.</td><td>Do:
Carry out neutralisation reactions and identify the products.

Construct word equations for neutralisation reactions.

Exemplify the uses of salts in industry and everyday life.

Use scientific vocabulary: base, metal oxide, metal hydroxide, metal carbonate, non-metal oxide, salt.</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Observable energy changes: temperature, sound, light.

Excludes
• Enthalpy change, calculating energy changes, making and breaking bonds.

Notes
• Endothermic reactions can feel cool because energy is transferred from the surroundings to the reacting substances.
• Energy is not ‘lost’ to the surroundings, it is transferred.
• Link to Our Scientific Knowledge: The Connected World – Materials and their properties. Nature; Energy sources and security; Energy and climate change.
• Link to Science in Action: Taking Scientific Action; Science Around Me.
- how can endothermic reactions be used in injury recovery?
- how can exothermic reactions be used to keep our homes warm?</td><td colspan="2"></td><td colspan="2">Includes, but not limited to
• Naming salts - chloride, nitrate, sulfate salts.
• Uses of salts may include everyday applications such as in foods, household products, industry and medicines.

Excludes
• Salts of carboxylic acids.

Notes
• Link to Science in Action: Taking Scientific Action; Science Around Me.
- uses of salts in everyday applications such as in foods, household products, industry and medicines.
• The application of knowledge and skills through everyday contexts is a significant focus at Fourth Level. See Science in Action for details.</td></tr>
</table>

	• The application of knowledge and skills through everyday contexts is a significant focus at Fourth Level. See Science in action details.		

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Strand	The Chemical World			
Sub-strand	Elements and compounds			
	Elements and the periodic table		Compounds	
Early Level	Understand:		Understand:	
	Know:	Do:	Know:	Do:
	Know:	Do:	Know:	Do:
First Level	Understand:		Understand:	
	Know:	Do:	Know:	Do:
	Know:	Do:	Know:	Do:
	Know:	Do:	Know:	Do:
Second Level	Understand:		Understand:	
	Know:	Do:	Know:	Do:
	Know:	Do:	Know:	Do:
	Know:	Do:	Know:	Do:

<table>
<tr><td rowspan="3">Third Level</td><td colspan="2">Understand: The periodic table organises all known elements in a logical way, and the patterns it contains help understand the properties and relationships of the building blocks that make up the world.</td><td colspan="2">Understand: Elements combine chemically to form compounds, creating the vast range of substances in the Universe, and the names of compounds help identify their composition and properties.</td></tr>
<tr><td>Know:
Elements
Elements are substances made of only one type of atom.

Elements are represented by symbols and have a number associated with them called the atomic number.

Symbols are written as capital and lower case.

The periodic table
Elements are arranged in the periodic table based on their properties.

The periodic table is organised into vertical columns called groups and horizontal rows called periods.

Elements in the same group have similar chemical properties (reactivity).

The periodic table can be used to predict how elements will react.

Group 1 elements are known as the alkali metals, and these are very reactive.

Group 7 elements are known as the halogens, and these are very reactive non-metals.

Group 0 elements are known as the noble gases, and these are very unreactive.</td><td>Do:
Use the atomic number and symbol to identify elements on the periodic table.

Relate the properties of elements to their position on the periodic table, their reactivity and use.

Use scientific vocabulary: element, atomic number, periodic table, alkali metals, halogens, noble gases.</td><td>Know:
Compounds
Compounds are substances made up of two or more types of atoms.

The properties of the compound are different to the properties of the constituent elements.

Naming compounds
Compounds containing two elements can be named from the constituent elements using the suffix of -ide.

Compounds containing three or more elements can be named from the constituent elements using the suffixes -ate, -ite.</td><td>Do:
Compare the properties of a compound to those of its constituent elements.

Relate the name of a compound to the elements it contains.

Use scientific vocabulary: compounds.</td></tr>
<tr><td colspan="2">Notes
• Link to Our Scientific Knowledge: The Connected World – Materials and their properties.
• The word ‘element’ has a different scientific meaning to its everyday use.</td><td colspan="2">Includes, but not limited to
Compounds with properties different to constituent elements might include water (liquid as a compound, gases as elements) and iron sulfide (iron is magnetic as an element, not magnetic when part of compound).
Relating the name of a compound might include naming the elements found in a compound or might involve constructing the name of two-element or three-element compounds.

Notes
• The word ‘compound’ has a different scientific meaning to its everyday use.
• Link to Our Scientific Knowledge: The Connected World – Materials and their properties.</td></tr>
</table>

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<table>
<tr><td rowspan="3">Fourth Level</td><td colspan="2">Understand: Atoms are made of subatomic particles which helps explain how atoms interact.</td><td colspan="2">Understand: Scientists use chemical formulae to communicate information about substances, helping to describe, identify and understand how the wide variety of substances in the Universe are made.</td></tr>
<tr><td>Know:
Structure of atoms
Atoms are made up of subatomic particles called protons, neutrons and electrons.

The protons and neutrons are found in the nucleus of the atom.

The electrons are arranged in shells which orbit the nucleus.

The electronic configuration or structure of an atom is how the electrons are arranged in shells.

Electronic structure can be shown as a list of numbers or as a diagram. The first shell holds up to two electrons; the second shell holds up to eight electrons. The third shell can hold up to 18 electrons but at this stage, only a subshell within it is considered, which contains up to eight electrons.

Properties of sub-atomic particles
Protons and neutrons have a mass of 1 atomic mass unit (amu), while electrons have a mass of almost zero.
Protons have a charge of 1+, electrons have a charge of 1- and neutrons have no charge (neutral).

Atomic number and mass number
The atomic number of an element is equal to the number of protons in its atoms.

Atoms are neutral as the number of positive protons is equal to the number of negative electrons.

The mass number of an atom is equal to the sum of the protons and neutrons.</td><td>Do:
Use a model to illustrate atomic structure.

Calculate the number of sub-atomic particles.
Use scientific vocabulary: sub-atomic, protons, neutrons, electrons, charge, mass, atomic number, mass number.</td><td>Know:
Compounds
A molecule is a group of non-metal atoms bonded together.

The chemical formula of a molecule uses the symbols to show the constituent elements, with the numbers indicating how many atoms of each element are present.</td><td>Do:
Identify the elements present and number of atoms of each from a chemical formula.

Use scientific vocabulary: molecule, formula.</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Use diagrams to represent the atomic structure of the first 20 elements in the periodic table.
• Calculating the number of protons, neutrons and electrons from the mass number and atomic number of an element.

Notes
• The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action for details.</td><td colspan="2">Includes, but not limited to
• Stating the number of atoms of each element present in a molecule given its formula.

Excludes
• Writing formula, valency rules.
• Formula for substances where the numbers indicate a ratio.

Notes
The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action for details.</td></tr>
</table>

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The Physical World

Strand	**The Physical World**			
Sub-strand	**Electricity**			
	Electrical circuits		**Static electricity and electromagnetism**	
Early Level	**Understand:**		**Understand:**	
	Know:	**Do:**	**Know:**	**Do:**
	Know:	**Do:**	**Know:**	**Do:**
First Level	**Understand:**		**Understand:**	
	Know:	**Do:**	**Know:**	**Do:**
	Know:	**Do:**	**Know:**	**Do:**
	Know:	**Do:**	**Know:**	**Do:**
Second Level	**Understand:**		**Understand:**	
	Know:	**Do:**	**Know:**	**Do:**
	Know:	**Do:**	**Know:**	**Do:**

<table>
<tr><td></td><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="3">Third Level</td><td colspan="2">Understand: Electrical circuits are systems in which components work together, allowing charge to flow when the circuit pathway is complete.</td><td colspan="2">Understand: Electric charge can create interactions at a distance, and moving charge can create magnetic effects that can be used in everyday technologies.</td></tr>
<tr><td>Know:
Circuits
A circuit is a complete loop.

Charge only flows when the loop is closed with no gaps.

Electric current is the movement of electric charge through a complete circuit.

Conductors allow electric charge to flow; insulators reduce or prevent the flow of electric charge.

A battery or power supply provides the voltage that causes charge to flow. In a series circuit, all parts are connected in one loop. Adding or removing components changes how the electrical system behaves.

Mains electricity can be dangerous due to:
- high voltage which can cause electrocution
- high current flow which can cause fire

Electrical circuits are drawn clearly as circuit diagrams where components are represented by symbols.</td><td>Do:
Build simple series circuits from given circuit diagrams.

Relate the addition or removal of components to changes in circuit behaviour.

Test materials to find out whether they allow current to pass.

Draw circuit diagrams using symbols.

Use scientific vocabulary: current, charge, voltage, circuit, conductor, insulator.</td><td>Know:
Charge transfer and interactions
Electric charge can move from one material to another when materials are rubbed or come into contact.

Static electricity involves a transfer of charge between materials.

Like charges repel and unlike charges attract.

Electromagnetism
A coil of wire with current flowing through it can act as an electromagnet.

Motors, generators and transformers use electromagnetism to transfer and convert energy.

Electromagnets can attract and move objects when current flows through the coil.</td><td>Do:
Relate changes in current and number of turns on a coil to the strength of electromagnets.

Identify ways in which electromagnets are used in everyday technologies.

Use scientific vocabulary: charge, static electricity, attract, repel.</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Measurement of current and voltage.
• Components for series circuits could include:
- cells, switches, lamps or LEDs
- ammeter (could be multimeter set to measure current)
- voltmeter to measure voltage

Other components may include:
- motor
- buzzer
- low or high power rating variable resistor or resistance wire

Notes
• Insulating electrical materials reduces the risk of electrocution and fires.
• The words ‘circuit’, ‘current’, ‘conductor’ and ‘cells’ have a different scientific meaning to their everyday use.
• Link to Our Scientific Knowledge: The Connected World - Energy sources and security.</td><td colspan="2">Includes, but not limited to
• Everyday use of electromagnets includes cranes, switches and bells.

Notes
• Electric charge can move between materials and create interactions at a distance.
• Learners may think charged objects need to touch to interact. Reinforce that electrostatic forces can act at a distance.
• The word ‘charge’ has a different scientific meaning to its everyday use.
• Link to Our Scientific Knowledge: The Connected World - Energy sources and security.</td></tr>
</table>

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<table>
<tr><td rowspan="3">Fourth Level</td><td colspan="2">Understand: The behaviour of electrical circuits depends on the relationship between potential difference, current and resistance, allowing circuits to be designed and controlled for different purposes.</td><td colspan="2">Understand:</td></tr>
<tr><td>Know:
Circuits
Circuits can be set up in series or in parallel, and these arrangements behave in different ways when components are removed.

Some components and materials make it harder for electric current to flow through a circuit. This is known as resistance.

Total resistance in a series circuit is the sum of resistances.

Use of the relationship between voltage, current and resistance:
$R = \frac{V}{I}$
where R is resistance in ohms (Ω)
V is voltage in volts (V)
I is current in amperes (A)

Fuses are used to primarily protect the flex of the electrical device from current overload.</td><td>Do:
Measure current and voltage in series and parallel circuits.

Use diagrams and data to explain and predict circuit behaviour.

Use scientific vocabulary: current, voltage, resistance.</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2">Includes, but not limited to
• Measurements of voltage and current in series and in parallel or across different components.
• Learners will be expected to re-arrange $R = \frac{V}{I}$ equation.
• Mention reference to earth wire.

Notes
• The words ‘circuit’, ‘current’, ‘conductor’ and ‘cells’ have a different scientific meaning to their everyday use.
• Link to Our Scientific Knowledge: The Connected World - Energy sources and security.
• The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action for details.</td><td colspan="2"></td></tr>
</table>

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<table>
<tr><td>Strand</td><td colspan="4">The Physical World</td></tr>
<tr><td>Sub-strand</td><td colspan="4">Forces</td></tr>
<tr><td></td><td colspan="2">Motion</td><td colspan="2">Forces and interactions</td></tr>
<tr><td rowspan="6">Early Level</td><td colspan="2">Understand: Things move in different ways, allowing movement to be observed, described and compared.</td><td colspan="2">Understand: Pushes and pulls can change what things do, helping us make sense of changes we see around us.</td></tr>
<tr><td>Know:
Observing motion
Things move when they go from one place to another.

Things can move in different ways.

Things can move fast or slow.</td><td>Do:
Explore how things move (e.g. rolling, sliding, bouncing).

Communicate about how things move.

Use scientific vocabulary: fast, slow.</td><td>Know:
Exploring push and pulls
A push can make something move away.

A pull can make something move closer.

Pushing, pulling, twisting, squashing and stretching can change the shape of things.
Magnetism
Magnets can pull some things closer.

Magnets can push some magnets away.</td><td>Do:
Relate pushes and pulls to their effect on objects.

Explore and sort materials attracted by magnets.

Use scientific vocabulary: push, pull, twist, squash, stretch, magnets, attract.</td></tr>
<tr><td colspan="2">Notes
• Focus on observing and describing movement such as rolling, sliding and bouncing.</td><td colspan="2">Excludes
• Use everyday language at this level rather than introducing more formal explanations of forces.
Notes
• Focus on observable changes caused by pushes and pulls.</td></tr>
<tr><td colspan="2">Understand:</td><td colspan="2">Understand:</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="3">First Level</td><td colspan="2">Understand: Changes in how objects move allow similarities and differences in their movement to be recognised and compared.</td><td colspan="2">Understand: Forces affect how objects move and change shape, making many everyday activities possible.</td></tr>
<tr><td>Know:
Comparing motion
Objects can move in straight lines or curved paths.

Objects can change direction when they move.

Objects can move faster or slower than other objects.</td><td>Do:
Compare the movement of different objects.

Use scientific vocabulary: fast, slow, straight lines, curved paths.</td><td>Know:
Effects of forces
A force is a push or pull between objects.

Forces can make objects move faster, slower, stop or change direction.

Pushes and pulls can change the shape of some objects, causing them to stretch or squash.
Magnetism
Magnets can attract and repel.</td><td>Do:
Identify push and pull forces.

Relate forces to their impact on the shape, direction and speed of objects.

Identify ways in which magnets interact and affect objects.

Use scientific vocabulary: force, lighter, heavier, attract, repel.</td></tr>
</table>

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<table>
<tr><td></td><td colspan="2">Includes, but not limited to
• Comparing movement using words such as faster, slower, straight and curved.
• Measurement of distance.
• Measurement of time.

Excludes
• Scientific units of measurement for speed do not need to be covered at this level.

Notes
• Focus on describing and comparing movement rather than measuring speed.</td><td colspan="2">Includes, but not limited to
• Pushes and pulls as interactions between objects.

Excludes
• Measuring forces or introducing units is not required at this level.

Notes
• Emphasise that forces are interactions between objects.
• Magnets can attract or repel depending on how they are positioned.
• Learners may think magnets always attract. Reinforce that magnets can also repel.
• The word ‘force’ has a different scientific meaning to its everyday use.</td></tr>
<tr><td></td><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td></td><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="3">Second Level</td><td colspan="2">Understand: The motion of an object can be described in terms of distance covered in a time, which allows movement to be measured.</td><td colspan="2">Understand: Forces act between objects through contact or at a distance, allowing for a variety of practical uses in everyday life.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td>Describing motion
Distance describes how far something has moved and can be measured in metres.

Time is the duration of movement and can be measured in seconds.

Both distance and time are needed to describe motion.</td><td>Relate the changing of distance or time to effects on motion.

Compare motion using measurements of distance and time.

Use scientific vocabulary: distance, time, motion.</td><td>Forces
Forces act between objects and can be contact forces or non-contact forces.

Contact forces happen when objects touch each other.

Non-contact forces act between objects without touching. Examples of non-contact forces include magnetic forces and gravitational forces.

Changes in motion
Forces can change the speed, direction or shape of objects.

Some objects are heavier or lighter than others.

Heavier objects may need more force to make them start moving.

Friction and air resistance
Friction is a contact force that occurs when surfaces are in contact with each other.

Friction opposes the relative motion of objects in contact with each other.</td><td>Relate how objects move on different surfaces to the effects of friction.

Identify practical examples of friction being used, or reduced, in everyday life.

Relate magnetic interactions to poles, distance and forces.

Use scientific vocabulary: speed, friction, air resistance.</td></tr>
</table>

<table>
<tr><td></td><td></td><td></td><td>Different surfaces create different amounts of friction.

Rough surfaces usually produce more friction than smooth surfaces.

Air resistance opposes the motion of an object as it moves in relation to the air.

Changes in shape of materials
Changes in shape are temporary or permanent.

Applications
Friction can be useful, for example, vehicle braking.

Wheels can help reduce friction making it easier to move objects.

Friction can be reduced with lubrication.

Magnetism
Magnets have poles. Like poles repel and unlike poles attract. (North-North or South-South poles repel. Unlike poles attract, for example, South-North.)

Magnetic forces can act at a distance.

Magnetic forces are stronger closer to the magnet.</td><td></td></tr>
<tr><td></td><td colspan="2">Includes, but not limited to
• Measurements of distance and time using metres and seconds.

Excludes
• The following points do not need to be covered at this level:
- formal speed calculations
- state units for speed

Notes
• Use practical measurements of motion in familiar contexts.
• Learners may think speed depends only on distance. Compare journeys to show that time also matters.</td><td colspan="2">Includes, but not limited to
• Static electricity is an example of a non-contact force.

Excludes
• Explaining motion using balanced and unbalanced forces is not required at this level.

Notes
• Learners may think forces only happen when objects touch. This comes from everyday experiences of pushing and pulling.
• Learners may think magnetic forces only happen when objects touch. Reinforce that magnetic forces act at a distance.
• The words ‘force’ and ‘pole’ have a different scientific meaning to their everyday use.</td></tr>
<tr><td></td><td>Know:</td><td>Do:</td><td>Know:</td><td></td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td></td><td>Know:</td><td>Do:</td><td>Know:</td><td></td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td></tr>
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<table>
<tr><td rowspan="3">Third Level</td><td colspan="2">Understand: Speed is a measure of how fast an object travels and can be determined using distance and time, helping us compare and predict motion.</td><td colspan="2">Understand: Forces can be measured and represented, allowing us to explain the motion of objects and the interaction of forces.</td></tr>
<tr>
<td>Know:
Calculating motion
Speed describes how distance changes over time.

Speed can be calculated by dividing the distance travelled by the time taken,
$v = \frac{d}{t}$
where v is speed in metres per second (m s^{-1})
d is distance in metres (m)
t is time in seconds (s)</td>
<td>Do:
Calculate speed from measurements of distance and time in everyday contexts.

Use scientific vocabulary: speed, metres per second.</td>
<td>Know:
Forces
When two objects interact, each object experiences a force from the other (a Newton pair).

Forces can act in different directions on an object.

More than one force can act on an object at the same time.

Balanced and unbalanced forces
Balanced forces occur when forces acting on an object are equal and opposite, resulting in no change in motion.

Unbalanced forces occur when the combined forces acting on an object are not equal and opposite, causing motion to change.

Representing and measuring forces
Forces can be represented using force arrows.

The direction of an arrow shows the direction of a force. Forces are measured in newtons (N).

A Newton balance can be used to measure the size of a force.

Mass and weight
Mass is a measure of how much matter an object contains and is measured in kilograms (kg).

The mass of an object does not change when it is moved to different locations.

Weight is the force on an object caused by a gravitational field.

Air resistance and forces in liquids
Air resistance and water resistance are forms of friction.

The shape of an object affects air resistance, and more streamlined shapes reduce air resistance.</td>
<td>Do:
Represent forces acting on moving or stationary objects using diagrams with arrows.

Measure forces using a newton balance.

Relate air resistance to its effect on moving objects.

Use scientific vocabulary: mass, weight, gravitational field strength, balanced and unbalanced forces.</td>
</tr>
<tr>
<td colspan="2">Includes, but not limited to
• Speed calculations using familiar contexts.

Excludes
• Re-arranging of equation for speed, distance and time is not required at this stage.
• Acceleration does not need to be introduced at this level.

Notes</td>
<td colspan="2">Excludes
• The introduction of Newton’s Laws is not required at this level.

Notes
• Learners may think only one object ‘has’ the force. This comes from focusing on one object in isolation. Reinforce that forces always occur as interactions between two objects.
• Learners may misinterpret force arrows as showing movement rather than force. Clarify that arrows represent direction and size of force only.</td>
</tr>
</table>

<table>
<tr><td></td><td colspan="2">• Link calculations to everyday examples of motion.
• Where learners calculate distance or time, the rearranged relationship should be provided.</td><td colspan="2">• Learners may think balanced forces mean no forces are acting. Focus on how forces affect speed, direction and stability.
• The words ‘force’ and ‘weight’ have a different scientific meaning to their everyday use.</td></tr>
<tr><td rowspan="2">Fourth Level</td><td colspan="2">Understand: Acceleration is the rate of change of speed, and can be represented on a speed-time graph to analyse and interpret other aspects of motion.</td><td colspan="2">Understand: Motion due to interacting forces is governed by physical laws, which allow us to model and predict motion.</td></tr>
<tr>
<td>Know:
Representing motion
The relationship between speed, distance and time can be rearranged to calculate any one of these quantities when the other two are known.

Speed–time graphs can be used to show how the speed of an object changes over time.

The slope (gradient) of a speed–time graph represents acceleration.

Acceleration describes the rate of change of speed.

When the speed of an object decreases it has a negative acceleration.
Acceleration can be calculated using:
$a = \frac{\Delta v}{t}$
where:
a is the acceleration in m s^{-2}
Dv is the change in speed in m s^{-1}
t is the time in s
t is the time in s</td>
<td>Do:
Use and rearrange the relationship between speed, distance and time to calculate speed, distance or time in a range of contexts.

Create and interpret speed–time graphs to explain motion and changes in speed (acceleration).

Calculate acceleration given appropriate data.

Use scientific vocabulary: speed, acceleration, metres per second per second.</td>
<td>Know:
Mass and weight
Gravitational field strength describes the force acting on each kilogram of mass in a gravitational field. measured in newtons per kilogram (N kg^{-1}).

The weight of an object will change when it is moved to different locations with different gravitational field strengths.

Weight can be calculated using the equation
$g = \frac{W}{m}$
where:
g is the gravitational field strength in newtons per kilogram (N kg^{-1})
W is the weight in newtons (N)
m is the mass in kilograms (kg)
Laws of motion
Newton’s three laws of motion and how they affect motion of objects are:
- First law. A body remains at rest, or in motion at a constant speed in a straight line, unless it is acted upon by an unbalanced force.
- Second law. Summarised as the relationship for unbalanced force.
$F = ma$
F is the unbalanced force in newtons (N)
m is the mass in kilograms (kg)
a is the acceleration in metres per second per second (m s^{-2}).

Third law. If two objects exert forces on each other, these forces are equal in size but opposite in direction.

Multiple forces or systems
The motion of an object depends on how different forces act together on it.</td>
<td>Do:
Calculate the weight of objects in different gravitational fields.

Use models and diagrams to explain how forces combine in systems.

Analyse forces acting within systems using diagrams, models and calculations (addition and subtraction).

Calculation of acceleration using Newton’s second law relationship.</td>
</tr>
</table>

			Multiple forces can act on an object at the same time resulting in an unbalanced force or balanced forces. **Energy and motion** Energy is transferred when motion changes. Energy can be dissipated as heat owing to friction.	
	Excludes • Formal equations of motion do not need to be covered at this level beyond acceleration calculations from graphs. **Notes** • Learners will be expected to re-arrange equations at Fourth Level. • The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action for details.		**Excludes** • The introduction of terminal velocity is not required at this level. **Notes** • Learners may think mass and weight are the same. This comes from everyday language where the terms are used interchangeably. Emphasise that mass stays the same, but weight depends on the gravitational field. • Learners may think forces act independently rather than as part of a system. Reinforce that forces interact within systems. • Learners will be expected to re-arrange equations at Fourth Level. • The words 'force' and 'weight' have a different scientific meaning to their everyday use. • The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action for details.	

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<table>
<tr><td>Strand</td><td colspan="3">The Physical World</td></tr>
<tr><td>Sub-strand</td><td colspan="3">Waves</td></tr>
<tr><td></td><td colspan="2">Sound</td><td>Light</td></tr>
<tr><td rowspan="6">Early Level</td><td colspan="2">Understand: Sounds can be made in different ways and allow people to identify and respond to things around them.</td><td>Understand: Light helps people and animals to see the world, helping them to live, move and stay safe.</td></tr>
<tr><td>Know:
Sound around us
Sound is something we can hear and feel.

Sounds can be made in different ways.

Sounds can be loud or quiet.</td><td>Do:
Identify and respond to different sounds in the environment.

Explore ways sounds can be made using voices, bodies and objects.

Identify which sounds can help keep people safe and which disturb people and animals.

Use scientific vocabulary: loud, quiet, high or low.</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2">Excludes
• Words like ‘high’ or ‘low’ might be used but learners are not expected to know them.
• Detailed explanations of how sound is made e.g. through vibrations, are not required at this stage.</td><td colspan="2"></td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:
Seeing with light
Light helps people and animals see things around them.

Light allows people and animals to see things when it shines on them.

Shadows form an area of darkness when light is blocked by some objects.

Light in the world
Light helps people and animals live, move and stay safe.</td><td>Do:
Notice light and dark.

Identify ways light helps people in everyday life.

Notice how shadows appear when light is blocked by some objects.

Use scientific vocabulary: light and shadows.</td></tr>
<tr><td colspan="2"></td><td colspan="2">Notes
• Light allows people to see things when it shines on them. This can be explored with torches in a dark space (inside or outdoors).</td></tr>
</table>

<table>
<tr><td rowspan="8">First Level</td><td colspan="2">Understand: Sounds are produced by vibrations, meaning they can change as they travel further from the source and as they travel through different materials.</td><td colspan="2">Understand: Light comes from different sources and travels from the source to the viewer, allowing people and animals to see objects.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Know:
How sound is made and travels
Sounds are produced when objects vibrate, for example, musical instruments and vocal chords.

Sound travels from a source (where it starts) through materials such as air and water.

A sound becomes quieter as the distance from the source increases.

Describing sounds
Sounds can be described as loud or quiet (volume).

Sounds can also be described as high or low (pitch).

Sound in everyday life
Some sounds are used as warnings to help keep people safe.</td><td>Do:
Identify ways in which vibrations produce sound.

Compare sounds produced by different materials or objects.
Relate how sound changes with distance from the source and as it travels through different materials.

Recognise natural and human-made sounds in everyday environments.

Use scientific vocabulary: volume, pitch and vibrations.</td><td>Know:
Light sources and seeing
Light is produced by a source.

A light source can be natural (e.g. Sun) or artificial (e.g. torch).

Darkness is the absence of light.</td><td>Do:
Identify different light sources.

Use scientific vocabulary: light as source.</td></tr>
<tr><td colspan="2">Notes
• Vibrations can be observed when objects produce sound.
• Pitch refers to how high or low a sound is. Volume refers to how loud or quiet a sound is.
• Learners may think all movement produces sound. Reinforce that sound is produced when objects vibrate.
• Some people cannot hear sounds but may still experience sounds through vibrations.</td><td colspan="2">Notes
• A light source is something that produces its own light, for example the Sun, a lamp or a torch.
• The word ‘light’ has a different scientific meaning to its everyday use, for example, light blue. It also has a different meaning when used to describe weight, for example, heavy or light.</td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="2">Second Level</td><td colspan="2">Understand: Sound travels through materials differently, resulting in them being absorbed, reflected or changed by different surfaces and environments.</td><td colspan="2">Understand: Light travels in straight lines and can be reflected, absorbed or transmitted when it meets materials.</td></tr>
<tr><td>Know:
How sound is made and moves
Sound travels from a source through solids, liquids and gases.

Sound spreads out from a source in all directions.</td><td>Do:
Compare sounds with different pitch and loudness.

Identify ways that sound can affect people, animals and environments.
Use scientific vocabulary: reflects, echoes, noise pollution.</td><td>Know:
How light behaves
Light travels in straight lines from a source.

Shadows form when light is blocked by objects that absorb the light.</td><td>Do:
Investigate how shadows are made when light is blocked.

Investigate and compare how moving the light source or object changes the shadow.

Identify everyday uses and applications of light.</td></tr>
</table>

<table>
<tr><td rowspan="10"></td><td>Sound can reflect from surfaces to produce echoes.

Vibrations transfer sound through materials.

Sound in everyday life
Sound is heard by humans when sound waves make the ear drum vibrate.

Sounds can affect people and animals, for example, by helping communication or causing disturbance and stress when they are too loud.

Very loud or background sounds (noise pollution) can have negative effects, such as disturbing sleep, causing hearing loss, or causing stress in animals.</td><td></td><td></td><td>Use scientific vocabulary: light, shadow.</td></tr>
<tr><td colspan="2">Notes
• Sound requires a material to travel through. Reflection of sound can produce echoes.
• Learners may think, mistakenly, that sound travels instantly or equally well through all materials.
• The word ‘reflect’ has a different scientific meaning to its everyday use.</td><td colspan="2"></td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Know:</td><td>Do:</td><td>Know:</td><td>Do:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="4">Third Level</td><td colspan="2">Understand: Sound is a wave that has properties such as pitch, loudness, frequency and amplitude which make sound useful for different purposes.</td><td colspan="2">Understand: Light can be reflected or absorbed by materials in predictable ways, helping us explain what we see and how reflection is used in everyday technologies.</td></tr>
<tr><td>Know:
How sound is made and moves
Sound is produced by a vibrating source, and sound waves transfer energy away from the source.

Sound waves cannot travel through empty space (vacuum) because they need a material (medium) to move through.

Frequency and amplitude
Frequency describes how many vibrations happen each second and is measured in hertz (Hz). A higher frequency produces a higher pitch and a lower frequency produces a lower pitch.</td><td>Do:
Identify and compare sounds in terms of frequency and amplitude.

Recognise high/low, loud/quiet sounds from waveform traces.

Use scientific vocabulary: frequency, amplitude and ultrasound.</td><td>Know:
How light behaves – reflection
Light can be reflected by surfaces.

Light travels from a source to an object, then reflects from a surface into our eyes.

A normal is an imaginary line perpendicular to a point on the reflecting surface.

The angle of incidence is the angle between the incoming ray and the normal.

The angle of reflection is the angle between the reflected ray and the normal.</td><td>Do:
Identify when reflection is taking place in different materials.

Identify ways in which white light can be separated into different colours.

Interpret diagrams showing reflection.

Use scientific vocabulary: reflection, angle of incidence, angle of reflection and normal.</td></tr>
</table>

<table>
<tr>
<td rowspan="3"></td>
<td>Amplitude describes the size of a vibration or wave. Larger amplitudes produce louder sounds.

An audio waveform can represent frequency and amplitude.

Frequency and range of hearing
Humans and animals can hear different ranges of sound.

Humans can hear only a limited range of sound frequencies, approximately 20 hertz to 20 000 hertz.

Infrasound is a sound wave with a frequency too low for humans to hear and can be used to detect storms and volcanic eruptions.

Ultrasound is a sound wave with a frequency too high for humans to hear and can be used for medical imaging and sonar.</td>
<td></td>
<td>The Law of Reflection states that the angle of incidence is equal to the angle of reflection.

Light can be absorbed by materials, transferring energy to them.

Using light in science and technology
The reflection of light including mirrors is used in many devices and applications.

All colours on a display screen are made by controlling the relative brightness of the red, green and blue parts of its pixels.</td>
<td></td>
</tr>
<tr>
<td colspan="2">Notes
• The words ‘frequency’ and ‘wave’ have a different scientific meaning to their everyday use.</td>
<td colspan="2">Includes, but not limited to
• Examples of where mirrors are used include:
- periscopes
- disco balls
- dentists' viewers
- kaleidoscopes
- reflector telescopes
- solar furnaces

Notes
• Reflection allows us to see objects and images in mirrors.
• Learners may think, mistakenly, that mirrors produce light rather than reflect it.
• The word ‘reflection’ has a different scientific meaning to its everyday use.</td>
</tr>
<tr>
<td>Fourth Level</td>
<td colspan="2">Understand: The speed and distance that sound travels depend on the medium it travels through, helping us predict its behaviour and use sound safely in different situations.</td>
<td colspan="2">Understand: Light changes direction in predictable ways as it passes between different materials, helping us explain how lenses and light technologies work.</td>
</tr>
<tr>
<td></td>
<td>Know:
How sound moves and changes
The speed of sound in air is approximately 340 metres per second (m s^{-1}).

Distance, speed and time for sounds are calculated using the equation:
$v = \frac{d}{t}$
where v is speed in metres per second (m s^{-1}),
d is distance in metres (m) and
t is time in (s).</td>
<td>Do:
Analyse data relating to the speed of sounds in different materials.

Evaluate how scientific evidence informs sound regulation and noise management.

Identify ways in which sound technologies and noise pollution affect people and environments.

Identify practical uses of sound in everyday life and in the world of work.</td>
<td>Know:
How light behaves – refraction
Light travels at 300 000 000 metres per second in a vacuum (much faster than sound) and can travel through empty space (vacuum).

When light passes from one medium to another it undergoes refraction. This can be observed as a change in direction when the angle between the ray of light and the normal is greater than 0º.

A light ray travelling along the normal entering a different medium does not change direction.</td>
<td>Do:
Draw ray diagrams of examples of refraction.

Identify ways in which white light can be separated into different colours.

Identify practical uses of light in communication, medicine and society.

Interpret diagrams showing refraction.

Use scientific vocabulary: refraction.</td>
</tr>
</table>

	The speed of sound depends on the properties of the medium and is usually faster in solids than gases. **Using sound in science and technology** Scientific understanding of sound is used to set safe limits for the volume of sound in places such as workplaces and public environments.		A light ray entering a different medium at an angle to the normal will change its direction, so it is closer to the normal in the denser medium. Lenses use refraction to manipulate light. **Using light in science and technology** Light technologies use light waves for communication, imaging, sensing and medicine.	
	Notes • Learners may think particles travel with the wave over long distances rather than vibrating back and forth. • Learners will be expected to re-arrange the equations at Fourth Level. • The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action for details.		**Includes, but not limited to** • Examples of where lenses are used include: - spectacles - microscopes - cameras - refracting telescopes - eyes - imaging tools **Notes** • The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action for details.	

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Strand	**The Physical World**			
Sub-strand	**Waves**			
	Wave properties		**Electromagnetic radiation**	
Early Level	**Understand:**		**Understand:**	
	Know:	**Do:**	**Know:**	**Do:**
	Know:	**Do:**	**Know:**	**Do:**
First Level	**Understand:**		**Understand:**	
	Know:	**Do:**	**Know:**	**Do:**
	Know:	**Do:**	**Know:**	**Do:**
	Know:	**Do:**	**Know:**	**Do:**
Second Level	**Understand:**		**Understand:**	
	Know:	**Do:**	**Know:**	**Do:**
	Know:	**Do:**	**Know:**	**Do:**
	Know:	**Do:**	**Know:**	**Do:**

<table>
<tr><td rowspan="3">Third Level</td><td colspan="2">Understand: Waves transfer energy from one place to another and play an important role in processes such as hearing and sight.</td><td colspan="2">Understand: Visible light is part of a wider electromagnetic spectrum, with the different types of radiation within the spectrum having a wide variety of uses in everyday life.</td></tr>
<tr><td>Know:
Waves transfer energy
Waves transfer energy from one place to another, for example, when sound travels from a source to our ears.

How waves travel
Waves can travel through different media (materials), such as sound travelling through air.

Some waves can travel through space, such as light travelling from the Sun to Earth.

Wave properties
Amplitude describes the size of a wave and relates to the amount of energy transferred by the wave.

Increasing amplitude increases the energy transferred by a wave.</td><td>Do:
Identify and measure amplitude.

Identify ways in which wave properties are used in everyday technologies.

Use scientific vocabulary: amplitude.</td><td>Know:
Electromagnetic spectrum
Visible light is part of a wider range of electromagnetic waves known as the electromagnetic spectrum.

The electromagnetic spectrum includes radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays and gamma rays.</td><td>Do:
Identify different types of electromagnetic radiation and their uses in everyday technologies and systems.

Identify ways in which electromagnetic radiation can affect living things and the environment.

Use scientific vocabulary: electromagnetic spectrum, radiation, X-rays, radio waves, infrared, ultraviolet, microwaves, gamma rays.</td></tr>
<tr><td colspan="2">Notes
• The word ‘wave’ has a different scientific meaning to its everyday use.
• Focus on qualitative relationships between wave properties before introducing formal wave equations.</td><td colspan="2">Notes
• At Third Level the focus should be on recognising and comparing different types of electromagnetic radiation and their uses.</td></tr>
<tr><td rowspan="2">Fourth Level</td><td colspan="2">Understand: Waves properties such as wavelength, frequency and amplitude can be measured, and these properties allow for different practical applications.</td><td colspan="2">Understand: Electromagnetic waves have different wavelengths and frequencies, and this explains their uses and effects.</td></tr>
<tr><td>Know:
Wave properties
Waves have properties including wavelength λ), frequency (f) and amplitude.

Wavelength (λ) is the distance between repeating points in a wave, such as the distance between successive wave crests. It is measured in metres (m).

Frequency (f) describes how many waves are produced or pass a point each second measured in hertz (Hz).

Properties affecting behaviour
Changes in wavelength and frequency affect how waves behave and interact with materials.

Waves can be compared and related
Wave speed depends on wavelength and frequency and is measured in metres per second (m s^{-1}).

The relationship between speed, frequency and wavelength of a wave can be expressed as:</td><td>Do:
Perform calculations involving wavelength, frequency and wave speed.

Learners will be expected to re-arrange the equations at Fourth Level.

Identify ways in which waves are used in communication, imaging and sensing technologies.

Use scientific vocabulary: wave speed and wavelength.</td><td>Know:
Electromagnetic spectrum
Electromagnetic waves have different wavelengths and frequencies across the electromagnetic spectrum.

All electromagnetic waves travel at the same speed in a vacuum, known as the speed of light, which travels at 300 000 000 m s^{-1}</td><td>Do:
Relate wavelength and frequency to the behaviour of electromagnetic radiation.

Evaluate the benefits, limitations and risks of different uses of electromagnetic radiation in society, technology and the environment.

Use scientific vocabulary: vacuum.</td></tr>
</table>

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	$v = f\lambda$ Where: v = speed (m s^{-1}) f = frequency (Hz) λ = wavelength (m) The speed, distance and time of a wave can be calculated using the following equation introduced in Forces (Motion) section: $$v = \frac{d}{t}$$			
	Notes • The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action for details.		**Notes** • Technologies that use properties of the EM spectrum include communication, medical imaging and sterilisation of equipment. • The application of knowledge and skills through everyday contexts will be a significant focus at Fourth Level. See Science in Action for details.	

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Science in Action: Be the Change

<table>
<tr><th>Strands</th><th colspan="2">Taking Scientific Action</th><th colspan="2">Science Around Me</th><th colspan="2">Informed and Responsible Decision-making</th></tr>
<tr><td rowspan="3">Early Level</td><td colspan="2">Understand: Exploring and asking questions about the world around us helps identify ways to use science to make things better for people and other living things.</td><td colspan="2">Understand: Science is part of everyday life and helps people make things better for others.</td><td colspan="2">Understand: Scientific knowledge can change when new evidence is discovered, helping to develop better explanations for observations.</td></tr>
<tr><td>Know:
Identify and plan
Exploring and questioning the world around us can help identify ways to make things better.

Take scientific action
Taking action can make a difference to people and other living things.

A variety of ideas can help solve a problem.

Collaborate and communicate
Working together can help solve problems.

Evaluate and improve
Sharing views on what worked well helps make things better next time.</td><td>Do:
Identify and plan
Notice simple problems and create ideas to address them.

Take scientific action
Apply science learning to carry out actions.

Collaborate and communicate
Work with others to take scientific action.

Evaluate and improve
Identify what worked well and what could be made better after taking action.</td><td>Know:
Science in our lives
Science is for everyone.

Science helps people understand what happens around them and to solve everyday problems.

Science at work
Science is used in a variety of jobs.

Science jobs are for everyone.</td><td>Do:
Science in our lives
Recognise ways people use science in their everyday lives.

Science at work
Recognise ways in which science is used by people in the workplace.</td><td>Know:
Scientific knowledge can change when new evidence is discovered.</td><td>Do:
Make observations and collect information to find out something new.</td></tr>
<tr><td colspan="2">Notes
• Taking scientific action is an essential component of the Sciences curriculum.</td><td colspan="2">Includes, but not limited to
• Examples of science helping to solve problems in everyday life might include: torches, heaters, medicines, fridges, soap.
• Jobs which use science but aren’t obvious ‘science jobs’ can include: chef, electrician, builder, farmer, pilot, firefighter, hairdresser, game designer and many more.

Notes
• It is important to challenge stereotypes and bias and to recognise and celebrate the diverse range of people who engage with and work in science.</td><td colspan="2">Includes, but not limited to
• Possible examples include:
- we wash our hands because scientists discovered it was a way to remove germs and stay healthy
- we wear sunscreen because science shows that too much sunlight can damage skin
- we wear seatbelts because science shows they can keep people safer in cars</td></tr>
</table>

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<table>
<tr><td rowspan="3">First Level</td><td colspan="2">Understand: Using scientific knowledge and skills helps to identify actions that can make a positive difference in the school or wider community.</td><td colspan="2">Understand: Science uses the scientific knowledge and skills of people from diverse cultures and communities to innovate and improve everyday lives.</td><td colspan="2">Understand: Scientific evidence is based on observations and information, helping to distinguish between fact and opinion.</td></tr>
<tr>
<td>Know:
Identify and plan
Investigations provide information that help people decide on appropriate action to take.

Setting goals helps to focus scientific action, and measure impact.

Take scientific action
Using science learning to take action can bring positive change to a school or community.

Collaborate and communicate
People may have differing views about an issue or solution.

Evaluate and improve
Identifying if an action has resulted in change allows for improvements next time.</td>
<td>Do:
Identify and plan
Investigate science-related problems and opportunities in the school community.

Gather information to help make choices between possible actions.

Develop a simple plan to take action.

Take scientific action
Apply science learning to carry out actions in the school community.

Generate, test and improve simple solutions.

Collaborate and communicate
Contribute ideas and support and challenge group decisions.

Work with others to achieve a goal, taking on different roles where appropriate.

Evaluate and improve
Identify if anything has changed from taking action and suggest improvements.</td>
<td>Know:
Science in our lives
Respecting and including diverse views can help develop better ideas to solve problems.

People from diverse cultures and communities across the world contribute scientific ideas, inventions and innovations.

Scientific innovation and invention is a creative process which helps to solve problems and test solutions.

Science at work
Science skills and knowledge are used in many jobs.

People from diverse backgrounds use and apply science in their jobs.</td>
<td>Do:
Science in our lives
Respect diverse views.

Creatively solve problems.

Identify a variety of scientific ideas, inventions and innovations in our lives and community.

Science at work
Recognise scientific knowledge and skills used in jobs.</td>
<td>Know:
Scientific evidence is based on observations and measurements rather than personal opinions or feelings.</td>
<td>Do:
Identify the difference between a fact and opinion.</td>
</tr>
<tr>
<td colspan="2">Include, but not limited to
• Taking on different roles - learners should have the opportunity to build skills of working in project teams. However, not all activities need to include this approach.

Notes
• Taking scientific action is an essential component of the Sciences curriculum at all levels.</td>
<td colspan="2">Includes, but not limited to
• Scientific ideas, inventions and innovations originating from the Global South and indigenous communities.

Notes
• It is important to challenge stereotypes and biases and to recognise and celebrate the diverse range of people who engage with and work in science. Stereotypes can shape attitudes, future interests, skills development and subsequently participation in jobs.</td>
<td colspan="2"></td>
</tr>
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	Understand: Using scientific evidence to solve problems helps make positive changes for people, other living things and the environment, and shows how solutions can be improved.		**Understand:** Science uses the ideas and innovations of people from diverse cultures and communities to improve people's lives, other living things and the environment, in the past, now and in the future.		**Understand:** Scientific evidence can be evaluated, helping to make responsible decisions and informed choices.	
	Know:	**Do:**	**Know:**	**Do:**	**Know:**	**Do:**
Second Level	**Identify and plan** Scientific evidence helps to identify causes of problems and compare possible solutions. Problems can often be made easier to solve by breaking them into smaller parts. **Take scientific action** Applying scientific knowledge and skills can make a positive difference to people, other living things and the environment. Problems often have more than one possible solution. Different solutions have different advantages and disadvantages. **Collaborate and communicate** A variety of roles are required for effective team-work and diverse perspectives strengthen group decisions. **Evaluate and improve** Observations and evidence help to evaluate if an action has made a difference. Learning from mistakes, unexpected outcomes and failures can help improve solutions.	**Identify and plan** Investigate science-related issues affecting people and other living things in the local community and environment. Generate creative ideas to address science-related problems or opportunities. Collect and use data to compare options. Identify who or what is affected by a problem and listen to people's views. Develop an action plan to solve problems. **Take scientific action** Apply scientific knowledge and skills by taking evidence-informed action in local community contexts. Design, prototype, test and refine solutions using evidence and feedback. Be resilient when faced with unexpected situations and know when to ask for help. Recognise that actions can affect people differently. **Collaborate and communicate** Respond to feedback when working with groups, adapting approaches where required. Take responsibility for agreed tasks within a team. Communicate with others by sharing, explaining and justifying views respectfully.	**Science in our lives** Contributions from people from diverse cultures and communities shape the development of scientific ideas, inventions and innovations over time. Scientific innovations should be developed responsibly, considering the needs of a wide range of people, other living things and the environment. Scientific ideas and innovations can change how people may live and work in the future. **Science at work** Scientific knowledge and skills are transferrable into a wide variety of jobs. Scientific workplaces benefit from a diverse workforce. Engineers use science and creativity to design solutions that help people and make everyday life better. STEM jobs use knowledge and skills from science, technology, engineering and mathematics.	**Science in our lives** Recognise the value and contribution of diverse scientists and how they impacted on people, living things and the environment. Recognise how scientific developments affect diverse people or communities. Use imagination to generate ideas for scientific solutions that could improve life for people, other living things and the environment. **Science at work** Identify ways in which scientific knowledge and skills are used in a wide variety of jobs, such as engineering.	Scientific evidence can help people make responsible decisions and informed choices. Misinformation is false or misleading information shared by mistake. Disinformation is false information spread deliberately to deceive or influence people.	Evaluate the evidence used to support a scientific claim. Use relevant scientific evidence to make and justify an informed decision. Use scientific vocabulary: misinformation, disinformation.

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<table>
<tr><td></td><td></td><td>Support and encourage others to complete actions.

Evaluate and improve
Use observations or evidence to evaluate whether an action has made a difference and to suggest improvements.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Include, but not limited to
• Taking responsibility for agreed tasks in a team – learners should have the opportunity to build skills of working in project teams. However, not all activities need to include this approach.

Notes
• Taking scientific action is an essential component of the Sciences curriculum
• Design, prototyping, testing and refining etc. is aligned with the Engineering Design Process.</td><td colspan="2">Includes, but not limited to
• Scientific ideas, inventions and innovations originating from the Global South and indigenous communities.

Excludes
• Career pathways – Learners are not expected to know about these in depth, just that there are many pathways that exist and that not all science-related jobs require an academic degree.

Notes
• Scientific ideas and discoveries are modern and historical and can be linked to colonial legacies. Decolonising the Sciences curriculum requires exploration of:
- which knowledge is valued?
- how is it assessed?
- how was it produced?
- by whom?
- at what cost?
• Jobs that use science are typically, but not always, part of the Science, Technology, Engineering and Maths (STEM) industries.
• The phrase ‘diverse backgrounds’ refers to people from a variety of ethnic, socio-economic, and cultural backgrounds, and includes diversity in gender and other protected characteristics.</td><td colspan="2">Includes, but not limited to
• Examples of evidence or sources to look at may include social media posts, manipulated graphs, artificial intelligence-generated content, climate misinformation or false health claims.

Notes
• Misinformation could be someone passing on a story they think is true.</td></tr>
<tr><td rowspan="2">Third Level</td><td colspan="2">Understand: Applying scientific evidence helps to make informed decisions, recognise the consequences of actions, and improve solutions to everyday problems.</td><td colspan="2">Understand: Responsible scientific innovation develops through the collaboration of people from diverse cultures and communities, helping to create jobs and new industries in Scotland.</td><td colspan="2">Understand: Scientific evidence can be evaluated and compared, helping to identify misinformation, disinformation and bias to justify decisions.</td></tr>
<tr><td>Know:
Identify and plan
Evaluating scientific evidence for quality and reliability helps make informed decisions.

Structured action plans include goals, tasks, required resources, timescales and ways to measure impact.

Take scientific action
Many environmental and societal issues are influenced by interacting factors within and between systems.</td><td>Do:
Identify and plan
Investigate science-related issues affecting people, other living things and the environment, locally and nationally.

Gather, analyse and interpret data to take evidence-informed action.

Combine ideas from different sources to develop innovative responses to problems.

Use evidence-informed decision making and stakeholder</td><td>Know:
Science in our lives
Scientific ideas, inventions and innovations (now and in the past) are strengthened by the knowledge, experiences and perspectives of people from diverse cultures and communities.

Responsible innovation considers how a solution will be used, who or what will be affected by it, its intended benefits, possible risks and unintended effects.</td><td>Do:
Science in our lives
Evaluate the contribution made by historic and contemporary scientists from diverse cultures and communities and their impact on people, other living things and the environment.

Evaluate the extent to which an innovation has been developed responsibly.

Use imagination to develop and refine scientific innovation ideas, considering how they can</td><td>Know:
Scientific knowledge and informed views can change in response to new evidence or improved methodologies.

It is important that different sources of evidence are compared to strengthen explanations.

Bias is when results or conclusions are unfairly influenced by personal opinions or expectations instead of evidence.
Scientific evidence is gathered and evaluated using methods designed</td><td>Do:
Evaluate scientific evidence from different sources and justify an informed decision.

Identify examples of scientific misinformation and disinformation.</td></tr>
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	Actions can have intended and unintended consequences. People may experience the impact of the same action in different ways. **Collaborate and communicate** Collaboration with people who have different knowledge, skills and perspectives can strengthen action. Working collaboratively with others to achieve a goal develops transferrable skills for life and work. **Evaluate and improve** Evidence and success criteria are needed to evaluate impact. Evidence can be used to make ongoing changes to improve and refine an action or solution.	perspectives to evaluate options for action. Create a structured action plan. **Take scientific action** Take science-informed action on local and national issues. Be willing to take the lead and responsibility for tasks. Consider fairness and diverse perspectives. Consider possible intended and unintended consequences of proposed actions. • Persevere with tasks and adapt approaches when required. **Collaborate and communicate** Facilitate aspects of teamwork and decision-making. Share constructive feedback and reach agreement through compromise. Communicate effectively and with confidence through a variety of means. Access support, advice and resources from others as required when taking scientific action. **Evaluate and improve** Use evidence, feedback and given success criteria to evaluate the impact of an action and make ongoing changes to improve the action or solution.	Artificial intelligence is accelerating the pace of scientific discovery and problem-solving. Access to science opportunities is not always equal and can be influenced by social and environmental factors. Choices made about scientific innovation can affect future outcomes. Science is a human endeavour. Scientists can be influenced by their experiences, assumptions, and the society in which they live. Scientific methods, critical evaluation of evidence and scrutiny by others can help identify and reduce bias. **Science at work** There are different pathways into science and STEM-related jobs. Science and STEM-related industries vary in size, skills requirements and job availability. Diverse representation benefits science and STEM-related industries and enables them to develop better solutions for society as a whole.	responsibly benefit people, other living things and the environment. **Science at work** Identify the requirements for, and pathways into, a particular science-related job. Compare how the science skills and knowledge required differs depending on the job.	to reduce bias, but evidence can have limitations and uncertainty. Scientific evidence can be used to identify misinformation and disinformation that can affect public understanding of science. Scientific scepticism means questioning claims and evaluating evidence before deciding whether they should be accepted. Artificial intelligence is a tool that supports analysis of evidence and decision-making. However, it can make mistakes and contain biases so its outputs needs to be checked carefully.	
	Includes, but not limited to • Transferrable skills may include: critical thinking, communication, working with others, problem-solving, digital literacy, numeracy, adaptability, time-management. **Notes** • Taking Scientific Action is an essential component of the Sciences curriculum.		**Includes, but not limited to** • Scientific ideas, inventions and innovations originating from the Global South and indigenous communities. • Career pathways include apprenticeships, college, university or workplace learning. It is important for learners to be aware that all pathways are equally valid and that not all science or STEM jobs require an academic degree.		**Includes, but not limited to** • Examples of evidence or sources to look at may include social media posts, manipulated graphs, artificial intelligence-generated content, climate misinformation or false health claims. **Notes** • Link to Being Scientific: Evaluation in Science.	

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<table>
<tr><td></td><td colspan="2"></td><td colspan="2">• Identifying requirements and pathways should include detail about the qualifications needed or gained, top skills required, entry routes, for example, apprenticeships, college, university or workplace learning, and the demand for that job in Scotland.</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Fourth Level</td><td colspan="2">Understand: Critically applying scientific knowledge, skills and evidence supports responsible action, informed decision-making and evaluation of impact, helping to contribute to positive change.</td><td colspan="2">Understand: Breaking down barriers in science enables diverse participation and responsible innovation that considers future, ethical, social, political, environmental, and economic impacts on global society.</td><td colspan="2">Understand: Scientific evidence can be critically evaluated, helping people and society to make informed and responsible decisions to address scientific and societal issues.</td></tr>
<tr>
<td>Know:
Identify and plan
Critically evaluating the quality, validity, reliability and limitations of evidence strengthens actions.

Decisions about actions may involve ethical, environmental, economic and social trade-offs.

A project plan includes features such as project goal, success criteria, task breakdown (action plan), timelines and deadlines, roles and responsibilities, resource needs, risks and contingencies.

Take scientific action
Complex challenges are interconnected across environmental, social and economic systems and require systems-level thinking to identify sustainable responses.

Scientific actions may create interacting short-term and long-term consequences across environmental, social and economic systems.

Collaborate and communicate
Constructive challenge, negotiation and shared decision-making can improve a response to a problem.

Evaluate and improve
Critical evaluation involves evaluating evidence of impact</td>
<td>Do:
Identify and plan
Investigate science-related issues affecting people, other living things and the environment, locally, nationally and globally.

Gather and critically evaluate data quality and limitations.

Generate innovative solutions which balance competing priorities and constraints to ignite change.

Evaluate trade-offs and justify decisions about actions using scientific, ethical and societal considerations.

Create and manage a project plan that includes risk assessment, contingencies, resource allocation and monitoring processes.

Consider qualities and skills of individuals when assigning roles in a team or task.

Take scientific action
Analyse how changes in one system may influence other connected systems and use this understanding to justify actions.

Take science-informed action on national and global issues.

Be open to new ideas and approaches, demonstrating a growth mindset.</td>
<td>Know:
Science in our lives
Responsible scientific innovation requires evaluating competing environmental, social, political, and economic priorities to make informed, ethical choices about potential benefits, risks, and trade-offs.

The impacts of scientific developments are not experienced equally.

Responsible scientific use of artificial intelligence requires transparency, appropriate data inputs, testing and human oversight, as well as consideration of bias, errors, privacy and ethical implications, environmental costs and unequal access.

Futures thinking uses evidence, trends and scenarios to explore possible consequences and inform preferred courses of action.

Science at work
Scientific careers increasingly involve collaboration across disciplines and the use of digital, communication, creativity and problem-solving skills.

Innovation, creativity and entrepreneurship in science and STEM helps to create new jobs.

The scientific community is working to remove barriers linked to participation in science and</td>
<td>Do:
Science in our lives
Recognise and explain why diversity and inclusion in science and STEM pathways and careers are important.

Recognise how scientific developments affect diverse people or communities.
Identify factors that affect access to science opportunities.

Critically evaluate the environmental, social, economic and ethical implications of scientific innovations, including artificial intelligence.

Consider and evaluate alternative future scenarios informed by scientific evidence and systems thinking.

Use imagination to create and justify responsible scientific innovations to address global challenges.

Science at work
Identify ways in which the scientific community is working to remove barriers to participation in science pathways and careers.</td>
<td>Know:
The strength of a scientific claim depends on the quality of the available evidence, including its source, relevance, consistency and limitations.

Scientific evidence from multiple disciplines may be integrated to address scientific and societal issues.

The focus of scientific research and development is influenced by ethical, social, political, environmental or economic factors.

Scientific evidence informs and influences public decision making and policy, locally and globally.

Scientific evidence may support multiple explanations, particularly when evidence is incomplete, uncertain or interpreted differently.

Peer review is a process in which independent experts evaluate scientific research before publication to help assess its quality, validity and reliability.</td>
<td>Do:
Evaluate sources of evidence and information based on relevance, validity, reliability and potential bias.

Interpret scientific evidence and compare differences in interpretation.

Identify ways in which scientific evidence influences public decision making.

Justify a scientific decision or recommendation that considers in terms of risks, benefits and trade-offs.</td>
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	including intended and unintended outcomes and wider effects on environmental, social and economic systems. Sustainable change often depends on long-term monitoring, adaptation and collaboration.	Consider the resources needed to carry out a proposed action and any practical constraints. Refine solutions iteratively in response to testing, evidence and stakeholder feedback. Use principles of equity and inclusion to create a positive change. **Collaborate and communicate** Treat others with respect and seek ways to co-operate, including resolving conflict. Lead collaborative scientific action and support others to contribute effectively. Proactively engage with a range of people and organisations to carry out actions. Communicate findings confidently and effectively with different audiences. **Evaluate and improve** Critically evaluate evidence of impact, including intended and unintended outcomes and systemic impacts, and justify improvements or further action.	STEM pathways and careers through more inclusive practices.			
	Includes, but not limited to • Use principles of equity, equality, inclusion and Learning for Sustainability to affect change. **Notes** • Taking scientific action is an essential component of the Sciences curriculum. • Resources required - This does not imply that learners require access to a project budget or external funding. Cost and budgeting may be considered theoretically where appropriate. • Evaluate = How good is it? • Critically evaluate = How good is it? What evidence supports that? What are its limitations, and how convincing is the evidence?	**Includes, but not limited to** • Factors that affect access to science opportunities include protected and non-protected characteristics*; ethnicity, culture and race; disability and neurodiversity; gender and sex; linguistic; sexual orientation; family, for example, care-experienced, young carers, nomadic families, LGBT families, lone parents; religion and belief; socioeconomic and geography, for example, distance to school. • Data shows that women and those with intersecting characteristics and marginalised identities are less represented in STEM due to inequality and barriers. This can impact participation and engagement. **Notes** • Scientific developments may affect people unequally depending on their characteristics*, resources, geography, infrastructure and access to technology, for example, data which drives innovation can be biased towards one group, and healthcare misdiagnoses are more common for minority groups. Links to UNCRC Articles 28, 29 and 31. • Evaluate = How good is it?	**Includes, but not limited to** • The influence politics can have is in relation to scientific funding for research and development. **Excludes** • Detailed information about politics and political systems. **Notes** • Identifying misinformation or disinformation will likely involve evaluating sources of evidence for, relevance, validity, reliability and bias. • Link to Being Scientific: Evaluating Scientific Evidence.		

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		• Critically evaluate = How good is it? What evidence supports that? What are its limitations, and how convincing is the evidence?	

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Declaration

The content of this document was written by the author, exercising full professional judgement. Education Scotland approved AI tools were used to support review, clarity and quality assurance. Education Scotland staff retain full responsibility and have reviewed and approved all content.

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Version History

Version	Date	Detail
Version 1.0	4 November 2026	First released

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