Education Scotland
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Benchmarks

Sciences

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Transforming lives through learning

Education Scotland
Guidance on using Benchmarks for Assessment
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Education Scotland's Curriculum for Excellence (CfE) Statement for Practitioners (Aug 2016) stated that the two key resources which support practitioners to plan learning, teaching and assessment are:

- **Experiences and Outcomes**
- **Benchmarks**

Benchmarks have been developed to provide clarity on the national standards expected within each curriculum area at each level. They set out clear lines of progression in literacy and English and numeracy and mathematics, and across all other curriculum areas from Early to Fourth Levels (First to Fourth Levels in Modern Languages). Their purpose is to make clear what learners need to know and be able to do to progress through the levels, and to support consistency in teachers' and other practitioners' professional judgements.

All eight significant aspects for learning for sciences are clearly embedded in the Benchmarks and provide the structure against which the Benchmarks have been developed.

Skills development is integrated into the Benchmarks to support greater shared understanding. An understanding of skills and how well they are developing will enable learners to make links between their current learning and their future career options and employment.

Benchmarks draw together and streamline a wide range of previous assessment guidance (including significant aspects of learning, progression frameworks and annotated exemplars) into one key resource to support teachers' and other practitioners' professional judgement of children's and young people's progress across all curriculum areas.

Benchmarks have been designed to support professional dialogue as part of the moderation process to assess where children and young people are in their learning. They will help to support holistic assessment approaches across learning. They should not be ticked off individually for assessment purposes.

Benchmarks for literacy and numeracy should be used to support teachers' professional judgement of achievement of a level. In other curriculum areas, Benchmarks support teachers and other practitioners to understand standards and identify children's and young people's next steps in learning. Evidence of progress and achievement will come from a variety of sources including:

- observing day-to-day learning within the classroom, playroom or working area;
- observation and feedback from learning activities that takes place in other environments, for example, outdoors, on work placements;
- coursework, including tests;
- learning conversations; and
- planned periodic holistic assessment.

Practical activities contribute in an important way to learning within the sciences and allow learners to further develop their skills and understanding of scientific concepts. Evidence of progress and achievement can also be drawn from practical activities too to support Benchmark outcomes.

Benchmarks in curriculum areas

Benchmarks in each curriculum area are designed to be concise and accessible, with sufficient detail to communicate clearly the standards expected for each curriculum level.

Teachers and other practitioners can draw upon the Benchmarks to assess the knowledge, understanding, and skills for learning, life and work which children are developing in each curriculum area.

In secondary schools, Benchmarks can support subject specialist teachers in making robust assessments of learners' progress and the standards they achieve. They will help teachers ensure that learners make appropriate choices and are presented at an appropriate level for National Qualifications in the senior phase. This can help avoid excessive workload for teachers and unnecessary assessments for learners. For example, learners should have achieved relevant Fourth level Experiences and Outcomes before embarking on the National 5 qualifications. Schools should take careful account of this when options for S4 are being agreed. Benchmarks should be used to help with these important considerations.

Literacy and numeracy

In literacy and numeracy, Benchmarks support teachers' professional judgement of achievement of a level. Teachers' professional judgements will be collected and published at national, local and school levels. It is important that these judgements are robust and reliable. This can only be achieved through effective moderation of planning learning, teaching and assessment.

Achievement of a level is based on teacher professional judgement, well informed by a wide range of evidence. Benchmarks should be used to review the range of evidence gathered to determine if the expected standard has been achieved and the learner has:

- achieved a **breadth** of learning across the knowledge, understanding and skills as set out in the experiences and outcomes for the level;
- responded consistently well to the level of **challenge** set out in the Experiences and Outcomes for the level and has moved forward to learning at the next level in some aspects; and
- demonstrated **application** of what they have learned in new and unfamiliar situations.

It is not necessary for learners to demonstrate mastery of every individual aspect of learning within Benchmarks at a particular level and before moving on to the next level. However, it is important that there are no major gaps in children's and young people's learning when looking across the major organisers in each curriculum area.

Bundling of Experiences and Outcomes

Practitioners are encouraged to bundle Experiences and Outcomes and Benchmarks together where it is relevant and meaningful to do so. This can promote a more holistic approach to planning learning, teaching and assessment and can help learners make connections between different concepts, knowledge and skills in the sciences and to other curriculum areas. Practitioners are also encouraged to consider how learning, teaching and assessment in the sciences can be enhanced through interdisciplinary links to other subjects, including STEM subjects such as technologies and mathematics.

The bundling of Experiences and Outcomes, and respective Benchmarks, has largely been avoided in the development of these Benchmarks so as not to prescribe to schools and centres how this bundling should take place. This is best done by schools and centres to suit the needs of their learners and their local contexts.

Planning learning, teaching and assessment using the Benchmarks

In addition to the Curriculum for Excellence (CfE) Statement for Practitioners from HM Chief Inspector of Education, August 2016 on the purpose and use of Benchmarks, teachers and other practitioners should note the following advice.

KEY MESSAGES – WHAT TO DO	KEY MESSAGES – WHAT TO AVOID
• Use literacy and numeracy Benchmarks to help monitor progress towards achievement of a level, and to support overall professional judgement of when a learner has achieved a level.	• Avoid undue focus on individual Benchmarks which may result in over-assessing or recording of learners' progress.
• Become familiar with other curriculum area Benchmarks over time.	• Avoid the requirement to spend time collating excessive evidence to assess learners' achievement.
• Use Benchmarks to help assess whether learners are making suitable progress towards the national standards expected and use the evidence to plan their next, challenging steps in learning.	• There is no need to provide curriculum level judgements in all curriculum areas – stick to literacy and numeracy.
• Discuss Benchmarks within and across schools to achieve a shared understanding of the national standards expected across curriculum areas.	• Do not create excessive or elaborate approaches to monitoring and tracking.
	• Do not assess Benchmarks individually. Plan periodic, holistic assessment of children's and young people's learning.
	• Do not tick off individual Benchmarks.

Early Level Sciences

The table immediately below has been included as a helpful guide to the scientific skills to be developed within the sciences at Early Level.

Skills	
Inquiry and investigative skills	*Plans and designs scientific investigations and enquiries* - Explores and observes through play. - Asks questions arising from play activities. - Makes simple predictions of what might happen. - Makes suggestions about what to do to answer the selected question. *Carries out practical activities within a variety of learning environments* - Discusses obvious risks and takes appropriate steps to protect themselves and others. - Uses their senses to acquire information. - Measures using simple equipment and non-standard units. *Analyses, interprets and evaluates scientific findings* - Presents and sorts data/information, for example, using displays, photographs, simple charts and drawings. - Provides oral descriptions of what was done and what happened. - Recognises similarities, patterns and differences in the findings and links these to the original question. - Discusses, with support, how the experiment might be improved. - Relates findings to everyday experiences. - Identifies and discusses new knowledge and understanding. *Presents scientific findings* - Communicates findings to others verbally and through drawings, photographs, displays and simple charts. - Responds to questions about their investigation.
Scientific analytical thinking skills	- Demonstrates natural curiosity and shows development of basic skills of analysis in simple and familiar contexts, for example, through asking questions, experimenting and making predictions. - Demonstrates creative thinking by offering suggestions and solutions to everyday problems. - Demonstrates reasoning skills by explaining choices and decisions.

Skills and attributes of scientifically literate citizens	- Talks about science, showing developing understanding of risks and benefits, and listens to the views of others. - Demonstrates awareness of the importance of respecting living things and the environment and of managing the Earth's resources responsibly. - Demonstrates a developing understanding of science in the world around them. - Explores the ways in which people use science and science skills as part of their job.

Curriculum Organisers		Experiences and Outcomes for planning learning, teaching and assessment	Benchmarks to support practitioners' professional judgement
Planet Earth	**Biodiversity and interdependence**	I have observed living things in the environment over time and am becoming aware of how they depend on each other. SCN 0-01a	• Explores and sorts objects as living, non-living or once living. • Describes characteristics of livings things and how they depend on each other, for example, animals which depend on plants for food.
		I have helped to grow plants and can name their basic parts. I can talk about how they grow and what I need to do to look after them. SCN 0-03a	• Explores, observes and discusses basic needs of plants and what they need to grow including water, heat, sunlight and soil. • Demonstrates understanding of how plants grow from seeds.
	Energy sources and sustainability	I have experienced, used and described a wide range of toys and common appliances. I can say what makes it go and say what they do when they work. SCN 0-04a	• Ask questions and describes what can 'make things go', for example, batteries, wind-up toys and sunlight. • Talks about toys and common appliances and what they do when they work, for example, produce heat, light, movement or sound.

	Processes of the planet	By investigating how water can change from one form to another, I can relate my findings to everyday experiences. SCN 0-05a	• Investigates the different properties of water and shares their findings with others. • Talks about water in nature and how it influences their everyday lives. • Identifies three main states of water (ice, water and steam) and uses scientific vocabulary such as 'melting', 'freezing' and 'boiling' to describe changes of state.
	Space	I have experienced the wonder of looking at the vastness of the sky, and can recognise the sun, moon and stars and link them to daily patterns of life. SCN 0-06a	• Describes how the rotation of the Earth in relation to the sun gives us day and night. • Talks about how the pattern of night and day changes over the course of a year.
Forces, electricity and waves	**Forces**	Through everyday experiences and play with a variety of toys and other objects, I can recognise simple types of forces and describe their effects. SCN 0-07a	• Explores and sorts toys and objects into groups according to whether they need to be pushed or pulled. • Measures, using simple equipment, how the movement of an object is affected by the size of the force or the weight of the object. • Demonstrates, through play, how a force can make an object stay still, start to move, speed up, slow down and change shape.
	Electricity	I know how to stay safe when using electricity. I have helped to make a display to show the importance of electricity in our daily lives. SCN 0-09a	• Groups objects into those which get electricity either from mains electrical sockets or alternative sources, such as batteries and solar cells. • Talks about the importance of electricity in their daily lives. • Identifies the risks that can be caused by electricity and recognises how to stay safe.
	Vibrations and waves	Through play, I have explored a variety of ways of making sounds. SCN 0-11a	• Predicts, then investigates, ways to make sounds louder and quieter. • Identifies different sources of sound.

Biological systems	**Body systems and cells**	I can identify my senses and use them to explore the world around me. SCN 0-12a *HWB 0-47b*	• Identifies specific parts of the body related to each of the senses. • Uses their senses to describe the world around them, giving examples of things they see, hear, smell, taste and feel.
	Inheritance	*HWB 0-47a*	
Materials	**Properties and uses of substances**	Through creative play, I explore different materials and can share my reasoning for selecting materials for different purposes. SCN 0-15a	• Explores and sorts materials into different groups depending on their properties, for example, whether they are strong, smooth, rough and if they float or sink. • Justifies the selection of appropriate materials for different uses based on their physical properties.
Topical science	**Topical science**	I can talk about science stories to develop my understanding of science and the world around me. SCN 0-20a	• Talks about the science they encounter in their everyday experiences. • Explores, through role-play, how science and science skills are used in a variety of jobs.

First Level Sciences

The table immediately below has been included as a helpful guide to the scientific skills to be developed within the sciences at First Level.

Skills	
Inquiry and investigative skills	*Plans and designs scientific investigations and enquiries* - Collaborates with others to identify questions to find out more about a specific scientific concept, idea or issue. - Makes predictions about the scientific investigation/enquiry being planned. - Contributes to the design of procedures for carrying out scientific investigations. *Carries out practical activities in a variety of learning environments* - Identifies risks and hazards and ensures safe use of all tools, equipment and procedures. - Collaborates to undertake investigations. - Observes and collects information and makes measurements using appropriate equipment and units. *Analyses, interprets and evaluates scientific findings* - Records and presents data/information using a range of methods including tables, charts and diagrams, using labelling and scales. - Organises data and information and identifies significant patterns and relationships. - Interprets findings and discusses links to the original question. - Reports on limitations of their investigation and possible improvements. - Relates findings to their wider experiences of the world around them. - Identifies and discusses additional knowledge or understanding gained. *Presents scientific findings* - Presents data/information using a range of methods including tables, charts and diagrams, using labels and scales. - Reports in writing, orally or visually using a variety of media. - Structures a presentation or report, with support, to present findings in a coherent and logical way.
Scientific analytical thinking skills	- Applies learning in the sciences. - Provides creative solutions to scientific issues and problems. - Contributes to the design processes and uses components to make models. - Demonstrates reasoning skills and draws on understanding of science concepts to make and test predictions. - Provides explanations which are supported by evidence.
Skills and attributes of scientifically literate citizens	- Expresses informed views of scientific issues, both orally and in writing, and respects the views of others. - Makes connections between science and their own health and wellbeing. - Demonstrates awareness of their own impact on the world. - Demonstrates awareness of how people use science in their everyday lives and in a variety of jobs and careers. - Discusses science topics in real-life contexts including those appearing in the media.

Curriculum Organisers		Experiences and Outcomes for planning learning, teaching and assessment	Benchmarks to support practitioners' professional judgement
Planet Earth	**Biodiversity and interdependence**	I can distinguish between living and non-living things. I can sort living things into groups and explain my decisions. SCN 1-01a	• Explains the difference between living and non-living things, taking into consideration movement, reproduction, sensitivity, growth, excretion and feeding. • Creates criteria for sorting living things and justifies decisions. • Sorts living things into plant, animal and other groups using a variety of features.
		I can explore examples of food chains and show an appreciation of how animals and plants depend on each other for food. SCN 1-02a	• Demonstrates awareness of how energy from the sun can be taken in by plants to provide the major source of food for all living things. • Interprets and constructs a simple food chain, using vocabulary such as 'producer', 'consumer', 'predator' and 'prey'.
		I can help to design experiments to find out what plants need in order to grow and develop. I can observe and record my findings and from what I have learned I can grow healthy plants in school. SCN 1-03a	• Observes, collects and measures the outcomes from growing plants in different conditions, for example, by varying levels of light, water, air, soil/nutrients and heat. • Structures a presentation or report, with support, to present findings on how plants grow.
	Energy sources and sustainability	I am aware of different types of energy around me and can show their importance to everyday life and my survival. SCN 1-04a	• Identifies and talks about types of energy that we get from different energy sources, for example, light, sound, heat and electrical. • Uses knowledge of different energy sources, for example, sun, food, fuel, wind and waves, to discuss the importance of different types of energy for everyday life and survival.

	Processes of the planet	By investigating how water can change from one form to another, I can relate my findings to everyday experiences. SCN 1-05a	• Uses more complex vocabulary to describe changes of states of water, for example, 'condensation' and 'evaporation'. • Contributes to the design of an experiment to determine the temperature at which water boils, freezes and melts, ensuring appropriate use of units. • Knows that pure water boils at 100°, melts at 0° and freezes at 0°.
	Space	By safely observing and recording the sun and moon at various times, I can describe their patterns of movement and changes over time. I can relate these to the length of a day, a month and a year. SCN 1-06a	• Describes how the Earth spins around its axis in 24 hours resulting in day and night. • Observes and records the different patterns of movement of the moon and explains why the moon appears to have different shapes and positions in the sky at different times in a lunar month. • Demonstrates understanding of how the Earth takes one year to completely orbit the sun. • Demonstrates understanding of how the tilt of the Earth on its axis as it circles the sun causes the pattern of the seasons and changes to the number of daylight hours over the course of a year.
Forces, electricity and	**Forces**	By investigating forces on toys and other objects, I can predict the effect on the shape or motion of objects. SCN 1-07a	• Predicts and then investigates how a force can make an object change speed, direction or shape, and uses vocabulary such as pushing, pulling, stretching, squashing and twisting to describe forces. • Investigates balanced forces and explains that if a push and pull are equal in strength and opposite in direction then there is no change in movement.
		By exploring the forces exerted by magnets on other magnets and magnetic materials, I can contribute to the design of a game. SCN 1-08a	• Reports in writing, visually, orally how magnets exert a non-contact force on each other and attract certain materials. • Demonstrates through practical activities that like poles repel and opposite poles attract. • Gives at least two examples for how magnets are used in everyday life.

	Electricity	I can describe an electrical circuit as a continuous loop of conducting materials. I can combine simple components in a series circuit to make a game or model. SCN 1-09a	• Builds simple circuits containing bulbs, switches, bells and batteries. .
	Vibrations and waves	By collaborating in experiments on different ways of producing sound from vibrations, I can demonstrate how to change the pitch of the sound. SCN 1-11a	• Demonstrates how sounds can be made higher or lower pitch by altering tightness, length, width or thickness or other physical characteristics of the sound source. • Explains that sound is caused by a vibration in a material.
Biological systems	**Body systems and cells**	By researching, I can describe the position and function of the skeleton and major organs of the human body and discuss what I need to do to keep them healthy. SCN 1-12a	• Uses components to make simple models of a skeleton which identify the skull, spine, ribcage and some bones of the arms and leg and which show how the skeleton gives us support and protects our organs. • Describes the position and function of major organs including the brain, heart, lungs, stomach and bladder. • Describes how skin, as an organ, provides a barrier to infection and helps to control our temperature. • Structures a presentation or report, with support, on how to have a healthy lifestyle, for example, through a balanced diet, regular exercise, sufficient sleep and by avoiding substance misuse.
		I have explored my senses and can discuss their reliability and limitations in responding to the environment. SCN 1-12b	• Uses their senses to detect information and explains how they help to keep people safe. • Investigates the reliability and limitations of the senses, for example, using taste tests, limits of sound, optical illusions and blind-fold games.

		I know the symptoms of some common diseases caused by germs. I can explain how they are spread and discuss how some methods of preventing and treating disease benefit society. SCN 1-13a	• Describes the symptoms of some common diseases including colds, mumps, measles, chicken pox and flu. • Provides explanations, supported by evidence, of how some diseases spread and discusses ways in which some diseases can be prevented through good hygiene and vaccination.
	Inheritance	By comparing generations of families of humans, plants and animals, I can begin to understand how characteristics are inherited. SCN 1-14a	• Uses their own experiences to illustrate how inherited characteristics are passed from one generation to the next. • Knows that genetic information determines characteristics such as colour of eyes and shape of petals. • Demonstrates understanding of the variations within family groups.
Materials	**Properties and uses of substances**	Through exploring properties and sources of materials, I can choose appropriate materials to solve practical challenges. SCN 1-15a	• Classifies materials into natural and human-made (synthetic). • Identifies properties of different materials, for example, rigidity, flexibility, rough, smooth and waterproof, and their uses linked to their properties.
		I can make and test predictions about solids dissolving in water and can relate my findings to the world around me. SCN 1-16a	• Links new knowledge of dissolving to real-life examples of things that dissolve and things that don't dissolve. • Predicts, investigates and records how solubility is affected by heat and stirring.
	Earth's materials		
Topical science	**Topical science**	I have contributed to discussions of current scientific news items to help develop my awareness of science. SCN 1-20a	• Discusses and expresses opinions about science topics in real-life contexts, including those featured in the media. • Discusses how people use science in their everyday lives. • Describes a variety of jobs and careers which require scientific knowledge and skills.

Second Level Sciences

The table immediately below has been included as a helpful guide to the scientific skills to be developed within the sciences at Second Level.

Skills	
Inquiry and investigative skills	*Plans and designs scientific investigations and enquiries* - Formulates questions and predictions (hypotheses), with assistance, based on observations and information. - Identifies the independent, dependent and controlled variables, with assistance. - Anticipates some risks and hazards. *Carries out practical activities in a variety of learning environments* - Applies appropriate safety measures. - Contributes to carrying out all the procedures. - Makes observations and collects information and measurements using appropriate devices and units. - Manages identified controlled variables to ensure validity of results. *Analyses, interprets and evaluates scientific findings* - Selects appropriate methods to record data/information. - Identifies relationships between the independent and dependent variables. - Makes links to original questions or predictions. - Relates findings to the wider world. - Draws basic conclusions consistent with findings. - Identifies and discusses additional knowledge and understanding gained. - Recognises anomalous results and suggests possible sources of error. - Evaluates the investigation and suggests one way of improving it if it was to be repeated. *Presents scientific findings* - Presents data/information by choosing from an extended range of tables, charts, diagrams, graphs, including bar graphs and line graphs. - Reports collaboratively and individually using a range of methods. - Collates, organises and summarises findings, with assistance, using headings or questions to provide structure for presentations. - Uses appropriate scientific vocabulary and acknowledges sources, with assistance.

Scientific analytical thinking skills	- Applies scientific analytical thinking skills, with assistance, working with less familiar (or familiar but more complex) contexts. - Applies understanding, and a combination of more than one science concept, to solve problems and provide solutions. - Demonstrates further development of creative thinking including through the engineering processes of design, construction, testing and modification.
Skills and attributes of scientifically literate citizens	*At Second Level, it is anticipated that learners will be able to demonstrate the skills below with assistance.* - Presents a reasoned argument based on evidence, demonstrating understanding of underlying scientific concepts, and engages with the views of others. - Demonstrates understanding of the relevance of science to their future lives and the role of science in an increasing range of careers and occupations. - Demonstrates increased awareness of creativity and inventiveness in science, the use of technologies in the development of sciences and the impact of science on society. - Expresses informed views about scientific and environmental issues based on evidence.

Curriculum Organisers		Experiences and Outcomes for planning learning, teaching and assessment	Benchmarks to support practitioners' professional judgement
Planet Earth	**Biodiversity and interdependence**	I can identify and classify examples of living things, past and present, to help me appreciate their diversity. I can relate physical and behavioural characteristics to their survival or extinction. SCN 2-01a	• Classifies living things into plants (flowering and non-flowering), animals (vertebrates and invertebrates) and other groups through knowledge of their characteristics. • Begins to construct and use simple branched keys which can be used to identify particular plants or animals. • Identifies characteristics of living things and their environment which have contributed to the survival or extinction of a species. • Describes how some plants and animals have adapted to their environment, for example, for drought or by using flight.

		I can use my knowledge of the interactions and energy flow between plants and animals in ecosystems, food chains and webs. I have contributed to the design or conservation of a wildlife area. SCN 2-02a	• Describes how energy flows between plants and animals in more complex food chains and webs and ecosystems, using vocabulary such as 'producers', 'consumers' and 'herbivore'.
		Through carrying out practical activities and investigations, I can show how plants have benefited society. SCN 2-02b	• Relates findings from practical investigations to describe how plants have benefited society, for example, in medicine, dyes, fuels, construction, prevention of soil erosion and by influencing the balance of gases in the air.
		I have collaborated in the design of an investigation into the effects of fertilisers on the growth of plants. I can express an informed view of the risks and benefits of their use. SCN 2-03a	• Collaborates with others to present a reasoned argument, based on evidence, of the risks and benefits of using fertilisers, demonstrating understanding of the underlying scientific concepts.
	Energy sources and sustainability	By considering examples where energy is conserved, I can identify the energy source, how it is transferred and ways of reducing wasted energy. SCN 2-04a	• Demonstrates understanding of the law of conservation of energy (energy can be converted from one form to another but cannot be created or destroyed). • Identifies the common types of energy (kinetic, potential, electrical, chemical, light, sound and heat) used in energy transfers and transformations that occur in everyday appliances. • Explains that when energy transfers and transformations take place, energy is converted into 'useful' and 'wasted' energy, for example a mechanical braking system transforms kinetic energy into heat energy which is dissipated to the atmosphere as 'waste' heat.

		Through exploring non-renewable energy sources, I can describe how they are used in Scotland today and express an informed view on the implications for their future use. SCN 2-04b	• Researches non-renewable sources of energy, such as fossil fuels and nuclear, and discusses how these are used in Scotland. • Draws on increasing knowledge and understanding to suggest ways in which they can reduce their own energy use and live more sustainably.
	Processes of the planet	I can apply my knowledge of how water changes state to help me understand the processes involved in the water cycle in nature over time. SCN 2-05a	• Discusses the necessity of water for life, for example, for the growth of crops, for drinking and in river formation/flow. • Demonstrates understanding of the processes involved in the water cycle.
	Space	By observing and researching features of our Solar System, I can use simple models to communicate my understanding of size, scale, time and relative motion within it. SCN 2-06a	• Reports collaboratively on the key features of the planets including size, distance from the sun, length of day, length of year, temperature, materials from which they are predominantly made and the number of moons. • Uses simple models to communicate understanding of size, scale, time and relative motion within our Solar System, including how solar & lunar eclipses occur.
Forces, electricity and waves	**Forces**	By investigating how friction, including air resistance, affects motion, I can suggest ways to improve efficiency in moving objects. SCN 2-07a	• Describes friction as a force which opposes the motion of moving objects, for example, two solid surfaces rubbing against one another or a solid surface moving through air or water. • Finds an association between air resistance (drag), the speed of the object being investigated and the surface area exposed to the air, making links to original predictions. • Demonstrates understanding of how friction and air resistance can both be useful, for example, in braking systems, and also a problem, for example, causing moving parts to wear. • Describes efficient movement as that which requires the least possible energy and suggests ways to improve efficiency in moving objects, for example, by streamlining.

		I have collaborated in investigations to compare magnetic, electrostatic and gravitational forces and have explored their practical applications. SCN 2-08a	• Measures gravitational force with a force meter or newton meter and records results using appropriate units (newtons). • Explains how some objects may become electrically charged by rubbing two surfaces together and how the charges produce an electrostatic force. • Investigates and demonstrates understanding that magnetic and electrostatic forces can both repel and attract. • Describes practical applications of magnetic, electrostatic and gravitational forces, for example, magnetised needle in a compass.
		By investigating floating and sinking of objects in water, I can apply my understanding of buoyancy to solve a practical challenge. SCN 2-08b	• Explores the factors which affect floating, for example, the object's shape and the density of the material that the object is made of, and collates, organises and summarises findings with assistance.
	Electricity	I have used a range of electrical components to help to make a variety of circuits for differing purposes. I can represent my circuit using symbols and describe the transfer of energy around the circuit. SCN 2-09a	• Designs and builds a variety of electrical circuits for differing purposes, using an increasing range of components. • Draws circuit diagrams using appropriate symbols to denote a bulb, switch, motor, bell, buzzer, wires, cell and a battery. • Describes how components in a circuit transfer energy into different forms.
		To begin to understand how batteries work, I can help to build simple chemical cells using readily-available materials which can be used to make an appliance work. SCN 2-10a	• Applies knowledge and understanding to build simple batteries (chemical cells) and demonstrates understanding that a battery (cell) is a portable energy source which has a store of chemical energy. • Explains the process of energy transformation from battery (cell) to electrical components.

	Vibrations and waves	Through research on how animals communicate, I can explain how sound vibrations are carried by waves through air, water and other media. SCN 2-11a By exploring reflections, the formation of shadows and the mixing of coloured lights, I can use my knowledge of the properties of light to show how it can be used in a creative way. SCN 2-11b	• Discusses and demonstrates through experiments how sound travels differently through air, water and solids. • Explains how hearing is limited by a range of factors, for example, age, position, and flexibility (direction) of ears. • Demonstrates and records, through practical investigations, that light travels in straight lines, can be reflected by highly-polished surfaces and that curved faces can distort the image. • Predicts and investigates how the position, shape and size of a shadow depend on the position of the object in relation to the light source. • Demonstrates that white light/sunlight can be dispersed to show the colours of the visible spectrum and identifies the colours and order of the rainbow as red, orange, yellow, green, blue, indigo and violet. • Explains that we see objects because they give out or reflect light rays that enter our eyes. • Draws on findings from practical investigations to describe the effect that coloured filters have on white light and how they can be used to make other colours. • Explains how we can recognise the colour of an object due the reflection and absorption of particular parts of the visible spectrum.
Biological systems	**Body systems and cells**	By investigating some body systems and potential problems which they may develop, I can make informed decisions to help me to maintain my health and wellbeing. SCN 2-12a	*The expectation is that at least two of the following body systems will be studied at Second Level.* Respiratory system • Describes the function of the respiratory system (lungs, windpipe and bronchi), for example, in gas exchange. • Discusses the main preventable causes of bronchitis, lung cancer and asthma, for example, smoking.

			Circulatory system • Describes the function of the circulatory system (heart and blood vessels), for example, transport of food, oxygen and waste materials. • Discusses the main preventable causes of heart disease or stroke, for example, obesity, lack of exercise, smoking and high (saturated) fat diet. Digestive system • Describes the function of the digestive system (mouth, oesophagus, stomach, liver, small intestine, large intestine, rectum and anus), for example, breakdown of food and absorption of nutrients, minerals and water. • Discusses the main preventable causes of liver disease, for example, alcohol and drug misuse. Reproductive system • Describes the function of the reproductive system (penis, testes, sperm tube/duct, ovaries, egg tube/duct, uterus and vagina), for example, to make a baby. • Discusses some preventable causes of fertility problems, for example, alcohol misuse, anorexia and obesity. Skeletal system • Describes the function of the **skeleton** (skull, spine, ribcage some bones of the arm and leg), for example, to provide support, protection and enable movement. • Discusses some common problems of bones (for example, arthritis, osteoporosis and breaks) and how their incidence can be reduced (for example, through calcium in the diet and weight-bearing exercise).
		I have explored the structure and function of sensory organs to develop my understanding of body actions in response to outside conditions. SCN 2-12b	• Describes how senses work individually or together to keep people safe from harm. • Demonstrates understanding of how, if one sense is impaired, it can have an effect on the other senses, either positively or negatively. • Describes how light enters the eye through the pupil and how the pupil changes size in dark/light conditions.

		I have contributed to investigations into the role of microorganisms in producing and breaking down some materials. SCN 2-13a	• Demonstrates understanding of how microorganisms, including bacteria, viruses and fungi, can multiply rapidly. • Investigates and explains the action of some microorganisms used in food production, for example, yeast in bread and bacteria in yoghurt. • Describes how some micro-organisms break down food causing it to be inedible or harmful if digested, and how others exist in the gut to break down food to aid digestion. • Investigates, observes and records how microscopic organisms are necessary for the process of decomposition (the breaking down of dead material – decay).
	Inheritance	By investigating the lifecycles of plants and animals, I can recognise the different stages of their development. SCN 2-14a	Plants • Describes how pollination occurs when the male cell (pollen) lands on the stigma. • Describes how fertilisation (sexual reproduction) occurs when the genetic information in the male cell fuses (joins) with the genetic information in the female cell. • Describes how the fertilised ovule develops into a seed and how the ovary ripens to form a fruit. • Investigates and explains how a seed germinates into a plant using water, oxygen, a food store and warmth. Animals • Identifies and compares the two distinct groups of animals – vertebrates and invertebrates. • Researches the lifecycles of the five main types of vertebrates including fish (spawn), birds (eggs which are rigid but fragile), amphibians (spawn and metamorphosis), reptiles (leathery shelled eggs) and mammal (live young), and communicates findings using a range of media. • Compares the lifecycles of some invertebrates, for example, ladybird and spider.

		By exploring the characteristics offspring inherit when living things reproduce, I can distinguish between inherited and non-inherited characteristics. SCN 2-14b	• Knows that genetics is the study of inherited characteristics and that inherited characteristics are carried on genes and can sometime skip a generation. • Explores and categorises characteristics into inherited (eye and hair colour, height and right/left handedness) and non-inherited (native language spoken and favourite colour). • Describes how every living thing has its own DNA fingerprint.
Materials	**Properties and uses of substances**	By contributing to investigations into familiar changes in substances to produce other substances, I can describe how their characteristics have changed. SCN 2-15a	• Investigates and explains physical changes to the properties of materials which are fully and partially reversible, for example, salt dissolving in water, chocolate melting and water freezing. • Uses scientific vocabulary such as 'melting', 'freezing', 'evaporating' and 'condensing' to describe changes of state. • Investigates and records chemical changes to the properties of materials which are irreversible, for example, cooking, rusting and striking a match. • Observes and identifies some of the signs of a chemical reaction, for example, production of bubbles, colour/texture change and heat given out/taken in. • Explores and describes the characteristics of solids, liquids and gases, for example, solids retain the same volume and shape, liquids keep the same volume but the shape changes to fit the container and that gases change shape and volume to fill the container.
		I have participated in practical activities to separate simple mixtures of substances and can relate my findings to my everyday experience. SCN 2-16a	• Draws on findings from practical investigations to explain how a mixture of solids of different sizes can be separated using a sieve or magnet, for example, sand and peas or salt and iron filings. • Selects the most appropriate practical technique for separating insoluble solids, for example, filtering or sieving. • Explains why a dissolved solid cannot be separated from the solvent by filtering but can be separated by evaporation. • Uses scientific vocabulary such as 'soluble', 'insoluble', 'dissolve' and 'solution' in context. • Relates findings of practical investigations about dissolving to everyday experiences, for example, recycling, salt production and water purification.

		By investigating common conditions that increase the amount of substance that will dissolve or the speed of dissolving, I can relate my findings to the world around me. SCN 2-16b	• Finds an association between the quantity of substance that dissolves and a range of conditions – temperature, time, particle size, stirring and quantity of solvent. • Investigates how a range of factors such as particle size and heat can affect the rate of dissolving. • Relates learning about the quantity and rate of dissolving to everyday examples such as dissolving sugar in tea or salt in water (granules or big crystals, hot or cold liquid, stirred or not stirred).
	Earth's materials	Having explored the substances that make up Earth's surface, I can compare some of their characteristics and uses. SCN 2-17a	• Analyses and compares samples of rocks, soil and minerals and reports their characteristics and uses, using a range of media.
	Chemical changes	I have investigated different water samples from the environment and explored methods that can be used to clean and conserve water and I am aware of the properties and uses of water. SCN 2-18a	• Uses knowledge of the water cycle to explain how the quantity of water on the Earth has remained approximately the same. • Investigates and discusses the methods used to purify water, for example, sedimentation, filtration, evaporation, desalination and the addition of chemicals such as chlorine. • Researches methods used to conserve water within the home, school and globally and communicates findings to others. • Discusses the many uses of water, for example, to support all living things, in preservation (ice) and to generate electricity.
		I have collaborated in activities which safely demonstrate simple chemical reactions using everyday chemicals. I can show an appreciation of a chemical reaction as being a change in which different materials are made. SCN 2-19a	• Collaborates with others to safely demonstrate simple chemical reactions, for example, effervescence. • Investigates examples of everyday chemical reactions, such as burning and corrosion, and names some of the new substances which are produced. • Uses prior knowledge to identify when a chemical reaction has occurred to produce a new substance.

Topical science	**Topical science**	Through research and discussion, I have an appreciation of the contribution that individuals are making to scientific discovery and invention and the impact this has made on society. SCN 2-20a	• Researches historic and contemporary scientists (ensuring gender balance) and their scientific discoveries and reports collaboratively to others using a range of methods. • Describes the impact of scientific discovery, creativity and invention on society past and present, for example, in design, medicine and agriculture. • Demonstrates understanding of how science impacts on every aspect of our lives. • Relates the development of scientific skills in the classroom to an increasingly wide variety of science, technology, engineering and mathematics (STEM) careers.
		I can report and comment on current scientific news items to develop my knowledge and understanding of topical science. SCN 2-20b	• Explores items of current scientific interest within the school, local community, nationally or in the global media and collates, organises and summarises findings, with assistance. • Shares opinions about a variety of topical scientific issues considering, for example, moral, ethical, societal, cultural, economic and environmental aspects.

Third Level Sciences

The table immediately below has been included as a helpful guide to the scientific skills to be developed within the sciences at Third Level.

Skills	
Inquiry and investigative skills	*Plans and designs scientific investigations and enquiries* - Demonstrates initiative and increasing independence in identifying a number of key questions and in formulating aims, predictions and hypotheses based on information, observations and knowledge. - Designs procedures to test a hypothesis and identifies the independent, dependent and controlled variables, with limited assistance. - Anticipates most risks and hazards. - Demonstrates increased levels of collaboration and initiative in decision-making about samples, measurements, equipment and procedures to use. *Carries out practical activities within a variety of learning environments* - Applies safety measures to control all risks and hazards identified. - Collects increasingly complex data and information using a range of methods and equipment, for example, data and software analysis tools (where available). - Includes a control experiment when appropriate in experimental design. - Manages identified controlled variables to ensure validity of results. *Analyses, interprets and evaluates scientific findings* - Selects appropriate methods to record data/information and demonstrates increased precision in use of terminology, units and scales. - Interprets and analyses data and information to establish relationships between the independent and dependent variables and links to the original hypothesis. - Establishes links between the findings, aim and hypothesis. - Relates findings to scientific knowledge and understanding. - Draws a conclusion based on results gathered and in relation to the aim. - Begins to consider alternative explanations and applies or extends conclusions to new situations or to identify further studies. - Evaluates a range of aspects of the inquiry/investigation, including the relevance and reliability of evidence, and suggests at least two ways of improving the methodology, if repeated.

	Presents scientific findings - Presents data/information using an increasing range of tables, charts, diagrams and graphs and using suitable scales, with limited assistance. - Communicates effectively in a range of ways, for example, orally and through scientific report writing. - Presents findings using appropriate formats for different audiences. - Provides supporting evidence and quotes and acknowledges sources with limited assistance.
Scientific analytical thinking skills	- Applies scientific analytical thinking skills, with increasing independence, working with less familiar and more complex contexts. - Applies understanding of an increasing range of science concepts to solve problems and provide solutions. - Demonstrates further development of creative thinking including through the engineering processes of design, construction, testing and modification.
Skills and attributes of scientifically literate citizens	*At Third Level, it is anticipated that learners will be able to achieve the Benchmarks below with limited assistance.* - Demonstrates understanding of the impact of science on society and debates and discusses the moral and ethical implications of some scientific developments, demonstrating respect for the views of others. - Expresses informed views about topical scientific issues, including those featured in the media, based on evidence and demonstrating understanding of underlying scientific concepts. - Demonstrates increased awareness of creativity and inventiveness in science and the use of technologies in the development of sciences. - Demonstrates understanding of the relevance of science to their future lives and the role of science in an increasing range of careers and occupations, including science, technology, engineering and mathematics (STEM) careers.

Curriculum Organisers		Experiences and Outcomes for planning learning, teaching and assessment	Benchmarks to support practitioners' professional judgement
Planet Earth	Biodiversity and interdependence	I can sample and identify living things from different habitats to compare their biodiversity and can suggest reasons for their distribution. SCN 3-01a	• Identifies living things using biological keys. • Collects and analyses increasingly complex data and information, for example, temperature and light intensity, to suggest reasons for the distribution of organisms within different habitats.
		I have collaborated on investigations into the process of photosynthesis and I can demonstrate my understanding of why plants are vital to sustaining life on Earth. SCN 3-02a	• Describes the process of photosynthesis (using the word equation) in terms of reactants (raw materials) and products. • Applies knowledge gained from practical investigations to explain how green plants make their own food in the form of sugars and store this as starch. • Investigates and presents information on how plants help to sustain life, for example, by providing oxygen, food, habitat, raw materials and medicines.
		Through investigations and based on experimental evidence, I can explain the use of different types of chemicals in agriculture and their alternatives and can evaluate their potential impact on the world's food production. SCN 3-03a	• Interprets data and information to establish a link between the use of fertilisers and plant yield and nutrient levels in the soil. • Researches an agricultural method, for example, chemical fertilisers, herbicides, pesticides, organic methods, genetic modification (GM) and biological control and evaluates their impact on food production.

	Energy sources and sustainability	I can use my knowledge of the different ways in which heat is transferred between hot and cold objects and the thermal conductivity of materials to improve energy efficiency in buildings or other systems. SCN 3-04a	• Applies knowledge from practical investigations to explain how heat is transferred by conduction, convection and radiation. • Establishes a link between heat loss in buildings and the temperature difference between the inside and outside of the building. • Applies understanding of thermal energy efficiency, conductors and insulators to explain how materials can be used in building design to reduce heat loss, for example, in double and triple glazing.
		By investigating renewable energy sources and taking part in practical activities to harness them, I can discuss their benefits and potential problems. SCN 3-04b	• Presents research findings on the advantages and disadvantages associated with the use of renewable energy sources and their impact on society, demonstrating an informed view based on evidence.
	Processes of the planet	By contributing to experiments and investigations, I can develop my understanding of models of matter and can apply this to changes of state and the energy involved as they occur in nature. SCN 3-05a	• Describes, using particle models and diagrams, the properties of solids, liquids and gases and applies this knowledge to identify and classify unknown substances. • Applies understanding of models of matter to explain changes of state in terms of energy being gained or lost by a substance.
		I can explain some of the processes which contribute to climate change and discuss the possible impact of atmospheric change on the survival of living things. SCN 3-05b	• Explains how the levels of carbon dioxide in the atmosphere have increased over time, for example, through respiration of organisms, deforestation and increased combustion of fuels. • Draws on supporting evidence, quotes and sources to demonstrate an association between carbon dioxide in the atmosphere and increasing global temperatures as a result of the greenhouse effect.

	Space	By using my knowledge of our solar system and the basic needs of living things, I can produce a reasoned argument on the likelihood of life existing elsewhere in the universe. SCN 3-06a	• Presents a reasoned argument on the likelihood of life existing elsewhere in the universe including factors such as: the distance of planets from their stars, the number of stars in the universe and the availability of liquid water, nutrients and energy.
Forces, electricity and waves	**Forces**	By contributing to investigations of energy loss due to friction, I can suggest ways of improving the efficiency of moving systems. SCN 3-07a	• Draws on findings from investigations to explain how lubrication, streamlining and other methods can be used to reduce friction, reducing the energy lost and improving efficiency.
		I have collaborated in investigations into the effects of gravity on objects and I can predict what might happen to their weight in different situations on Earth and in space. SCN 3-08a	• Knows that weight is a force caused by the Earth's (or other planet's) gravitational pull on an object, measured in newtons (N), and uses the formula $W = mg$ to calculate weight. • Predicts the effects on the weight of an object due to the gravitational field strength in different positions in the universe, for example, at different altitudes on Earth, on different planets and in deep space.
	Electricity	Having measured the current and voltage in series and parallel circuits, I can design a circuit to show the advantages of parallel circuits in an everyday application. SCN 3-09a	• Applies knowledge from practical investigations to describe the similarities and differences between series and parallel circuits and explain the advantages of parallel circuits in an everyday application.

		I can help to design simple chemical cells and use them to investigate the factors which affect the voltage produced. SCN 3-10a	• Investigates and explains how electricity can be produced when different metals are used as electrodes, with an electrolyte between them. • Investigates and discusses the relationship between a range of factors (for example, the combination of metal electrodes used, the electrolyte used, the electrolyte concentration, the distance between electrodes and surface area of electrodes) and the voltage produced by a simple chemical.
	Vibrations and waves	By exploring the refraction of light when passed through different materials, lenses and prisms, I can explain how light can be used in a variety of applications. SCN 3-11a	• Demonstrates through practical investigation how refraction can cause a change of direction of light as it passes from one material to another. • Describes the practical applications of refraction in everyday situations, for example, in corrective lenses in glasses, and in magnifying glasses and optical instruments. • Explains how a visible spectrum is produced as light passes through a prism.
		By exploring radiations beyond the visible, I can describe a selected application, discussing the advantages and limitations. SCN 3-11b	• Describes the electromagnetic spectrum as a family of waves including Gamma Rays, X-Rays, Ultraviolet, Visible Light, Infrared, Microwaves, Television and Radio. • Researches at least one application of an electromagnetic wave beyond the visible in everyday life, giving advantages and limitations of that application.
Biological systems	**Body systems and cells**	I have explored the structure and function of organs and organ systems and can relate this to the basic biological processes required to sustain life. SCN 3-12a	*Learning at Third Level should take account of, and extend prior learning, both in terms of breadth and depth.* • Explores and explains the structure and function of at least three of the major organ systems, for example, Respiratory, Circulatory, Digestive, Excretory, Reproductive and Skeletal, and relates this to the basic biological processes required to sustain life.

		I have explored the role of technology in monitoring health and improving the quality of life. SCN 3-12b	• Uses a variety of instruments to monitor and record aspects of health, for example, pulse rate, blood pressure and recovery rate and gives examples of other aspects of health that may be monitored, for example, cholesterol and BMI. • Researches one condition that is screened for (for example, bowel cancer, macular degeneration and diabetes) and describes the symptoms of the condition.
		Using a microscope, I have developed my understanding of the structure and variety of cells and of their functions. SCN 3-13a	• Identifies the structures found in plant and animal cells and describes their functions. • Describes the main similarities and differences between plant and animal cells. • Researches and describes the structure and function of some specialised cells, for example, nerve, root hair, red blood cell, sperm and egg.
		I have contributed to investigations into the different types of microorganisms and can explain how their growth can be controlled. SCN 3-13b	• Applies knowledge from investigations to describe the essential resources that micro-organisms need to grow and reproduce, for example, food, water, warm temperature and a suitable pH. • Draws conclusions from investigations to describe how conditions and chemicals can promote and restrict growth, including temperature, antibiotics and antifungals.
		I have explored how the body defends itself against disease and can describe how vaccines can provide protection. SCN 3-13c	• Describes how microbes (for example, bacteria and viruses) can cause disease and infection and how barriers to infection provide a first line of defence, for example, skin, mucus and stomach acids. • Describes how the immune system protects the body against disease if the first line of defence is breached, for example, through the action of white blood cells and production of antibodies. • Applies knowledge of body defence mechanisms to explain how vaccinations can protect individuals and populations from disease.

	Inheritance	I understand the processes of fertilisation and embryonic development and can discuss possible risks to the embryo. SCN 3-14a	• Knows that a sex cell (gamete) contains half the genetic information needed to a make a complete individual. • Explains how the nuclei of an egg and a sperm (sex cells) fuse through the process of fertilisation and how the fertilised egg divides repeatedly to form an embryo. • Identifies the main structures within the pregnant womb (for example, placenta, amniotic fluid and umbilical cord) and describes their function. • Gives examples of substances, including toxins, which can cross the placenta from the mother to the embryo and demonstrates understanding of the potential damage to the embryo.
		I have extracted DNA and understand its function. I can express an informed view of the risks and benefits of DNA profiling. SCN 3-14b	• Knows that DNA is found in the nucleus of most cells and that it contains the instructions for the development and function of living things (genetic code). • Describes a gene as a piece of DNA which controls specific characteristics in an individual and demonstrates understanding that every individual has a unique combination of genes. • Describes DNA profiling as a way of using technology to analyse DNA to see a unique pattern for an individual and gives examples of practical applications (paternity tests and forensics). • Presents reasoned arguments on the ethical implications of collection, processing, storage and ownership of genetic information or DNA profiles.
Materials	**Properties and uses of substances**	I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions. SCN 3-15a	• Investigates and describes properties of metals and non-metals, for example, appearance, conductivity of electricity, position in the Periodic Table and their uses linked to their properties. • Knows that elements are organised in the Periodic Table by atomic number, each with its own unique symbol, and that elements with similar chemical properties are placed together in vertical groups. • Identifies and names the groups ‘alkali metals’, ‘halogens’ and ‘noble gases’ and describes their reactivity.

		Having contributed to a variety of practical activities to make and break down compounds, I can describe examples of how the properties of compounds are different from their constituent elements. SCN 3-15b	• Investigates and describes at least two examples of compounds with properties that are different from their constituent elements, for example, hydrogen explosion and electrolysis of water. • Constructs names of two-element compounds which are derived from the names of the elements, from which it is formed, with a suffix of-ide. • Constructs word equations for simple reactions, for example, carbon reacting with oxygen: carbon + oxygen → carbon dioxide.
		I can differentiate between pure substances and mixtures in common use and can select appropriate physical methods for separating mixtures into their components. SCN 3-16a I have taken part in practical investigations into solubility using different solvents and can apply what I have learned to solve everyday practical problems. SCN 3-16b	• Identifies elements present from simple molecular formulae. • Gives examples of pure substances and mixtures from everyday life. • Selects appropriate physical methods to separate mixtures into their components, for example, distillation, filtration and chromatography and justifies their choices. • Investigates and describes the solubility of substances in different solvents, for example, water and acetone/propanone. • Explains the link between the relative quantity of solute or solvent and changes in the concentration of a solution.
	Earth's materials	Through evaluation of a range of data, I can describe the formation, characteristics and uses of soils, minerals and basic types of rocks. SCN 3-17a	• Applies knowledge of the rock cycle to describe the formation and characteristics of sedimentary, igneous and metamorphic rocks and gives at least one example of how each is used. • Describes the formation and characteristics of loam, sand and clay soil types, providing examples of their uses, for example, in agriculture, building and beauty products. • Researches the formation, characteristics and uses of at least two common minerals, for example, quartz or gypsum and communicates their findings to others using a range of media.

		I can participate in practical activities to extract useful substances from natural resources. SCN 3-17b	• Investigates and describes how at least two useful substances can be extracted from natural resources, for example, metal from mineral ores, dyes from plants and oils from plants.
	Chemical changes	Having taken part in practical activities to compare the properties of acids and bases, I have demonstrated ways of measuring and adjusting pH and can describe the significance of pH in everyday life. SCN 3-18a	• Knows that indicators, such as universal indicator, are chemicals which produce different colours when placed in acid and alkali/bases. • Investigates and describes the colour changes of indicators when added to acid/bases. • Investigates and describes the pH of some everyday substances. • Identifies substances as acidic (pH of less than 7), alkaline/basic (pH greater than 7) or neutral (equal to 7). • Investigates and describes what happens to the pH when an acid is added to an alkali/basic.
		Through experimentation, I can identify indicators of chemical reactions having occurred. I can describe ways of controlling the rate of reactions and can relate my findings to the world around me. SCN 3-19a	• Identifies indicators of chemical reactions such as colour change, precipitate formation, release of gas, and/or a detectable energy change. • Finds the relationship between particle size, concentration temperature and catalysts and the rate of a reaction. • Explains how catalysts, including enzymes, can be used to speed up chemical reactions, and provides at least two everyday examples of reactions involving a catalyst.

		I have helped to design and carry out practical activities to develop my understanding of chemical reactions involving the Earth's materials. I can explain how we apply knowledge of these reactions in practical ways. SCN 3-19b	• Describes chemical reactions involving the Earth's materials, for example, combustion of fossil fuels, carbonate rocks reacting with acid and the formation and impact of acid rain.
Topical science	**Topical science**	I have collaborated with others to find and present information on how scientists from Scotland and beyond have contributed to innovative research and development. SCN 3-20a Through research and discussion, I have contributed to evaluations of media items with regard to scientific content and ethical implications. SCN 3-20b	• Collaborates with others to research how scientists, and those who use science in their jobs, have contributed to the development of scientific ideas. • Communicates findings in a suitable way to give an example of how scientists contribute to innovative research and development. • Gives examples of how skills developed through science are used in a wide variety of jobs and careers including science, technology, engineering and mathematics (STEM) careers. • Demonstrates understanding of bias and separates fact from opinion taking into account a range of reasons for bias, for example, selective sampling and political views. • Analyses the scientific content in media items and presents a reasoned argument on the ethical implications of the scientific issue being explored.

Fourth Level Sciences

As stated in Building the Curriculum 3, in the S1-S3 stage, "Most learners will progress towards the Fourth Level Experiences and Outcomes in many aspects of their learning". There is no expectation, therefore, that learners will overtake all the Fourth Level Sciences Experiences and Outcomes, and hence achieve all the Fourth Level Benchmarks. These should be used selectively by teachers to ensure that the foundation of knowledge and skills is developed which enables young people to make a seamless transition to any of the sciences qualifications. This should take account of learners' interests and aspirations and should ensure they have the opportunity to pursue other sciences qualifications at a later stage within the Senior Phase, should they decide to do so.

The table immediately below has been included as a helpful guide to the scientific skills to be developed within the sciences at Fourth Level. At Fourth Level, it is anticipated that learners will demonstrate the following skills independently.

Skills	
Inquiry and investigative skills	*Plans and designs scientific investigations and enquiries* - Formulates hypotheses and predictions, in more complex and less familiar contexts, based on prior knowledge and observations. - Designs a procedure for carrying out the investigation independently. - Devises an experimental aim. - Identifies the independent, dependent and controlled variables. - Includes a control experiment in experimental design (when appropriate to do so). - Selects an appropriate method for measuring the dependent variable. - Anticipates major risks and hazards and plans for them. - Selects a suitable range of values for the independent variable. *Carries out practical activities within a variety of learning environments* - Applies safety measures to control major risks and hazards identified. - Collects accurate measurements of complex data using appropriate method identified. - Uses correct units for measurements. - Records data in an appropriate way, demonstrating precision in the use of terminology, units and scales. *Analyses, interprets and evaluates scientific findings* - Makes use of suitable graph or diagram to look for trends or patterns within the data. - Interprets and analyses data and information to establish relationships between the independent and dependent variables and links to the original hypothesis. - Describes any trend or pattern within the data collected.

	- Considers alternative explanations and applies or extends conclusions to new situations and indicates additional studies. - Relates and applies findings to wider scientific knowledge and understanding. - Links the trend(s) in the results to the aim of the investigation and formulates an appropriate conclusion with supporting data. - Evaluates a range of aspects of the investigation, including the validity and reliability of evidence, giving at least two ways of improving the work if repeated, with justification. *Presents scientific findings* - Presents data/information using an increasing range of tables, charts, diagrams and graphs and using suitable scales, with no assistance. - Selects appropriate ways of presenting qualitative and quantitative findings, taking account of the audience. - Summarises data and information from at least two sources as supporting evidence, for example, quotes. - Acknowledges all sources used in an appropriate format, for example, using full URLs.
Scientific analytical thinking skills	- Applies scientific thinking skills while working with unfamiliar and complex contexts. - Applies and combines knowledge and understanding from different areas of science to solve problems. - Makes use of the engineering process in practical work to design, construct a model, test and modify the design to improve the solution.
Skills and attributes of scientifically literate citizens	*The skills below mirror those at Third Level but at Fourth Level it is anticipated that learners will be able to demonstrate these independently and that the content and arguments would be more complex and sophisticated.* - Demonstrates understanding of the impact of science on society and debates and discusses the moral and ethical implications of some scientific developments, demonstrating respect for the views of others. - Expresses informed views about topical scientific issues, including those featured in the media, based on evidence and demonstrating understanding of underlying scientific concepts. - Demonstrates increased awareness of creativity and inventiveness in science and the use of technologies in the development of sciences. - Demonstrates understanding of the relevance of science to their future lives and the role of science in an increasing range of careers and occupations, including science, technology, engineering and mathematics (STEM) careers.

Curriculum Organisers		Experiences and Outcomes for planning learning, teaching and assessment	Benchmarks to support practitioners' professional judgement
Planet Earth	Biodiversity and interdependence	I understand how animal and plant species depend on each other and how living things are adapted for survival. I can predict the impact of population growth and natural hazards on biodiversity. SCN 4-01a	• Describes how plants and animals depend on each other for food, shelter and pollination, using scientific vocabulary such as 'population', 'community' and 'species'. • Explains the possible effects of removal or addition of species on food webs and biodiversity. • Summarises research findings to provide examples of structural, physiological and behavioural adaptations which lead to species survival.
		I have propagated and grown plants using a variety of different methods. I can compare these methods and develop my understanding of their commercial use. SCN 4-02a	• Compares natural and artificial techniques to propagate plants, for example, seeds, bulbs and cuttings, and suggests commercial uses such as food production and food security.
		I can contribute to the design of an investigation to show the effects of different factors on the rate of aerobic respiration and explain my findings. SCN 4-02b	• Explains, using experimental findings, the effect of different factors on the rate of aerobic respiration. • Uses the word equation to describe the process of aerobic respiration.
		Through investigating the nitrogen cycle and evaluating results from practical experiments, I can suggest a design for a fertiliser, taking account of its environmental impact. SCN 4-03a	• Describes the nitrogen cycle and explains the importance of each stage. • Explores and explains the possible impact of the use of fertilisers, for example, algal blooms.

	Energy sources and sustainability	By contributing to an investigation on different ways of meeting society's energy needs, I can express an informed view on the risks and benefits of different energy sources, including those produced from plants. SCN 4-04a Through investigation, I can explain the formation and use of fossil fuels and contribute to discussions on the responsible use and conservation of finite resources. SCN 4-04b	• Applies knowledge and understanding from different areas of the curriculum to express an informed view of the risks and benefits of different energy sources, including at least one energy source derived from plants. • Discusses, following research, the formation and use of fossil fuels and the need to use remaining fossil fuel resources responsibly, for example, to preserve finite supplies, limit pollution and reduce emissions of greenhouse gases.
	Processes of the planet	I have developed my understanding of the kinetic model of a gas. I can describe the qualitative relationships between pressure, volume and temperature of gases. SCN 4-05a Through exploring the carbon cycle, I can describe the processes involved in maintaining the balance of gases in the air, considering causes and implications of changes in the balance. SCN 4-05b	• Calculates the pressure exerted by a force over an area using the relationship $P = F / A$. • Describes, from experimental observation, the relationships between pressure, volume and temperature for a fixed mass of gas. • Describes the steps in the carbon cycle and explains how processes such as respiration, photosynthesis and burning carbon-based fuels affect the balance of gases in the air. • Researches the effects of changes in the balance of gases in the air and shares their scientific findings in an appropriate manner.
	Space	By researching developments used to observe or explore space, I can illustrate how our knowledge of the universe has evolved over time. SCN 4-06a	• Describes the operation of an optical telescope, for example, reflecting or refracting telescopes, and explains the advantages of placing optical telescopes in orbit, for example, larger range due to less absorption and less atmospheric distortion. • Researches and describes advances in techniques for viewing the universe, for example, using radio telescopes, emission spectra

			or through gravitational wave detection. • Discusses how discoveries made through observations have improved our knowledge of the universe and provides supporting evidence.
Forces, electricity and waves	**Forces**	I can use appropriate methods to measure, calculate and display graphically the speed of an object, and show how these methods can be used in a selected application. SCN 4-07a	• Measures and records data from experiments to produce speed-time graphs and interprets speed-time graphs to accurately describe motion. • Calculates acceleration and distance travelled from a speed-time graph.
		By making accurate measurements of speed and acceleration, I can relate the motion of an object to the forces acting on it and apply this knowledge to transport safety. SCN 4-07b	• Explains the motion of objects in situations involving constant acceleration, using Newton's Second Law, and applies knowledge to the context of transport safety, for example, braking distances, seatbelts, airbags and other design features.
		I can help to design and carry out investigations into the strength of magnets and electromagnets. From investigations, I can compare the properties, uses and commercial applications of electromagnets and super magnets. SCN 4-08a	• Interprets and analyses data to establish a relationship between the strength of electromagnets and, for example, the number of coils, size of current, core material or dimensions. • Compares model electromagnets with those used in real-life applications, looking for similarities and differences. • Shares scientific findings about the uses of super magnets, for example, in MRI machines, computer hard drives, electric and hybrid motors, audio speakers, electric guitars and race car engines.
		Through experimentation, I can explain floating and sinking in terms of the relative densities of different materials. SCN 4-08b	• Calculates the density of a range of materials using the relationship *Density = mass / volume.*

	Electricity	Through investigation, I understand the relationship between current, voltage and resistance. I can apply this knowledge to solve practical problems. SCN 4-09a	• Investigates the electrical properties of at least one fixed resistor to determine the relationship R = V / I and applies this to solve practical problems in circuits.
		By contributing to investigations into the properties of a range of electronic components, I can select and use them as input and output devices in practical electronic circuits. SCN 4-09b	• Demonstrates understanding of the properties of input devices (for example, variable and light dependent resistors, thermistors and switches) and the operation of output devices (for example, bulbs, LEDs, motors and relays).
		Using my knowledge of electronic components and switching devices, I can help to engineer an electronic system to provide a practical solution to a real-life situation. SCN 4-09c	• Applies knowledge and understanding of the properties of switching devices, for example, transistors and logic gates, to design and construct an electronic circuit which solves a practical problem.
		Using experimental evidence, I can place metals in an electrochemical series and can use this information to make predictions about their use in chemical cells. SCN 4-10a	• Draws on findings from experiments to construct an electrochemical series using the voltage difference between pairs of metals. • Demonstrates an understanding of the use of different metals in electrochemical cells for different applications.
		Using a variety of sources, I have explored the latest developments in chemical cells technology and can evaluate their impact on society. SCN 4-10b	• Researches and demonstrates awareness of the developments in cell technology, for example, in relation to fuel cells. • Researches an application of chemical cells and its impact on society, communicating findings to others and acknowledging sources appropriately.

	Vibrations and waves	By recording and analysing sound signals, I can describe how they can be manipulated and used in sound engineering. SCN 4-11a By carrying out a comparison of the properties of parts of the electromagnetic spectrum beyond the visible, I can explain the use of radiation and discuss how this has impacted upon society and our quality of life. SCN 4-11b	• Interprets sound wave traces to describe changes in amplitude and frequency. • Compares non-visible parts of the electromagnetic spectrum, finding their common properties (speed, propagation), individual properties (range of frequencies, wavelengths) and discusses their uses.
Biological systems	**Body systems and cells**	I can explain how biological actions which take place in response to external and internal changes work to maintain stable body conditions. SCN 4-12a Through investigation, I can explain how changes in learned behaviour due to internal and external stimuli are of benefit to the survival of species. SCN 4-12b	• Describes the changes in the body in response to an external stimulus (for example, change in temperature) and an internal change (for example, water balance and the kidneys or the action of insulin in relation to the regulation of glucose). • Explains the importance of these changes in relation to the normal working conditions of the body (homeostasis). • Describes methods of learned behaviour in organisms, for example, the effect of light on the behaviour of woodlice, and explains how this behaviour contributes to their survival.
		By researching cell division, I can explain its role in growth and repair and can discuss how some cells can be used therapeutically. SCN 4-13a	• Summarises data and information from research to explain why cell division is required for growth and repair in organisms. • Researches and describes at least one therapeutic use of stem cells.

		I have taken part in practical activities which involve the use of enzymes and microorganisms to develop my understanding of their properties and their use in industries. SCN 4-13b	• Describes the properties and industrial uses of at least one microorganism, for example, the use of yeast in brewing and bacteria in yogurt production. • Describes the properties of at least one enzyme used in industry, for example, enzymes within biological detergents and stain removers or pectinase in the breakdown of plant material to release juice.
		I can debate the moral and ethical issues associated with some controversial biological procedures. SCN 4-13c	• Formulates a reasoned argument, based on evidence and using correct scientific vocabulary, to debate moral and ethical issues of the chosen controversial biological procedure, for example, the collection and use of stem cells and DNA profiling.
	Inheritance	Through investigation, I can compare and contrast how different organisms grow and develop. SCN 4-14a	• Investigates and researches the life cycles of at least two organisms and compares and contrast their related growth and development.
		Through evaluation of a range of data, I can compare sexual and asexual reproduction and explain their importance for survival of species. SCN 4-14b	• Evaluates and compares data and information on sexual and asexual reproduction, for example, rate of reproduction and numbers of organisms, and explains the importance of both methods for survival of species.
		I can use my understanding of how characteristics are inherited to solve simple genetic problems and relate this to my understanding of DNA, genes and chromosomes. SCN 4-14c	• Describes how the genetic information received from parent(s) determines some of our physical characteristics and demonstrates understanding that some genes have dominant and recessive versions called ‘alleles’. • Produces a worked example to solve a simple genetic problem, for example, a monohybrid cross to show the passage of genes from parents to offspring.

Materials	**Properties and uses of substances**	Through gaining an understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures. SCN 4-15a	• Constructs diagrams and models to illustrate the sharing of outer electrons in covalent bonds between non-metal atoms when forming molecules and to illustrate how ionic compounds exist as a crystal lattice. • Identifies, from temperature data, the relationship between melting and boiling points and the state at room temperature for covalent and ionic compounds. • Investigates and describes electrical conductivity for covalent and ionic compounds. • Identifies the most likely type of bonding in a compound based on its properties, for example, melting and boiling points and electrical conductivity.
		I have carried out research into novel materials and can begin to explain the scientific basis of their properties and discuss the possible impacts they may have on society. SCN 4-16a	• Summarises data and information from research to explain the properties, practical application and potential impact of a novel material.
		Through evaluation of experimental results, I can demonstrate my understanding of conservation of mass. SCN 4-16b	• Demonstrates understanding of conservation of mass by evaluating experimental results relating to the mass of reactants and products of at least two chemical reactions, for example, burning iron wool, making magnesium oxide or precipitation of ionic salts.
	Earth's materials	I have explored how different materials can be derived from crude oil and their uses. I can explain the importance of carbon compounds in our lives. SCN 4-17a	• Explains how fractional distillation can be used to separate crude oil into 'fractions' (groups of compounds with similar boiling points). • Identifies and describes the importance of at least three everyday substances that are made from hydrocarbons, for example, petrol for fuel, camping gas or plastics.

	Chemical changes	I can monitor the environment by collecting and analysing samples. I can interpret the results to inform others about levels of pollution and express a considered opinion on how science can help to protect our environment. SCN 4-18a	• Analyses and interprets findings from environmental sample data to identify the quantities of pollutants present. • Gives at least one reason for the presence of a pollutant in an environmental sample and describes the environmental change which may occur as a result of the presence of the pollutant.
		I can collect and analyse experimental data on chemical reactions that result in an obvious change in energy. I can apply my findings to explain the significance of the energy changes associated with chemical reactions. SCN 4-19a	• Collects and analyses temperature data to identify, on at least two occasions, where a chemical reaction is either exothermic or endothermic.

		Having carried out a range of experiments using different chemicals, I can place metals in an order of reactivity, and relate my findings to their everyday uses.
		SCN 4-19b
			• Uses data from experiments to list metals in order of reactivity, for example, involving metals reacting with oxygen (to produce oxides), metals reacting with water (to produce hydroxides) and metals reacting with a dilute acid (to produce hydrogen gas and aqueous salts).
			• Constructs simple formulae equations describing reactions of metals with oxygen, water and a dilute acid.
			• Investigates and describes three methods of extracting metals from their compound ores as:
			  ○ Heating alone, for example, with silver oxide
			  ○ Heating with carbon, for example, with copper oxide
			  ○ Electrolysis, for example, lead bromide (possible demonstration).
			• Identifies the appropriate extraction method for a metal depending on the position of the metal in the reactivity series.
			• Draws on findings from investigations to explain how metals above iron in the reactivity series can be used to sacrificially protect iron from corrosion.

Topical science	**Topical science**	I have researched new developments in science and can explain how their current or future applications might impact on modern life. SCN 4-20a Having selected scientific themes of topical interest, I can critically analyse the issues, and use relevant information to develop an informed argument. SCN 4-20b	• Researches and communicates developments in science, explaining how current and future applications might impact on life. • Demonstrates increasing understanding of how the transferrable skills developed through the sciences are used in a wide variety of jobs including science, technology, engineering and mathematics (STEM) careers. • Selects and analyses scientific content of topical interest from a range of sources, including the media. • Identifies examples of bias in sources and justifies decisions in separating fact from opinion. • Critically analyses a scientific issue and gives consideration to the ethical, moral, environmental, social or political implications of the scientific theme selected to develop an informed argument.