CfE Curricular Resource Mapping Tool

Version 1.0
August 2021
CfE Sciences at Third and Fourth Level

Introduction

Thank you for downloading this curricular mapping resource tool which links the curriculum organisers and experiences and outcomes within CfE to the wide range of courses and resources available to educators by SSERC.

This document is updated regularly and SSERC advises that educators check the professional learning calendar page on our website and also follow our STEM programmes Twitter account @SSERCSTEM for updates on all professional learning opportunities at SSERC.

This version 1.0 document contains:

All SSERC course and resource links for CfE Sciences at Third and Fourth Level.

Looking ahead:
Version 1.1 will be published before the end of 2021 with necessary updates including additional content for CfE Sciences at Early, First and Second Level and

Using this document

This PDF document has bookmarks entered throughout to allow you to move straight to a particular curriculum organiser. Navigate to the relevant area of the curriculum you are interested in and simply use the rightmost column to identify the course, resource or other offer SSERC has to support the educational delivery of this part of the curriculum. In cases where there are no relevant SSERC offers, the Benchmark statement from Education Scotland has been left in.

Acknowledgement

SSERC would like to thank our colleagues at Education Scotland for providing the original CfE benchmarking document from which this mapping tool has been produced.

Feedback

SSERC welcomes feedback on this document and if you would like to make any comments or suggestions to help us improve this tool, please contact us at enquiries@sserc.scot

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	SSERC courses, resources and other offers
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	Sampling, biodiversity and distribution https://www.sserc.org.uk/subject-areas/biology/biology-national-4/learned-behaviour-in-response-to-stimuli-linked-to-species-survival/ Animal and plant species depend on each other https://www.sserc.org.uk/subject-areas/biology/biology-national-4/sampling-and-distribution-b/
		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	Photosynthesis - plants are vital to sustaining life on Earth https://www.sserc.org.uk/subject-areas/biology/biology-national-4/photosynthesis-limiting-factors/
		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	Chemicals in agriculture: their potential impact on the world's food production https://www.sserc.org.uk/subject-areas/biology/biology-national-4/fertiliser-design-and-environmental-impact-of-fertilisers/

	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	Chemistry-based resources to support teaching of these two outcomes can be found here: https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/04-energy-sources-and-sustainability-3/ Physics-based: Heat transfer and energy Model house investigation
		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	Chemistry: Biodiesel (workshop) – A range of experiments based around the production and testing of Biodiesel from vegetable oil. Oil from coffee grounds – not technically an oil but a simple method for extracting an oil-like mixture of terpenoids from coffee grounds that can be used as a fuel. Physics: Wind turbines
	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	Climate change: impact of atmospheric change on the survival of living things. https://www.sserc.org.uk/subject-areas/biology/biology-national-4/impact-of-population-growth-and-natural-hazards-on-biodiversity/ Ion Migration (Demo) – Diffusion of lead nitrate and potassium iodide – yellow lead iodide precipitate at boundary.

		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	Diffusing precipitates – microscale – a microscale version of the above experiment (and some similar ones) which enables the concept to be put across by pupil experiment rather than demonstration. Chemistry-based resources to support teaching of these two outcomes can be found here: https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/05-processes-of-the-planet-3/ When a Fossil Fuel is Burned (Demo) – Collection of water and carbon dioxide when a Bunsen burns. YouTube video: The Physics of Climate Change
	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	**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	Smart Carts Bulletin 258

		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	Using multi-meters Just clowning around with switches
		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	Physics Fights Crime (refraction)

		By exploring radiations beyond the visible, I can describe a selected application, discussing the advantages and limitations. SCN 3-11b	UV and sun creams activities UV and IR experiments Thermal Imaging Bulletin 245 See the heat with thermochromic sheet
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	https://www.sserc.org.uk/subject-areas/biology/biology-national-5/the-need-for-transport/
		I have explored the role of technology in monitoring health and improving the quality of life. SCN 3-12b	https://www.sserc.org.uk/subject-areas/biology/biology-national-5/effects-of-lifestyle-choices-on-human-transport-and-exchange-systems/
		Using a microscope, I have developed my understanding of the structure and variety of cells and of their functions. SCN 3-13a	https://www.sserc.org.uk/subject-areas/biology/biology-national-5/cell-structure/ Liver cells Hanging Drop of Algal Culture

		I have contributed to investigations into the different types of microorganisms and can explain how their growth can be controlled. SCN 3-13b I have explored how the body defends itself against disease and can describe how vaccines can provide protection. SCN 3-13c	https://www.sserc.org.uk/subject-areas/biology/biology-national-4/properties-of-microorganisms-and-use-in-industries-nat-4/ https://www.sserc.org.uk/subject-areas/interdisciplinary-learning/lets-talk/let-s-talk-vaccines/
	Inheritance	I understand the processes of fertilisation and embryonic development and can discuss possible risks to the embryo. SCN 3-14a	Variation and inheritance
		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	https://www.sserc.org.uk/subject-areas/biology/biology-national-4/dna-genes-and-chromosomes-nat-4/

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	Chemistry-based resources to support teaching of these two outcomes can be found here: https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/15-16-properties-and-uses-of-substances-3/ Flame Colours – Some different methods of getting good colours for flame tests. Hydrogen Balloons – there is not much a chemist likes more than a good explosion and igniting balloons of hydrogen certainly fits the bill. Sodium (and other alkali metals) in water – Guidance on the safe way to carry out this classic chemistry demonstration.
		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	Electrolysis of lead bromide – microscale – a small scale version of the classic experiment that does not need to be carried out in a fume cupboard. Iron-sulphur – microscale – a small scale version of the classic experiment that reduces the production of toxic gases. The iron is reacted with sulphur and the properties of the resulting sulphides are investigated.
		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	Chemistry-based resources to support teaching of these two outcomes can be found here: https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/15-16-properties-and-uses-of-substances-3/ Black Magic – Simple paper chromatography of ink.

			Flash Chromatography (workshop) – Flash chromatography carried out in a syringe – using talc (or cornflour) – can be used to separate samples of food dyes or plant pigments. Concrete chemistry (workshop) – A series of activities looking at cement and concrete. (Looking more at importance and properties of mixtures than their separation) Food Forensics – An activity using Solid Phase Extraction to take food colourings out of soft drinks and then other forms of chromatography to analyse them. Shampoo (workshop) – Activity to make shampoo, involving steam distillation to extract natural essences. TLC of amino acids in Soy Sauce – an investigation into the different amino acids that can be found in different types/brands of soy sauce using thin-layer chromatography.
		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	Partition of Iodine – a simple reaction showing the equilibrium resulting from the partition of iodine between water and an organic solvent.
	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	Chemistry-based resources to support teaching of these two outcomes can be found here: https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/17-earth-s-materials-3/ Rocks and Minerals (workshop) – A series of simple experiments to make samples of sedimentary, igneous and metamorphic rocks.

		I can participate in practical activities to extract useful substances from natural resources. SCN 3-17b	Antioxidants (workshop) – A Range of investigations to look at antioxidant levels in fruits and teas (though the method can be adapted for any antioxidant). Biodiesel (workshop) – A range of experiments based around the production and testing of Biodiesel from vegetable oil. Concrete chemistry (workshop) – A series of activities looking at cement and concrete. Flash Chromatography (workshop) – Flash chromatography carried out in a syringe – using talc (or cornflour) – can be used to separate samples of food dyes or plant pigments. Lip Balm (workshop) – Activities researching and then making lip balms. Oil from coffee grounds – not technically an oil but a simple method for extracting an oil-like mixture of terpenoids from coffee grounds that can be used as a fuel. Shampoo (workshop) – Activity to make shampoo, involving steam distillation to extract natural essences. Silicon and Silanes from Sand (Demo) – Making silicon and silane from the reaction between magnesium and silicon dioxide (sand).
	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.	Chemistry-based resources to support teaching of this outcome can be found here: https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/18-19-chemical-changes-3/ Colourful Flowers (demo) – Make paper 'flowers' soaked in different buffer solutions. Then spray indicator on and you get different colour flowers.

		SCN 3-18a	Indicators – microscale – a small scale investigation into indicators and pH. Law of Similar Shapes (Demo) – Simple neutralisation reactions with phenolphthalein. Rainbow Reaction (Demo) – Form a rainbow of colours to illustrate pH scale with hydrochloric acid and sodium carbonate along the length of a burette. Spell Casting (Demo) – Clear liquid poured into beakers fails to change colour until the last one – phenolphthalein indicator – due to tiny amounts of acids/bases in beakers. Vinegar Cheats (workshop) – Using a simple titration (with pipettes) to find out which samples of vinegar have been watered down.
		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	Chemistry-based resources to support teaching of these two outcomes can be found here. https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/18-19-chemical-changes-3/ Bleaching Blue Food Dye (workshop) – simplified version of a more advanced experiment looking at how blue food dye is decoloured by household bleach. Blue Bottle Reaction (demo) – Redox Reaction – on standing methylene blue solution turns clear, shaking turns it back to blue. Blue Light (Demo) – Luminol reaction. A chemical experiment that produces light but not heat. Cannon Fire (Demo) – Potassium permanganate catalyses breakdown of hydrogen peroxide mixed with Ethanol. Burning ethanol/hydrogen peroxide mixture is quiet but loud bangs appear on addition of permanganate.

			Catalyst at Work (Demo) – Rochelle Salt and hydrogen peroxide, catalysed by cobalt chloride, shows different colour intermediate. Colourless, Orange or Blue (Demo) – The oscillating Briggs-Rauscher reaction (as used in antioxidants). A Cool Experiment (demo) – A very endothermic mixture of barium hydroxide and ammonium thiocyanate freezes a beaker to a wet plank/mat Electric Writing (Demo) – Electrical reduction to produce alkaline hydroxide ions which are shown up by indicator where you have 'written'. Electrolysis of lead bromide – microscale – a small scale version of the classic experiment that does not need to be carried out in a fume cupboard. Elephant's Toothpaste (Demo) – Foam produced by catalytic decomposition of hydrogen peroxide with detergent and food colouring. Equilibrium and Le Chatelier (demo) – effect of temperature on equilibrium – a complex is coloured differently in hot and cold. Fizz pops (workshop) – Using vitamin C tablets and bicarbonate of soda in 35mm film canisters to follow a reaction rate. Fire Writing (demo) – Draw trail on filter paper with sodium nitrate and dry it. Then light end of trail and watch the fire smoulder along the path. Flame Colours (Demo) – Using atomiser bottles for flame tests. Gloopy and Gooey (Demo) – Gaviscon in copper sulphate solution and PVA/Borax cross-linking polymers.

			Growing Silver Trees (Demo) – a displacement reaction with copper wite and silver nitrate that produces dendritic crystals of metallic silver. Hot Stuff (Demo) – Exothermic spontaneous reaction of glycerol with potassium permanganate. Invisible Writing (Demo) – Invisible ink made from Aspirin is revealed by an Iron sulphate spray. Lemons (workshop) – Investigating the effect of concentration and temperature on rate of reaction using lemon juice and potassium permanganate. Light Sticks (Demo) – Effect of temperature on luminosity of glow-sticks. Methane bags (Demo) – Burning bags with different ratios of methane:oxygen in. Methane Bubbles (Demo) – Preparing and igniting bubbles of methane. Methane Tin (Demo) – Using an old coffee tin with a methane flame from hole in top. Air comes in and eventually you get the right ratio for an explosion to blow the lid off. Polymer Slime (workshop) – Making slime from borax and PVA glue – and looking at the properties as the composition varies. Rhubarb Rhubarb (workshop) – (Similar to Lemons) Using rhubarb decolourising potassium permanganate to follow the rate of reaction, looking at concentration and surface area. Plus, a fun demo version – stir a beaker of dilute potassium manganate VII with a stick of rhubarb, the solution goes clear.

			Screaming Jelly Baby (Demo) – Molten potassium chlorate V causes rapid combustion of sugar in a jelly baby. Silver Mirror (Demo) – Ammoniacal silver nitrate is prepared and this is reduced in a flask by a reducing sugar leading to a coating of silver on its inside. Thionin (Demo) – A photochemical reduction. Thionin is a different colour in light and dark. Traffic Lights (Demo) – A reversible redox reaction variant on the blue bottle reaction. Dye changes colour on shaking and reverts on standing. Turning Copper Coins into Silver and Gold (Demo) – Zinc plating a copper coin with sodium zincate and then heating it to make brass. Vitamin C Drops (workshop) – Determining the concentration of Vitamin C in a variety of fruit juices using a simple titration with iodine. Whoosh Bottle (Demo) – Ignition of alcohol vapour in a 15l water bottle to produce a spectacular ‘whoosh’.

		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	Copper Etching (workshop) – Activity using the displacement reaction between copper sulphate solution and zinc plate to etch a design. Fizz pops (workshop) – Using vitamin C tablets and bicarbonate of soda in 35mm film canisters to follow a reaction rate. Lemons (workshop) – Investigating the effect of concentration and temperature on rate of reaction using lemon juice and potassium permanganate. Vinegar Cheats (workshop) – Using a simple titration (with pipettes) to find out which samples of vinegar have been watered down. Antioxidants (Workshop) – A Range of investigations to look at antioxidant levels in fruits and teas (though the method can be adapted for any antioxidant). Dye Sensitised Solar Cells (workshop) – An activity to show generation of electricity from plant pigments.

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	https://www.sserc.org.uk/subject-areas/interdisciplinary-learning/lets-talk/ Antioxidants (Workshop) – A Range of investigations to look at antioxidant levels in fruits and teas (though the method can be adapted for any antioxidant). Dye Sensitised Solar Cells (workshop) – An activity to show generation of electricity from plant pigments.
		Through research and discussion, I have contributed to evaluations of media items with regard to scientific content and ethical implications. SCN 3-20b	Chemistry: Antioxidants (Workshop) – A Range of investigations to look at antioxidant levels in fruits and teas (though the method can be adapted for any antioxidant). Dye Sensitised Solar Cells (workshop) – An activity to show generation of electricity from plant pigments. Shampoo (workshop) – Activity to make shampoo, involving steam distillation to extract natural essences. Physics: Millimetre waves

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	SSERC courses, resources and other offers
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	Growth and development of different organisms - Scottish Schools Education Research Centre (sserc.org.uk)
		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 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	• 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. Factors affecting respiration - Scottish Schools Education Research Centre (sserc.org.uk)
		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	Fertiliser design and environmental impact of fertilisers - Scottish Schools Education Research Centre (sserc.org.uk)

	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	Chemistry-based resources to support teaching of these two outcomes can be found here. https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/04-energy-sources-and-sustainability-4/ Biodiesel (workshop) – A range of experiments based around the production and testing of Biodiesel from vegetable oil. Oil from coffee grounds – not technically an oil but a simple method for extracting an oil-like mixture of terpenoids from coffee grounds that can be used as a fuel.
		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	When a Fossil Fuel is Burned (Demo) – Collection of water and carbon dioxide when a Bunsen burns
	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	Chemistry-based resources to support teaching of these two outcomes can be found here: https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/05-processes-of-the-planet-4/
		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	When a Fossil Fuel is Burned (Demo) – Collection of water and carbon dioxide when a Bunsen burns.

	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	Physics fights Crime (motion) Speed Camera App – Bulletin 252 BeeSpiV – Bulletin 264 Tracker – Bulletin 272 BeeSpiV – Intro sserctv Tracker in a browser sserctv Rolling resistance
		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	Teaching forces as a road safety context Reaction times Bulletin 241 BeeSpiV – Bulletin 264 BeeSpiV – Intro sserctv CD Hovercraft

		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 Through experimentation, I can explain floating and sinking in terms of the relative densities of different materials. SCN 4-08b	• 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. Ice Cubes floating
	Electricity	Through investigation, I understand the relationship between current, voltage and resistance. I can apply this knowledge to solve practical problems. SCN 4-09a	Velostat – Bulletin 270

		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 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	Using alpha kit SSERCTV
		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 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	• Draws on findings from experiments to construct an electrochemical series using the voltage difference between pairs of metals. • Demonstrates an understanding of the use of different metals in electrochemical cells for different applications. • Researches and demonstrates awareness of the developments in cell technology, for example, in relation to fuel cells. • Researches an application of chemical cells and its impact on society, communicating findings to others and acknowledging sources appropriately.
	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	Phys X Factor sound engineering

		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	UV and IR activities UV and IR hidden radiations
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). Learned behaviour in response to stimuli linked to species survival - Scottish Schools Education Research Centre (sserc.org.uk)
		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	Therapeutic use of cells - Scottish Schools Education Research Centre (sserc.org.uk)

		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	Properties of enzymes & use in industries - Scottish Schools Education Research Centre (sserc.org.uk)
		I can debate the moral and ethical issues associated with some controversial biological procedures. SCN 4-13c	Let's Talk - Scottish Schools Education Research Centre (sserc.org.uk)
	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	Genetic information - Scottish Schools Education Research Centre (sserc.org.uk)

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	Chemistry-based resources to support teaching of this outcome can be found here. https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/15-16-properties-and-uses-of-substances-4/
		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	Chemistry-based resources to support teaching of these two outcomes can be found here. https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/15-16-properties-and-uses-of-substances-4/ Smart Materials (workshop) – Some short activities looking at the properties of commercially available smart/novel chemical materials. Physics: Novel materials QTC composite Electrolycra – Bulletin 268 Velostat – Bulletin 270
		Through evaluation of experimental results, I can demonstrate my understanding of conservation of mass. SCN 4-16b	Formula of magnesium oxide – microscale – a small scale version of the experiment to determine the mass of oxygen added to burning magnesium and hence work out its formula.
	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	Chemistry-based resources to support teaching of these two outcomes can be found here. https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/17-earth-s-materials-4/

	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	Chemistry-based resources to support teaching of these two outcomes can be found here. https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/18-19-chemical-changes-4/ Water analysis – A range of experiments analysing the content of water, including phosphates which should be suitable for this sort of environmental link.

		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	Chemistry-based resources to support teaching of these two outcomes can be found here: https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/18-19-chemical-changes-4/ Blue Light (Demo) – Luminol reaction. A chemical experiment that produces light but not heat. Cannon Fire (Demo) – Potassium permanganate catalyses breakdown of hydrogen peroxide mixed with Ethanol. Burning ethanol/hydrogen peroxide mixture is quiet but loud bangs appear on addition of permanganate. A Cool Experiment (Demo) – A very endothermic mixture of barium hydroxide and ammonium thiocyanate freezes a beaker to a wet plank/mat. Dynamite Soap (Demo) – Exploding hydrogen/oxygen bubbles generated by electrolysis of water. Elephant's Toothpaste (Demo) – Foam produced by catalytic decomposition of hydrogen peroxide with detergent and food colouring. Genie in a Bottle (Demo) – Exothermic catalytic decomposition of hydrogen peroxide by potassium iodide. Hot Stuff (Demo) – Exothermic spontaneous reaction of glycerol with potassium permanganate. Hydrogen Balloons – there is not much a chemist likes more than a good explosion and igniting balloons of hydrogen certainly fits the bill.

			Light Sticks (Demo) – Effect of temperature on luminosity of glow-sticks. Methane bags (Demo) – Burning bags with different ratios of methane:oxygen in. Methane Bubbles (Demo) – Preparing and igniting bubbles of methane. Methane Tin (Demo) – Using an old coffee tin with a methane flame from hole in top. Air comes in and eventually you get the right ratio for an explosion to blow the lid off. Screaming Jelly Baby (Demo) – Molten potassium chlorate V causes rapid combustion of sugar in a jelly baby. Whoosh Bottle (Demo) – Ignition of alcohol vapour in a 15l water bottle to produce a spectacular ‘whoosh’.

		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	Copper Etching – Activity using the displacement reaction between copper sulphate solution and zinc plate to etch a design. Growing Silver Trees (Demo) – a displacement reaction with copper wire and silver nitrate that produces dendritic crystals of metallic silver. Electrode potentials – microscale – a microscale procedure for determining the electrode potentials of a range of metals and hence their relative reactivities.

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	Chemistry-based resources to support teaching of these two outcomes can be found here: https://www.sserc.org.uk/subject-areas/chemistry/chemistry-cfe-levels-3-4/20-topical-science-4/ Antioxidants (Workshop) – A Range of investigations to look at antioxidant levels in fruits and teas (though the method can be adapted for any antioxidant). Ceramics (workshop) – A suite of activities to explore the properties of some ceramics. Dye Sensitised Solar Cells (workshop) – An activity to show generation of electricity from plant pigments. Guzzling Plants (workshop) – Experiment and activities looking at phytoremediation and copper uptake in plants. Liquid Crystals (workshop) – Making liquid crystals of different compositions and investigating the effect of temperature on their colour changes Plastic Fantastic (workshop) – Synthesis and testing of an electrically conductive plastic – polypyrrole.
		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	Let's Talk - Scottish Schools Education Research Centre (sserc.org.uk) Biodiesel (workshop) – A range of experiments based around the production and testing of Biodiesel from vegetable oil. Dye Sensitised Solar Cells (workshop) – An activity to show generation of electricity from plant pigments.

			Shampoo (workshop) – Activity to make shampoo, involving steam distillation to extract natural essences Vitamin C Drops (workshop) – Determining the concentration of Vitamin C in a variety of fruit juices using a simple titration with iodine.