St Julian's Knowledge Organiser - SCIENCE- Electricity - Year 3/4

National Curriculum learning objective (Physics)	● identify common appliances that run on electricity ● construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers ● identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery ● recognise that a switch opens and closes a circuit and associate this with whether or not a lamp lights in a simple series circuit ● recognise some common conductors and insulators, and associate metals with being good conductors	
Vocabulary:	electricity, electrical, mains, plugged in, battery, power, rechargeable, solar, wind up, sound, light, heat, movement, cell, wire, bulb, bulb holder, buzzer, motor, component, circuit, complete circuit, short circuit, flow, break, make, metal, connect, disconnect, terminal, positive, negative, switch, press switch, toggle switch, tilt switch, pendulum switch, property, electrical conductor, electrical insulator, electron, filament, sets, Venn diagram, Carroll diagram, table, conclusion, evidence, annotate	
Essential prior knowledge / vocabulary to check:	● *Identify common appliances that run on electricity* ● *Know and understand that a battery can run down if left on and that some batteries are rechargeable.* ● *Construct a simple series electrical circuit* *NB these are not typically taught in KS1 so lesson 1 must assess pupil prior knowledge*	
National Curriculum learning objective (Working Scientifically)	● asking relevant questions and using different types of scientific enquiries to answer them ● setting up simple practical enquiries, comparative and fair tests ● making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment, including thermometers and data loggers ● gathering, recording, classifying and presenting data in a variety of ways to help in answering questions ● recording findings using simple scientific language, drawings, labelled diagrams, keys, bar charts, and tables ● reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions ● using results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions ● identifying differences, similarities or changes related to simple scientific ideas and processes ● using straightforward scientific evidence to answer questions or to support their findings.	**Suggested enquiries:** **Asking Questions** **Pattern Seeking**: What are the effects of adding different/more components / switches to a simple series circuit? **Comparative and fair testing:** Which material conducts electricity best? **Identify, classify and group:** group conductors and insulators of electricity; group electrical products according to their electrical source **Research using Secondary Sources:** investigate the symbols used in electoral circuit diagrams
Vocabulary:	what, how, why, when, question, observe, pattern, test, measure, compare, enquiry, function, relationship, notice, group, classify, answer enquiry, fair test, comparative test, variable factor, gather, record, measure, diagrams, prediction, improvement, conclusion, evidence, explain	

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	• Question: I would like to find out? • Method:How will I do this? • Variables: What will I measure or observe? What will I change? What must I keep the same? • Prediction: What do I think will happen? • Results: What have I noticed? • Conclusion: What does this tell me? • Evaluation: What could I do differently next time? What else would I like to find out next? patterns, relationships, cause, effect, data, changes, similarities, differences, predict, question, observations, conclude, improve, investigate further, spiral (fibonacci) differences, similarities, classify, diagram, chart, key, Carroll Diagram, Venn Diagram, behaviour, properties, criteria, classification key secondary source, practical investigation
Essential prior knowledge/skills /vocab to check:	• asking simple questions and recognising that they can be answered in different ways • observing closely, using simple equipment • performing simple tests • identifying and classifying • using their observations and ideas to suggest answers to questions • gathering and recording data to help in answering questions questions, answers, gather, measure, explore, observe look, notice, observe, compare, describe, similar, different, features, sort, group, notice, biggest/smallest, best/worst, Venn diagram find out, look up, investigate, research, photo, website, leaflet, information book
Suggested sequence of learning	1. **Identify common appliances that run on electricity.** 2. **Construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers.** 3. **Identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery.** 4. **Recognise that a switch opens and closes a circuit and associate this with whether or not a lamp lights in a simple series circuit.** 5. **Recognise some common conductors and insulators, and associate metals with being good conductors.**
Useful facts to support teaching this unit	A **cell** is the correct term for what is commonly called a **battery**. A cell is a single unit of electrical supply providing a voltage of 1.5V. Technically a battery is a collection of cells and will have a voltage which is a multiple of 1.5. The **voltage** of a battery is a measure of how much **energy** (or '**push**') it can provide. It is important to match the voltage on other components to the voltage of the battery. A 6V bulb or motor will not work if a single 1.5V cell is used. A 1.5V bulb is likely to blow if connected in a circuit with several cells. Mains electricity is dangerous because it has a high voltage

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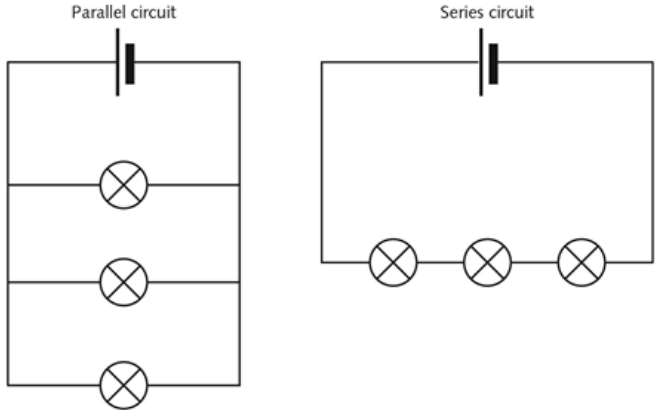
Electricity (or electrical current) is a **flow of electrons** (negatively charged particles) which transfers energy. It requires an **energy source**, such as the **chemical reaction** that takes place in the cell, and a **complete circuit**. Children need to know that a complete circuit is required for electricity to flow and that the cell is the power source for the circuit, which creates the flow of electricity. The flow of electricity (which carries energy) through a bulb, motor or buzzer is what makes it work. It is not a curriculum requirement for them to know what electrons are or that it is electrons which flow, but introducing this idea can help to counter common misconceptions. It is also not necessary for children to understand energy transfer at this stage.

Electrons are present throughout the circuit so the flow in all parts of the circuit is instantaneous when it is connected. A cell has a **positive terminal** and a **negative terminal**. Although current is sometimes shown in circuit diagrams as flowing from positive to negative, this is a convention that pre-dates scientific understanding of what electricity is. Electrons are negative so electricity actually flows from the negative terminal of the cell to the positive one. Because electricity is a flow through all parts of the circuit at the same time a complete circuit is always needed.



A series circuit is a single loop. Parallel circuits have multiple loops connected to the same cell. The series circuit is the only type which children need to know in Key Stage 2, so the word 'series' does not need to be introduced.

A **short circuit** occurs when electricity flows from the negative to the positive terminal of the cell without passing through a component which has resistance to the flow of electricity and will use some of the energy. Electricity will always take the 'easy' route, the path of least resistance. A short circuit can cause overheating and will drain the battery very quickly so should be avoided.

A **switch** is a means of controlling the flow of electricity in the circuit. When the switch is open the circuit is broken: there is a gap which prevents electricity from flowing. When the switch is closed the circuit is made and electricity flows. There are many different types of switch; some of the most common are shown in the resource sheets for Snap Science Lessons 5 and 8.

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	Materials with electrons which can move easily have very low resistance to the flow of electricity and are **electrical conductors**. Metals are good electrical conductors. Materials which do not allow electricity to flow through them are known as **electrical insulators**. Most non-metals are electrical insulators although graphite, a form of carbon, is an exception. **Electrical conductivity** is a continuum (not a simple yes or no) with some materials conducting better than others. The flow of electricity can be modelled in many different ways such as the flow of water in pipes and the wheels, pedals and chain of a bicycle. Like all models and analogies, they all have their merits, but none of them is a complete analogy so in this module a simple role play is used. The role play can be extended to show energy transfer, but this would be more appropriate for Year 6 or KS3.		
Common misconceptions	• Mains electricity and batteries are entirely different things – battery powered devices are not electrical. • Electricity goes to rather than through a component so only one wire is needed. In this model electricity is seen as a fuel used by the component rather than a flow through it. This misunderstanding can be seen in the way some children try to connect circuits and in their drawings. • Mains electricity only requires one wire (because the different wires within the single cable are not visible). • Electricity is something which is made by the battery and has to travel to the component rather than flowing in all parts of the circuit at once. • A switch will only control a component if it is 'before' the component in the circuit. • Water conducts electricity. Although it is a rule of electrical safety not to mix electricity and water, pure water does not conduct; it is the impurities in tap water which allow it to conduct electricity.		
Threshold Concept	**Learning**	**Scientific enquiry skills to teach, use, apply and deepen**	**Milestone expectations**
Physics - understanding electrical circuits Throughout this unit children should be using the skills of **asking questions**:	**Identify common appliances that run on electricity.** Recap, review and assess prior learning. (Suggest SS Lesson 1) To learn about different sources and uses of electricity. By the end of this lesson they will know that electrical items can be powered by mains electricity or batteries and that electricity can be used to produce light, sound, heat and movement.	**Identify, classify and group:** group electrical products according to their electrical source *Identify differences, similarities or changes related to simple scientific ideas and processes.* *Talk about criteria for grouping, sorting and classifying and use simple keys.* *Compare and group according to behaviour or properties, based on testing.*	**1) Identify common appliances that run on electricity.** *B: Identify and name common appliances that run on electricity. Label appliances that run on high and low voltage electricity. Identify and describe sources of electricity for appliances, including mains, battery, solar and others.* *A: Explain the similarities and differences between a 240 volt 40 watt halogen light bulb and a 12 volt, 6 watt L.E.D light bulb. Explain the similarities and differences between a 240 volt mains powered*

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The children answer questions posed by the teacher. *The children explore everyday phenomena and the relationships between living things and familiar environments. They begin to develop their ideas about functions, relationships and interactions. Children raise their own questions about the world around them.* *Given a range of resources, the children decide for themselves how to gather evidence to answer the question. They recognise when secondary sources can be used to answer questions that cannot be answered through practical work. They identify the type of enquiry that they have chosen to answer their question.* *Children make some decisions about which types of enquiry will be the best way of answering questions including observing changes over time, noticing patterns, grouping and classifying, carrying out simple comparative and fair tests, finding things out using secondary sources*		*Record classifications eg. using tables, Venn diagrams, Carroll diagrams.*	*vacuum cleaner and a 12 volt battery vacuum cleaner.* *D: Investigate battery powered road cars and draw some conclusions about their benefits and problems.* **2) Construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers.** *B: Follow instructions to create a series circuit. Label the components of the circuit.* *A: Make a number of series circuits containing different components. Explain the similarities between the circuits despite the different components.* *D: Explain the concept of a series circuit and recommend some general rules.* **3) Identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery.** *B: Complete incomplete circuits by adding the correct components. Answer questions about the completeness of various circuits.* *A: Predict the effect of changing the arrangement of the components of a circuit (some of which maintain a circuit and others that do not). Experiment with the effect of placing more than one bulb in a series circuit and summarise your findings.* *D: Find and rectify faults (solve non-routine problems) for a range of incomplete circuits* **4) Recognise that a switch opens and closes a circuit and associate this with whether or not a lamp lights in a simple series circuit.**
	Construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers. (Suggest SS lesson 2) To explore making circuits using different components. By the end of this lesson children will know the names of common components and will be able to make and draw complete circuits.	**Research using Secondary Sources:** investigate the symbols used in electoral circuit diagrams *Begin to recognise when and how secondary sources might help to answer questions that cannot be answered through practical investigations*	
	Identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery. (Suggest SS lesson 3) To learn more about how electricity flows in a complete circuit and how to use a model to explain their observations. By the end of this lesson children will be able to use a model to explain how a simple circuit works. (Suggest SS Lesson 4) To learn more about how electricity flows through components in a complete circuit and apply their knowledge to identify and correct circuits which will not work. By the end of this lesson children will be able to recognise correct and incorrect circuits and identify some simple things to look for and try if a circuit does not work.	**Pattern Seeking**: What are the effects of adding different / more components to a simple series circuit? *Children begin to look for naturally occurring patterns and relationships and decide what data to collect to identify them.* *With help, children can look for changes, patterns, similarities and differences in their data in order to draw simple conclusions and answer questions.* *Children can say what they found out, linking cause and effect.* *With support, children can identify new questions arising from the data, make new predictions and find ways of improving what they have already done.*	
	Recognise that a switch opens and closes a circuit and associate this with whether or not a lamp lights in a simple series circuit.	**Pattern Seeking**: What are the effects of adding switches to a simple series circuit?	

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	(Suggest SS lesson 5) To make and use toggle and press switches. By the end of this lesson they will know that a switch is a controlled break which stops electricity flowing to all parts of the circuit.	*Children begin to look for naturally occurring patterns and relationships and decide what data to collect to identify them.* *With help, children can look for changes, patterns, similarities and differences in their data in order to draw simple conclusions and answer questions.* *Children can say what they found out, linking cause and effect.* *With support, children can identify new questions arising from the data, make new predictions and find ways of improving what they have already done.*	*B: Observe and describe the effect of using switches in a circuit. Complete circuit diagrams showing and labelling switches.* *A: Explain why opening and closing switches affects a series circuit.* *D: True or false: If there are five switches in a row in a series circuit, only one needs to be 'on' for the circuit to be complete? Relate the idea of switches to the creation and sending of 'morse code'.* **5) Recognise some common conductors and insulators, and associate metals with being good conductors.** *B: Observe and record how different materials act as conductors or insulators of electricity. Observe the effect of some poor and good conductors and label materials as poor or good conductors.* *A: Categorise materials on the basis of their conductivity. Experiment with materials that conduct but also resist the flow of electricity. Summarise your findings.* *D: True or false: Everything on Earth either conducts or doesn't conduct electricity, including humans?*
	Recognise some common conductors and insulators, and associate metals with being good conductors. (Suggest SS lessons 6 and 7) To test materials to see whether they are electrical conductors or insulators and record information in tables, Venn diagrams and Carroll diagrams. By the end of this lesson they will be able to identify common conductors and insulators and interpret information presented in different ways. Consider what they can conclude from the data collected in Lesson 6 and collect further data so they can be more certain about their conclusions. By the end of this lesson children will know that metals are conductors of electricity, most non-metals are electrical insulators and conclusions can only be based on the evidence collected, which must be sufficient. Possible alternative lesson - plan and carry out a comparative test to find out the material that conducts electricity the best.	**Identify, classify and group:** group conductors and insulators of electricity *Identify differences, similarities or changes related to simple scientific ideas and processes.* *Talk about criteria for grouping, sorting and classifying and use simple keys.* *Compare and group according to behaviour or properties, based on testing.* *Record classifications eg. using tables, Venn diagrams, Carroll diagrams.* **Comparative and fair testing:** Which material conducts electricity best? *Children can suggest and set up simple practical enquiries.* *Children can plan and carry out: observations and tests to classify; comparative and simple fair tests; observations over time; and pattern seeking.* *Children recognise when a simple fair test is necessary and help to decide how to set it up. Children can think of more than one variable factor.* *Children recognise when a simple comparative test is necessary and help to decide how to set it up. Children can think of more than one variable factor.*	

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		They gather, record, classify and present data in a variety of ways to help in answering questions. *Findings are recorded using simple scientific language, drawings, labelled diagrams, keys, bar charts and tables.* *Children use results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions.* *Using straightforward scientific evidence to support their findings, children can report on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions.*	
	Recognise some common conductors and insulators, and associate metals with being good conductors. (Suggest SS lesson 8) In this lesson children will learn more about the properties and uses of conductors and insulators and will make tilt and pendulum switches. By the end of this lesson they will know that some materials are better electrical conductors than others and be able to choose suitable materials to make the different parts of a switch.	**Comparative and fair testing:** Which material conducts electricity best? *Children can suggest and set up simple practical enquiries.* *Children can plan and carry out: observations and tests to classify; comparative and simple fair tests; observations over time; and pattern seeking.* *Children recognise when a simple fair test is necessary and help to decide how to set it up. Children can think of more than one variable factor.* *Children recognise when a simple comparative test is necessary and help to decide how to set it up. Children can think of more than one variable factor.* *They gather, record, classify and present data in a variety of ways to help in answering questions.* *Findings are recorded using simple scientific language, drawings, labelled diagrams, keys, bar charts and tables.* *Children use results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions.* *Using straightforward scientific evidence to support their findings, children can report on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions.*	

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Assessment of learning task and/or title of double page spread outcome Assessment of the National Curriculum Objective by applying understanding of Threshold Concepts and demonstrating Milestones/Skills.	Teachers should assess children's learning of knowledge and vocabulary frequently throughout the unit. Use recap, refresh and revision to start the unit and each lesson. Use the BAD outcomes to assess depth of learning each lesson against the 4 expected outcomes for this unit. Teachers should refer to the milestone expected outcomes for scientific enquiry when assessing these skills (see St J's Science Progression Document) Possible writing task to be used as an assessment of learning: SS lesson 9