Physical phenomena

Stage 3

Connected Outcomes Group (F)

Connection focus: understanding that energy can be transferred, stored and transformed from one form to another.

SciTech

There are many forms of energy, including electrical, chemical, solar, nuclear, heat, light and sound.

Students demonstrate their knowledge and understanding of energy by developing and explaining the workings of a model such as a hydroelectric turbine, catapult or a cooking device.

Students will be engaged in:

- analysing nutritional labels on food products
- singing and performing own musical compositions
- researching forms of energy
- designing electrical circuits
- designing and making a product that uses transformation of electrical energy.
- composing and performing a dance.

Planned assessment:

- observation of student participation in presentation of a rap composition
- observation of student devised activity sessions
- observation of students' participation in scientific investigations
- analysis of students' SciTech log book.

Planning page

Student work:	Resources needed:	Literacy links include:	Numeracy links include:
• students will keep a log book to record reflections and understandings in SciTech. • students will be designing and making an electrical product.	Copies of DET, BOS and Curriculum Corporation resources have been sent to all schools. • *Vocal-Ease modules 1 and 2* (DET) (currently out of print; teachers' book is available as a pdf on *arts action* CD-ROM (DET)# • selection of components for investigations of electricity including wires, alligator clips, batteries, torch globes, nails. Construction kits provide a source of well-organised components • equipment for physical activity session. Collaborate with your teacher-librarian for teaching and resource support. #Additional copies of these DET resources are available from DET sales at: https://www.det.nsw.edu.au/doingbusiness/product_service/schcurresource/index.htm	• uses graphic organisers to gather information and focus further research • writes an explanation of a science investigation identifying cause and effects as well as using supporting diagrams and correct terminology • records and analyses information gathered in group tasks • makes generalisations from information gathered about food packaging to justify opinions • writes and presents a procedure for a fitness session • uses rhyming words and syllables, prior knowledge and terminology to write and present a rap for the class	• solves problems involving different units of mass • converts between measurement units • uses a stopwatch to measure and compare duration of events.

Term planner (teachers may want to use this to plan the work over a term)

SciTech
Electricity Light up
Circuits: Simulation activities
Investigating electric currents
Sources and storage of electricity
Design brief 1: transforming electrical energy
Design brief (cont)
Design brief 2: generating electricity for a small community
Design brief (cont)

Unit of work

Outcomes	Learning experience	Planned assessment
SciTech **INVS3.7** Conducts their own investigations and makes judgements based on the results of observing, questioning, planning, predicting, testing, collecting, recording and analysing data, and drawing conclusions • *constructs appropriate self-questions to guide investigations* • *decides the type of data needed and works cooperatively to collect such data* • *plans repeat trials of tests or experimental procedures* • *identifies factors that are to be kept the same when carrying out tests or conducting investigations, and recognises the term controlled experiment* • *ensures that equipment is working and can be used effectively and safely* • *records data in an appropriate form and evaluates collected data to ensure that it satisfies the purpose of an investigation* • *transforms data to show important relationships, trends, patterns or associations* • *uses the ideas of fair testing to evaluate whether predictions or explanations are reliable and valid* • *communicates what has been learned by choosing from a variety of media, tools and forms, taking into account audience and purpose.* **PPS3.4** Identifies and applies processes involved in manipulating, using and changing the form of energy • *energy may be moved in a range of ways (e.g. an electric current, radiation and conduction of heat). This is called transfer of energy* • *energy may be transferred as light, sound, heat, electrical and movement energy* • *energy can be stored in a variety of ways, e.g. in a battery, in a hydroelectric dam, in food. (Refer to notes)* • *energy of one form can be changed to energy of another form, e.g. from electricity to heat, from chemical energy, e.g. petrol, to kinetic energy, e.g. movement. This change is called transformation* • *there are a variety of resources that provide us with energy, including oil, gas, coal, food,*	**Electricity** **Observing and exploring** (ask questions, pose problems, find out what is currently known) • Define what an energy form is i.e. heat, light, sound or movement. • Ask students to collect pictures of items that use electricity or items that are used to create electricity. • Have students group their pictures into items that: 1. use electricity 2. produce electricity 3. transport electricity 4. store electricity. • In groups, record (appoint a recorder) on a KWHL chart (know, want to know, how, learnt): - what do we know and understand about electricity? - what do we want to find out? - how might we get this information? Leave 'learnt' till the end of the unit. A KWHL chart can be found at: https://detwww.det.nsw.edu.au/media/downloads/csupport/cogs/units/fstring/kwlh.doc NB shaded text is background information for teachers. • Appoint a reporter, then have groups report back to compare information. (*Literacy link*: uses graphic organisers to gather information and focus further research) **Light up** **Observing and exploring** (ask questions, pose problems, find out what is currently known) • Supply small student groups with a battery, two pieces of wire and a torch globe. Ask students to explore ways of making the torch globe glow. • Ask students to draw and label a diagram of their observations. • Ask students to write an explanation (using text and drawings) of how the globe was able to glow. • Record the methods used to make the globe shine and why they did/didn't work. **Circuits: Simulation activities** • Explain to students that electricity is a flow of electrons. Electrons flow through the wires to the globe and back to the battery. Discuss open, closed and short circuits. The attached file contains background information for teachers: What is electric current? • Organise a simulation activity: - mark out a circuit in the playground using a chalk line and place small obstacles along the circuit e.g. a box. - ask several students to stand at regular intervals along the drawn circuit while the teacher stands opposite the obstacle with a bowl of jelly beans. - have students walk along the circuit maintaining their distance from the person in front and jumping over the obstacle. As students pass the teacher they each receive a jelly bean.	**Assessment strategy** The teacher: • observes students' investigations. **Assessment criteria** The student: • constructs appropriate questions to guide investigations • collects and records data • uses the ideas of fair testing to evaluate whether predictions or explanations are reliable and valid. These criteria relate to outcomes **INVS3.7**, **PPS3.4**

Outcomes	Learning experience	Planned assessment
wind, waves and batteries. Some of these resources are renewable; others are non-renewable. **English** **TS3.1** Communicates effectively for a range of purposes and with a variety of audiences to express well-developed, well-organised ideas dealing with more challenging topics. **TS3.2** Interacts productively and with autonomy in pairs and groups of various sizes and composition, uses effective oral presentation skills and strategies and listens attentively. **RS3.5** Reads independently an extensive range of texts with increasing content demands and responds to themes and issues. **RS3.6** Uses a comprehensive range of skills and strategies appropriate to the type of text being read. **WS3.9** Produces a wide range of well-structured and well-presented literary and factual texts for a wide variety of purposes and audiences using increasingly challenging topics, ideas, issues and written language features. **WS3.10** Uses knowledge of sentence structure, grammar and punctuation to edit own writing. **WS3.14** Critically evaluates how own texts have been structured to achieve their purpose and discusses ways of using related grammatical features and conventions of written language to shape readers' and viewers' understanding of texts.	• Discuss the circuit activity. Identify the various representations in the activity such as the chalk line representing wires, the obstacle representing the light globe, the jelly beans representing the battery and the students representing electrons. • Discuss the function of each of the parts of the circuit such as the wires, (to allow the flow of electrons), the battery (which recharges the electrons) and the light globe (that uses some of the energy). • Simulate an open circuit by placing the students on the circuit and asking them to walk around. Rub out a section of the chalk line. Once the circuit is open, all students should stop walking around the circuit. • Discuss the simulation. It is important that students develop an understanding that once a circuit is open, all electrons stop flowing. • Simulate and discuss a short circuit by drawing a chalk line bypassing the light bulb (obstacle). Ask students to walk the circuit again using the bypass. • Discuss with students the short circuit. Electrons will follow the path of least resistance to return to their energy source. • Have students make notes of new terminology and concepts in their science log books or add to KWHL charts. (*Literacy link*: identifies key words and records information from simulation activities) **Investigating electric circuits** **Hypothesising and predicting** (define a problem that can be investigated scientifically) • Provide students with a selection of equipment including wires, alligator clips, batteries, torch globes, electric motors and nails. • Students complete a series of investigations to further their understanding of electric circuits. Investigation may include: - making a torch globe glow brighter by adding batteries - connecting two globes in series and in parallel, then removing a globe - connecting batteries in series and in parallel. For explanation refer to: http://ourworld.compuserve.com/homepages/g_knott/elect27.htm - creating an electro magnet - creating a coil radiator - making an electric motor spin. • Model the process students would use to organise their investigation • Discuss with students how the electrical energy is transformed in the various activities i.e. a globe transforms electrical energy into light and heat; a motor transforms electrical energy into kinetic energy (movement), heat and sound. • Have students record their observations of the investigations in their log books. Students should use labelled diagrams to support their written explanation. (*Literacy link*: writes an explanation of a science investigation identifying cause and effects as well as using supporting diagrams and correct terminology)	

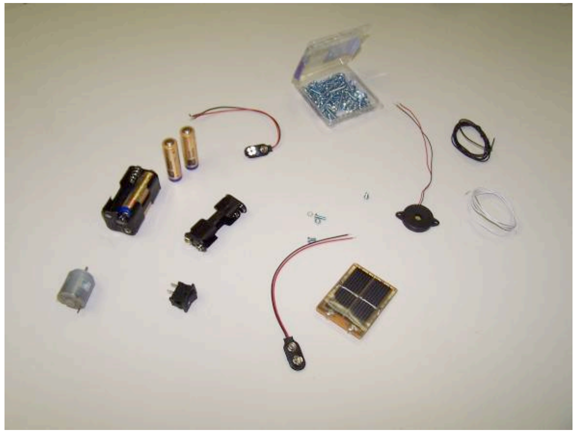
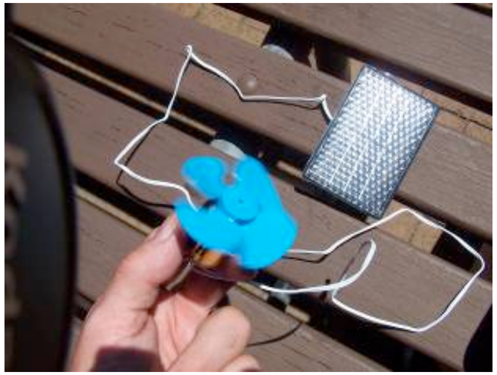
<table>
<tr><th>Outcomes</th><th>Learning experience</th><th>Planned assessment</th></tr>
<tr><td></td><td>Sources and storage of electricity
Observing and exploring (ask questions, pose problems, find out what is currently known)
• Research further sources and storage of electrical energy. Students may choose to research:
- electricity generation (e.g. hydro, coal, nuclear, solar, wind)
- electricity storage (e.g. wet and dry cells),
electricity uses (e.g. electric motors)
- energy systems (e.g. powerlines used to transport electricity/transformers)

(Literacy link: uses a range of sources of information for research)</td><td></td></tr>
<tr><td>SciTech
DMS3.8 Develops and resolves a design task by planning, implementing, managing and evaluating design processes
• researches needs that influence the development of products, systems and environments and establishes criteria for the evaluation of produced designs
• generates design concepts that reflect the consideration of aesthetic, cultural, safety and functional requirements
• produces annotated concept sketches and (freehand) drawings for use by other people
• elects tools, equipment and resources to meet the requirements of production and use
• assesses the efficiency of processes of design and production and evaluates the result against established criteria for success.

PSS3.5 Creates and evaluates products and services, demonstrating consideration of sustainability, aesthetic, cultural, safety and functional issues
• communities create complex systems to manufacture products and provide services
• systems that provide services to communities greatly influence how we live.</td><td>In SciTech, students demonstrate understanding gained through a scientific investigation by resolving a design brief.
Transforming electrical energy
Design brief: Design and make a product that uses the ‘transformation of electrical energy’ as an essential feature of its operation. The product must meet a personal need of students, i.e. be designed for self.
Before commencing any work in this area, all students are to be given instruction in the safe use of electrical energy.
Useful introductory information is available at the following web site:
http://www.electrickids.com.au/
• Inform the class that the product will use batteries as a source of power and that they must not use mains power supplied to homes (240 volts).

Exploring the task
• In groups, students use the table below to review uses of electrical energy explored in earlier activties. Students identify the need addressed by the product or the system, and the energy transformations involved in its operation.
<table>
<tr><th>Product/System</th><th>Need/Purpose</th><th>Energy transformations</th></tr>
<tr><td>Home security alarm</td><td>Warn of intruders
Disuade intruders
Protect people and property</td><td>Sensor (light/sound energy) > electrical energy > sound energy</td></tr>
<tr><td>Vacuum cleaner</td><td>Remove dust and dirt
Remove dust mites that cause allergies</td><td>Electrical energy > mechanical energy</td></tr>
<tr><td>Stove</td><td>Heat or cook food</td><td>Electrical energy > heat energy</td></tr>
<tr><td>Solar garden lights</td><td>Provide lighting for paths
Provide security
Increase enjoyment of garden</td><td>Light energy > electrical energy > chemical energy (battery) > electrical energy > light energy</td></tr>
</table></td><td></td></tr>
</table>

Outcomes	Learning experience	Planned assessment
	Ensure that students understand that we cannot ‘see’ electricity. We can only ‘sense’ what electricity does e.g. cause light to be emitted, cause sound to be emitted, cause an electric motor to rotate. We see power lines that are used to transfer electrical energy, but we do not see the electricity they carry. • In pairs, students brainstorm problems, difficulties and interests that reflect a personal need. For example: - my little brother reads my diary - everyone barges into my room. I have no privacy - I like reading in bed at night but the light disturbs my little sister - we get very hot in our tree house - the mosquitoes always bite me when I am in the garden. • From the brainstorm, each pair of students prepares a list of problems/needs and decides which one they would like to work on together. The selected problem/need should have the potential to use electrical energy as part of its design solution. • Revise earlier design tasks and review the stages of the design process each group must work through. Discuss with each group how they will apply a design process to this product development task. • Without pre-empting a solution, each group will generate a list of criteria to be used to judge the success of their solution. Ensure that each group includes in its list a criterium that states: ‘uses the transformation of electricity as a feature of its operation’. • In pairs, students draft questions that will be addressed as they work through their design process. For example: - what products exist that address similar problems or needs? How do they work? - what resources are available to construct our product? - how will we test and evaluate our design solution? - how will we manage the time available to develop our product? - how much time do we have to design our product, to make it and to evaluate it? - is there a technical expert who can provide assistance? - where can we purchase components and materials? **Sources of electrical energy** • Selected groups can research the sources of electrical energy used in the NSW power grid and present their findings to the class. As time allows at different points in the project, select other groups to research issues of the sustainable use of electrical energy, e.g. wind generation, tidal generation. • Demonstrate to the class how solar cells can be used to power a light or an electric motor. **Generating ideas and realising solutions** • Students sketch initial ideas for their product and annotate their sketch to explain how the product works. With each group the teacher discusses the method to be used to evaluate the initial idea, e.g. prepare questions for friends in another group, consult a mentor. • Have students consider the circuit required to operate the product. Review earlier activities in	

Outcomes	Learning experience	Planned assessment
	which students constructed a circuit, e.g. to illuminate a light globe. To explore possible solutions for the circuit, provide students with a greater variety of functioning components, e.g. batteries, battery holder, switch, globe holder, globe, buzzer (peizo), solar panel, electric motor.  Details of some components are included in the attached file: https://detwww.det.nsw.edu.au/media/downloads/csupport/cogs/units/fstring/circuit_s3fu.doc Ensure students have access to necessary tools, e.g. pliers (long nose)   Construction kits provide a source of well-organised components. However, when using kits care must be taken ensure that students think creatively. For instance, students could be challenged to use a solar-powered electric motor (shown above) for some purpose other than a fan, e.g. to automatically open or close shutters on an environmentally sensitive building.	

Outcomes	Learning experience	Planned assessment
	• Ensure that students understand their product must be housed in a suitable casing. Discuss what functions the casing must perform. For example: - hold the circuit in place - hold the working parts - protect the product from dirt and damage - be easy to handle, - be aesthetically pleasing, - convey information about the operation of the product. • Provide students with a wide range of materials that can be used to complete the product e.g. paddle pop sticks, construction blocks, elastic bands, cardboard, adhesive tape, styrene foam. Information for teachers on the design and development of a product that uses electrical energy, e.g. the *Dyson* vacuum cleaner, can be found at http://www.dyson.co.uk/education/default.asp **Evaluating products and processes** • As each group completes the construction of its product, have group members prepare a survey to be used for the purposes of evaluation. Ensure that the questions in each group's survey clearly relate to the criteria for success established at the commencement of the project. • Have each group work with another group to test its product, e.g. user testing. Ensure that comments collected during user testing are included in the group's evaluation of its product. • Provide all students with questions to be used when reflecting on their project. For example: - what part of the project was most enjoyable? - what part of the project was least enjoyable? - what was learnt? - what part of the learning was most important? Why is it important? - what other things could have been done to assist groups? (*Literacy link*: uses research strategies and records design process)	

Outcomes	Learning experience	Planned assessment
SciTech **DMS3.8** Develops and resolves a design task by planning, implementing, managing and evaluating design processes • *researches needs that influence the development of products, systems and environments and establishes criteria for the evaluation of produced designs.* **PSS3.5** Creates and evaluates products and services, demonstrating consideration of sustainability, aesthetic, cultural, safety and functional issues • *communities create complex systems to manufacture products and provide services* • *systems that provide services to communities greatly influence how we live.*	**Generating electricity** **Design brief:** Design, propose and evaluate a system for generating electricity for a small isolated community using a renewable source of energy. Currently, houses in the community are connected by a grid that supplies electricity from a diesel driven electrical generator. Diesel fuel is very costly for the community. • Divide the class into groups and allocate each group a different geographic location in NSW for the generation of electricity. For example: - a desert location in the west - a river location in the mountains - a seaside location. • The proposed system will be presented to the class as a design concept rather than as a finished product or as a working model. It is not important that all students understand the physics principles on which an electrical generator is based. However, students should understand that a generator is used to transform mechanical energy (movement) to electrical energy (electricity). The web sites below provide suitable background information. http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/genhow.html http://www.wvic.com/how-gen-works.htm **Exploring the task** • As a class, discuss the key terms used in the design brief, e.g. renewable energy, grid, generator. • Explain how a generator functions. Point out that the system currently used by the local community transforms stored chemical energy (diesel fuel) to mechanical energy (via a motor that rotates the generator) and hence to electrical energy that is transferred through the grid. The task requires students to 'harness' a form of mechanical energy and use it to rotate the coil (stator) of the generator. • Set a requirement that each group must document the process it follows in a design folder and that the folder must include research that addresses the following questions: - what is the source of diesel fuel? - does diesel fuel come from a renewable source? - what are some sources of renewable energy? - what conditions must prevail to make each re-newable source useful in a geographic location? - why is it important that we increase the use of energy from renewable sources? • Provide the class with a model of the design process and have each group record the types of activities appropriate to each phase of the process. Have each group complete a table by drafting questions that need to be answered as they work through each phase of the process.	

<table>
<tr><th>Outcomes</th><th>Learning experience</th><th>Planned assessment</th></tr>
<tr><td></td><td>

<table>
<tr><th>Process phase</th><th>Questions</th></tr>
<tr><td>Exploring needs</td><td>• What sources of energy are renewable?
• What sources of renewable energy are available in the local area? How can we find out?
• How much time should we allocate to each activity?
• What will each group member do?
• How will we know if our proposal is practical?
• How will we know if our proposal is appropriate for the community?</td></tr>
<tr><td>Generating ideas</td><td>•</td></tr>
<tr><td>Selecting an appropriate solution</td><td>•</td></tr>
<tr><td>Producing and communicating a proposal</td><td>•</td></tr>
<tr><td>Evaluating our design proposal</td><td>•</td></tr>
<tr><td>Evaluating our design process</td><td>•</td></tr>
</table>

- Questions can then be shared between groups.

Ensure that all groups recognise that their criteria for success must be established early in the process and used for evaluation during each phase. Each group’s questions can then be used as scaffolding for its design process.

- Provide groups with a requirement that its process must be documented for others to read and all documentation must be submitted in a design folder. Each group should allocate documentation tasks to group members and the contribution of different members should be clearly acknowledged.

If necessary, make learning more concrete for students by suggesting a specific location that typifies conditions in the area allocated to each group, e.g. conditions in Broken Hill would be similar to conditions in a desert location. The research of environmental conditions is important if students are to determine a form of renewable energy that is appropriate for their community.

Generating ideas and realising solutions

- Monitor the progress of groups to ensure that each group is working to its plan and its planned timeframe for activities.
- Provide support for groups as they work through the questions. The following portal web site provides links to a range of valuable resources: http://www.teachers.ash.org.au/jmresources/energy/renewable.html
- Have students explore a renewable energy initiative currently being developed in NSW. Information on some of these initiatives is available at: http://www.countryenergy.com.au/internet/cewebpub.nsf/Content/edu_env_renewable+energy
- Ensure that all groups develop a proposal that communicates the essential features of their design concept to the target audience, e.g. the whole class. Encouragement should be provided to those groups that wish to model the operation of their generator. Solar cells and small dynamos (generators) can be purchased from electronics shops.

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Outcomes	Learning experience	Planned assessment
	Evaluating products and processes • Groups complete an evaluation to reflect on the learning experience. • Collect each group's design folder. Allocate time for the discussion of each group's design folder with group members.	