SWITCH on to SAFETY

Electricity is the fuel we use in our everyday lives for things like lighting, heating, appliances, computers, telephones and games. You cannot see it, but it's always there.

Electricity is part of our everyday lives – providing us with a safe and reliable source of energy. Staying safe around electricity is everyone's responsibility. You should watch out for yourself, your friends and your family.

This Electricity and Safety Unit lesson book for Stage 3 teachers aligns with the NSW Science & Technology Syllabus and outcomes in other key learning areas.

It provides opportunities for students to learn about electrical energy through a series of hands-on activities, complemented by STEM design challenges, and four interactive whiteboard lessons containing videos and embedded interactive activities to engage your students.

Ausgrid

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It has been developed to align with part of the NSW Science and Technology Syllabus and outcomes in other key learning areas.

The following advisers have made a contribution to the development of these materials.

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The sections 'How to use a Scitech journal' and 'How to organise a cooperative learning group' are sourced from the Australian Academy of Science Primary Connections series, and are reproduced with permission.

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Foreword

Helping the community understand the importance of electrical safety is at the forefront of Ausgrid's plans to operate a safe and reliable electricity network.

That's why we introduced Electricity Safety Week back in 2002. Events such as Electricity Safety Week help us educate people about how our electricity network works and how to behave safely around electrical equipment.

To support the teachers who are supporting us in delivering important safety messages to students, we have developed curriculum material in partnership with the NSW Department of Education to help students learn about electricity and electrical safety.

This education material includes teachers' notes, student lesson plans, extension activities and Interactive Whiteboard lessons with embedded resources.

This material will help teachers discuss how electricity works, how we use it and how everyone, including students, can stay safe in their homes and around electrical equipment.

By working with schools we can encourage learning through scientific investigation and ensure students stay safe around electricity for the rest of their lives.

Richard Gross
Chief Executive Officer, Ausgrid

Unit Overview

Lesson Sequence	Overview
1. What do we know about electricity?	A lesson to capture students' interest and determine what students know about electricity using a KWL chart.
2. Electricity Safety	Informing students about electricity safety using online, interactive activities. Reinforce the importance of electricity safety.
3. What is Energy?	Brainstorm and discussion about what energy is and where it comes from.
STEM Design Challenge: Transferred Energy	Design a balance arm scales that demonstrates transferred energy.
4. Transforming Energy	Providing a hands-on shared investigation of changing energy.
STEM Design Challenge: Transformed Energy	Design a balloon rocket using knowledge of transformed energy.
5. Electricity Generation and Transmission	A lesson to discuss and investigate the generation and movement of electricity.
6. Exploring Electrical Circuits	A lesson to provide opportunities to simulate electrical circuits. Providing a hands-on shared investigation of the creation of electrical circuits. Students apply their understanding of electrical circuits.
STEM Design Challenge: Circuit Design	Design a board game that incorporates an electrical circuit.
7. Investigating Conductors and Insulators	A student-driven investigation to determine the materials that conduct electricity.
STEM Design Challenge: Energy Conductors	Design a test of conductivity using knowledge of circuits, conductors and insulators.

8. Investigating Series and Parallel Circuits **STEM Design Challenge:** Series and Parallel Circuits	A lesson exploring electrical concepts. Design a safety vest that incorporates series and parallel circuits.
9. Generating Electricity Investigation	Constructing circuits to observe the generation of electricity.
10. Transforming Electricity Investigation	Students explore the transformation of electricity.
11. Design Task	Students undertake a design and make task applying their understanding of electric circuits and electricity to satisfy a personal need.

Unit Outcomes

NSW Science & Technology Stage 3 Syllabus

Outcomes:

Skills:

- **ST3 – 1WS – S** – plans and conducts scientific investigations to answer testable questions, and collects and summarises data to communicate conclusions
- **ST3 – 2DP – T** – plans and uses materials, tools and equipment to develop solutions for a need or opportunity
- **ST3 – 3DP – T** – defines problems, and designs, modifies and follows algorithms to develop solutions

Knowledge and Understanding:

- **ST3 – 8PW – ST** – explains how energy is transformed from one form to another

Working Scientifically Skills Continuum:

- pose testable questions, make and justify predictions about scientific investigations (questioning and predicting)
- manage resources safely (planning and conducting investigations)
- select appropriate measurement methods, including formal measurements and digital technologies, to record data accurately and honestly (planning and conducting investigations)
- reflect on and make suggestions to improve fairness, accuracy and efficacy of a scientific investigation (planning and conducting investigations)
- employ appropriate technologies to represent data (processing and analysing data)
- present data as evidence in developing explanations (processing and analysing data)

Design and Production Skills Continuum:

- investigate materials, components, tools, techniques and processes required to achieve intended design solutions (identifying and defining)
- produce labelled and annotated drawings including digital graphic representations for an audience (research and planning)
- demonstrate safety and sustainability when choosing resources to produce designed solutions, managing constraints and maximising opportunities (producing and implementing)
- develop project plans that consider resources when producing designed solutions individually and collaboratively (producing and implementing)
- evaluate design ideas, processes and solutions according to criteria for success (testing and evaluating)

NSW Mathematics Stage 3 Syllabus

Outcomes:

Working Mathematically – Communicating:

- **MA3-1WM** – describes and represents mathematical situations in a variety of ways using mathematical terminology and some conventions

Working Mathematically – Problem Solving:

- **MA3-2WM** – selects and applies appropriate problem-solving strategies, including the use of digital technologies, in undertaking investigations

Working Mathematically – Reasoning:

- **MA3-3WM** – gives a valid reason for supporting one possible solution over another

Working Mathematically – Statistics and Probability:

- **MA3-18SP** – uses appropriate methods to collect data and constructs, interprets and evaluates data displays, including dot plots, line graphs and two-way tables

Number and Algebra - Fractions, Decimals and Percentage:

- **MA3-7NA** – compares, orders and calculates with fractions, decimals and percentages

Measurement and Geometry - Length:

- **MA3-9MG** – selects and uses the appropriate unit and device to measure lengths and distances, calculates perimeters, and converts between units of length

NSW English Stage 3 Syllabus

Outcomes:

- **ENS-2A** – composes, edits and presents well-structured and coherent texts

NSW Personal Development, Health and Physical Education Stage 3 Syllabus

Outcomes:

- **PD3-6** – distinguishes contextual factors that influence health, safety, wellbeing and participation in physical activity which are controllable and uncontrollable
- **PD3-7** – proposes and implements actions and protective strategies that promote health, safety, wellbeing and physically active communities
- **PD3-9** – applies and adapts self-management skills to respond to personal and group situations

NSW National Literacy Learning Progression

Indicators:

Interacting (INT3):

- actively listens to stay on topic in a small group discussion
- joins in small group and whole-class discussion
- asks relevant questions for clarification or to find out others' ideas (What do you think about that?)
- takes turns as speaker and listener
- interacts using appropriate language in pairs or a small group to complete tasks

Speaking (SPK3):

- makes short presentations using a few connected sentences, on familiar and learnt topics (retells a familiar story or describes a process)
- speaks audibly and clearly to a familiar audience (own class)
- uses some extended sentences
- organises key ideas in logical sequence
- provides some supporting details
- expresses causal relationships (when the egg cracked the chicken came out)
- provides simple justifications (I chose cherries because they are red)
- uses some varying intonation or volume for emphasis
- regulates pace with pausing

Vocabulary:

- uses some precise vocabulary from learning areas
- uses connectives to sequence ideas (first, then, next, finally)
- uses vocabulary to express cause and effect (the excursion was cancelled because it rained)
- uses some modal language to influence or persuade (should, will)

Australian Curriculum: Science

Content Descriptions

Science Understanding:

- **ACSSU097** – electrical energy can be transferred and transformed in electrical circuits and can be generated from a range of sources

Science as a Human Endeavour:

- **ACSHE098** – science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions
- **ACSHE100** – scientific knowledge is used to solve problems and inform personal and community decisions

Science Inquiry Skills:

- **ACSIS232** – with guidance, pose clarifying questions and make predictions about scientific investigations
- **ACSIS103** – identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks
- **ACSIS104** – decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate
- **ACSIS107** – construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate
- **ACSIS221** – compare data with predictions and use as evidence in developing explanations
- **ACSIS108** – reflect on and suggest improvements to scientific investigations
- **ACSIS110** – communicate ideas, explanations and processes in a variety of ways, including multi-modal texts

Australian Curriculum: Mathematics

Content Descriptions

Number and Algebra:

- **ACMNA123** – select and apply efficient mental and written strategies and appropriate digital technologies to solve problems involving all four operations with whole numbers

Measurement and Geometry:

- **ACMMG135** – connect decimal representations to the metric sy
- **ACMMG136** – convert between common metric units of length, mass and capacity
- **ACMMG137** – solve problems involving the comparison of lengths and areas using appropriate units

Statistics and Probability:

- **ACMSP145** – conduct chance experiments with both small and large numbers of trials using appropriate digital technologies
- **ACMSP146** – compare observed frequencies across experiments with expected frequencies

Australian Curriculum: Technologies

Content Descriptions

Design and Technologies - Knowledge and understanding:

- **ACTDEK020** – investigate how electrical energy can control movement, sound or light in a designed product or sy
- **ACTDEK023** – investigate characteristics and properties of a range of materials, sys, components, tools and equipment and evaluate the impact of their use

Design and Technologies - Processes and Production Skills:

- **ACTDEP025** – generate, develop and communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques
- **ACTDEP026** – select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions
- **ACTDEP027** – negotiate criteria for success that include sustainability to evaluate design ideas, processes and solutions
- **ACTDEP028** – develop project plans that include consideration of resources when making designed solutions individually and collaboratively

Australian Curriculum: English

Content Descriptions

Literacy:

- **ACELY1709** – participate in and contribute to discussions, clarifying and interrogating ideas, developing and supporting arguments, sharing and evaluating information, experiences and opinions
- **ACELY1816** – use interaction skills, varying conventions of spoken interactions such as voice volume, tone, pitch and pace, according to group size, formality of interaction and needs and expertise of the audience
- **ACELY1710** – plan, rehearse and deliver presentations, selecting and sequencing appropriate content and multimodal elements for defined audiences and purposes, making appropriate choices for modality and emphasis
- **ACELY1714** – plan, draft and publish imaginative, informative and persuasive texts, choosing and experimenting with text structures, language features, images and digital resources appropriate to purpose and audience

Australian Curriculum: Health and Physical Education

Content Descriptions

Personal, Social and Community Health:

- **ACPPS053** – investigate community resources and ways to seek help about health, safety and wellbeing
- **ACPPS054** – plan and practise strategies to promote health, safety and wellbeing
- **ACPPS058** – investigate the role of preventive health in promoting and maintaining health, safety and wellbeing for individuals and their communities

1 What do we know about electricity?

TASK:
To ascertain what we know about electricity

A lesson to discuss what students currently know and understand about electricity. This is a great opportunity to **engage** students, elicit questions and find out what is currently known.

Teacher Background Information

Electricity is simply the flow of electrons. It takes two things to make the electrons flow, something to push the electrons and a path for the electrons to travel along. The force that pushes electrons is called voltage and is measured in volts. The flow of electrons is called current and is measured in amperes which we call amps for short.

Assessment

Diagnostic assessment of students' knowledge and understanding of electricity is observed throughout this lesson.

Equipment

- KWL sheets (1 for each group)
- Word cards (for word wall)
- SciTech journals

Activity Steps:

- Explain to students that they are going to learn all about electricity, but first we will find out what they already know.
- Ask the students to think about what electricity is, where it comes from and how we use it.
- Form small groups and ask students to share and record what they know about electricity on a small KWL chart (know, what to know, learnt):
  - What do we know about electricity?
  - What do we want to find out about electricity?
  - What have we learnt about electricity? (Leave until the end of the unit).
- Have groups share their KWL charts with the class.
- Discuss the groups KWL charts then combine the students KWL charts to construct a large class KWL chart to display on the classroom wall.

- Start a word wall – identify and write all new or technical words on word cards and place them around the class KWL chart. Students will be able to refer to and add to the word wall throughout the duration of this unit of work.
  - Ask students to identify and list appliances that use energy in the classroom in their SciTech journals.
  - Walk around school to identify and add to lists, items that use energy.
- Return to the classroom and discuss the list of appliances.
  - List all the items that students have identified and group them according to the energy form they use.
  - What is the most common energy form used in our school? (Electricity).
  - Ask students to think about how many times they used electrical appliances yesterday, (battery powered or plugged into the wall) and put this information into a table in their SciTech journals.

Appliance	Battery	Power point	Number of times used

Interactive Resources

interactive whiteboard lesson 1

- Slide 2 – Video about electricity
- Slide 3 – KWL chart
- Slide 4 – Picture match activity

click here to access the online resource

1 KWL Chart

Attachment

Know, want, learnt

What I know, what I want to know and what I learned

Teachers activate students' prior knowledge by asking them what they already know; then students (collaborating as a class unit or within small groups) set goals specifying what they want to learn; and after reading (or other experiences to provide input) students discuss what they have learned; students apply higher order thinking strategies which help them construct meaning from what they read and help them monitor their progress towards their goals. A worksheet is given to every student that includes columns for each of the activities.

K What do I know about electricity?	W What do I want to find out?	L What have I learnt?
In addition to initial brainstorming and discussion activities, students could answer questions after watching the video in interactive whiteboard lesson 1. *For example:* Electricity travels along power lines. Electricity travels in circuits. Don't touch an electric dryer if it falls in the water. Don't put your finger in a power switch. Don't go near fallen wires. Lots of appliances use electricity. Stay out of substations.	**Possible questions to guide research.** *For example:* What is a circuit? What does serial and parallel mean? Why can water conduct electricity? Are there alternative sources of power? What is a transformer? What should I do in an electrical emergency? Define an electrical emergency. What happens when you are electrocuted?	**Completed as a class or by individual student.**

K What do I know about electricity?	W What do I want to find out?	L What have I learnt?

1 Word Wall Cards (enlarge for display on wall)

Attachment

appliance	insulation	investigation
ampere	cell	insulator
atom	kilowatt	power
battery	kinetic	renewable
circuit	lightning	resource
charge	magnet	series
chemical	magnetic	solar
meter	power point	mechanical
current	megawatt	consumption

static	conductor	substation
electricity	motor	transmission
electric	nuclear	transformer
electron	turbine	transformation
energy	metabolic	observation
fuse	safety	hydroelectric
current	static	megawatt
generator	power	photovoltaic
voltage	parallel	wind turbine
potential	watt	prediction

1 How to Use a SciTech Journal

Attachment *- Reproduced from the Australian Academy of Science Primary Connections series with permission*

How to use a SciTech journal

A SciTech journal is a record of observations, experiences and reflections. It contains a series of dated, chronological entries. It may include written text, drawings, labelled diagrams, photographs, tables and graphs.

Using a SciTech journal provides an opportunity for students to be engaged in a real SciTech situation as they keep a record of their observations, ideas and thoughts about SciTech activities. The SciTech journal is a useful assessment tool. Frequent monitoring of students' journals will allow you to identify student alternative conceptions, find evidence of their understanding of the steps in the investigating and designing and making processes and see evidence of student learning for planning future learning activities in SciTech.

Using a SciTech Journal

1. At the start of the year, or before starting a SciTech unit, provide each student with a notebook or exercise book for their SciTech journal, or use an electronic format. Tailor the type of journal to fit the needs of your classroom. Explain to students that they will use their journals to keep a record of their observations, ideas and thoughts about SciTech activities. Emphasise the importance of including drawings as well as written entries.

2. Use a large project book or A3 paper to make a class SciTech journal. This can be used at all stages to model journal entries. With younger students, the class SciTech journal may be used more frequently than individual journals and may take the place of individual journals.

3. Make time to use the SciTech journal. Provide opportunities for students to plan procedures and write their predictions before an activity, to make observations during an activity and reflect on them afterwards.

4. Provide guidelines in the form of questions and headings and facilitate discussion about recording strategies, for example, note-making, lists, tables, concept maps and mind maps. Use the class SciTech journal to show students how they can modify and improve their recording strategies.

5. In SciTech journal work, you may refer students to display charts, pictures, diagrams, word walls and phrases about the topic displayed around the classroom. Revisit and revise this material during the unit. Explore the vocabulary, visual texts and ideas that have developed from the SciTech unit and encourage students to use them in their SciTech journals.

6. Review entries in the SciTech journal regularly. Give positive feedback. Write questions or comments that will clarify a student's thinking and/or improve observation. When commenting on work-in-progress, use adhesive notes instead of writing in journals so that students can make the appropriate changes themselves.

7. Combine the use of resource sheets with journal entries. After students have pasted their completed resource sheets in their journal, they may like to add their own drawings and reflections.

8. Explore the importance of entries in the SciTech journal during the steps of each process. Demonstrate how the information in the journal will help students develop and clarify their learning.

9. Use the SciTech journal to assess student learning in SciTech. For example, during the hypothesising and predicting step, use journal entries for diagnostic assessment as you determine students' prior knowledge.

2 Electricity Safety

TASK:
To inform students about electricity safety

A lesson to **engage** students, elicit questions and lead discussions about electricity safety through online and interactive activities. Class activities will provide students with hands on experience to assist them with **exploring** the topic of electricity safety.

Teacher Background Information

Interactive whiteboard lessons and activities can be downloaded at:

- www.ausgrid.com.au/learnelectricity

NB: There are several activities and online lessons on this site. They can be referred to and taught concurrently throughout this electricity unit.

Assessment

- **Formative assessment** – monitoring students' learning and developing understanding via observation and providing feedback to extend learning
- **Summative assessment** – via quiz at the conclusion of online activities

Equipment

- Butcher's paper
- Marker pens
- Safety quiz – photocopied back to back
- Dangerous scenario cards
- Interactive whiteboard lesson 2
- Interactive whiteboard

Activity Steps:

- Lead a discussion about why we should be safe around electricity.
- Ask students to brainstorm situations that display unsafe electrical practices.
- Divide the class into groups and hand out paper and pens.
- Ask each group to list and illustrate as many unsafe situations as they can.
- Regroup the class and ask each group to present their findings.
- Explain to the students that they are going to become actors and will act out some of the scenarios that have been discussed.

- Divide the class into groups again and display the dangerous scenario cards.
- Ask each group to choose a scenario to act out.

  For example:

  Tommy: “Let’s take our balloon down to the substation and see if we can get it to spark.”

  Johnny: “I don’t think that is such a good idea. You shouldn’t muck around with electricity.”

  Steven: “Don’t be such a wimp, Johnny. It sounds like fun.”

  Johnny: “It wouldn’t be fun to get an electric shock. We should stay here and rub the balloons on our hair to make static electricity instead.”

  Tommy: “Okay, that sounds like fun too. Let’s do that.”

- When all students have had a turn of dramatising their scenes, begin the interactive whiteboard lessons and activities.
- At the completion of the interactive whiteboard activities, hand out the electricity safety quiz and ask for students to complete.

Interactive Resources

click here to access the online resource

interactive whiteboard lesson 2

- Slides 2 to 3 – Electrical safety officer test
- Slides 4 to 13 – Videos and activities about electricity safety rules
- Slides 14 to 19 – Identifying dangerous situations
- Slides 20 to 22 – Knowing what to do in an electrical emergency
- Slides 23 to 32 – Electricity safety quiz

2 Electricity Safety Quiz

Attachment

Name:____

1. What is the emergency phone number in Australia?

a) 111
b) 222
c) 000 (Triple ZERO)

2. If someone is getting an electric shock inside a house, what is the first thing you should do?

a) Pull them away
b) Tell an adult– so they can turn off the main power switch
c) Turn the power off at the power point

3. If there is a small electrical fire, you should get an adult to put it out. What do you think would be the best thing they could use to put out an electrical fire?

a) Water
b) Fire blanket
c) Dry powder extinguisher

4. Why can a bird sit on a power line and not get an electric shock?

a) They are electricity insulators
b) They have no water in them
c) They are only touching one wire and nothing else, so the electricity cannot make a circuit

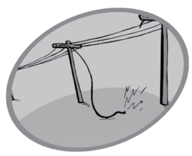
5. If your ball should accidentally go into a substation you should:

a) Carefully climb the fence to get it
b) Stay away and tell an adult to contact the electricity authority
c) Allow your friend to get it for you

6. What do you do if your toast gets stuck in the toaster?

a) Turn off the toaster, unplug it and once it has cooled down, you can turn it upside down
b) Get it out with a fork
c) Turn it off and get it out with a knife

7. If you see a fallen power line across a footpath, you should:



a) Stay at least 8 metres away from it and anything it may be touching
b) Tell an adult
c) Both of the above

8. Your sister is using a hair dryer next to a bath containing water, what should you do?

a) Tell your sister it is dangerous and that she should not use her hair dryer near water.

b) Walk away so you don't get hurt

c) Tell her to be careful

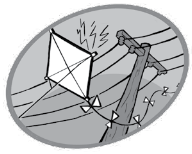
9. Your friend asks you to play near the substation because it is a cool place. What should you do?

a) Tell him it isn't safe and that he shouldn't go near it

b) Go with him because you can learn a lot about electricity there

c) Go with him but be careful

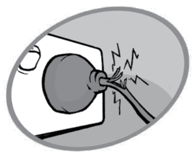
10. Why should you never fly your kite near overhead power lines?



11. What can happen if you plug in too many appliances at one power point or power board?

12. Why shouldn't you dig near underground power lines?

13. What should you do with faulty appliances or appliances that have a damaged cord?



14.Think of a dangerous electrical situation. Draw and label it in the box below.

2 Electricity Safety Quiz – Answers

1. **Answer is B**. Emergency phone number is 000.
2. **Answer is B.** Tell an adult immediately, so they can turn off the main power switch. It is not recommended that students approach the meter box without adult supervision.
3. **Answer is C**. Dry powder extinguisher. It is important to emphasise that water and water-based extinguishers should not be used because water is a conductor of electricity.
4. **Answer is C.** When birds are only touching one wire and nothing else, the electricity cannot make a circuit.
5. **Answer is B.** Students should stay away from the substation and tell an adult. Substations contain special equipment with invisible hazards. You don't even have to touch anything to get hurt. Just being too close to some substation equipment can be dangerous and may even kill you. The adult can ring the electricity provider to see if they have an expert who can safely retrieve the ball.
6. **Answer is A.** Turn off the toaster, unplug it and once it has cooled down, turn it upside down. Explain to students that metal is a conductor of electricity.
7. **Answer is C.** Both of the above. Tell an adult and stay at least 8 metres away from the fallen power line and anything it may be touching. You may like to practically demonstrate the distance of 8 metres. i.e. ask a student to stand in the playground and represent a fallen power line. Ask the other students to stand at least 8 metres away from the student. The teacher can then measure 8 metres to see if the students have an accurate understanding of the distance.
8. **Answer is A.** Tell your sister it is dangerous and that she should not use her hair dryer near water. If she wants to use the hair dryer in the bathroom, she should make sure the bath is empty. If not, she should move to another room where there is no water present.
9. **Answer is A.** Tell your friend it isn't safe and that he shouldn't go near it.
10. Live electricity can travel down the string and seriously hurt you. Electricity poles and wires are all around us. They can be above us, next to us, and even below us. Play in open spaces away from electricity poles, towers and power lines.
11. Stacked power points with too many plugs connected to it can cause an electrical fire. Never stack power points. You should use a power board or have an extra power point installed by an electrician.
12. If you hit an underground power line, you could be electrocuted and interrupt power to your suburb. Remember – before you or your family do any major digging in the yard, your parents should ring Dial Before You Dig on 1100 to make sure there are no underground cables near your property.
13. They should be disconnected at the power point and fixed or replaced by an electrician.
14. Always be on the lookout for dangers in and around your home. This could be anything from a faulty electrical lead to a 'stacked' power point – one with too many plugs in it. These situations could be life threatening and an electrician should be called in to fix them.

3 What is Energy?

TASK:
Identifying different forms of energy

A lesson to discuss what energy is and where it comes from. The class activities will **engage** students, elicit questions and find out what is currently known.

Teacher Background Information

Energy is the capacity or power to do work, such as the capacity to move an object (of a given mass) by the application of force. Energy can exist in a variety of forms, such as electrical, mechanical, chemical, thermal, or nuclear, and can be transformed from one form to another. It is measured by the amount of work done, usually in joules or watts. Energy cannot be created and cannot be destroyed but it can be transformed and transferred.

Assessment

Diagnostic assessment of student's knowledge and understanding of energy is observed throughout this lesson.

Equipment

- Word cards (attachment to this lesson)
- SciTech journals

Activity Steps:

- Have students sit in a circle.
- Review the discussion from lesson 1 to lead the students into a discussion about how important energy is to our everyday lives.
- Explain to the students that energy is the power that makes things work. To make energy you need an energy resource or fuel. The energy resource that gives our bodies energy is food.
- Place the word cards contained at the back of this lesson (sun, wind, food, petrol, water) on the floor in the centre of the circle.
- Explain to the students that each card represents an energy resource.
- Go around the circle and ask each student to think of something that uses one of these energy resources. E.g. Plants use energy from the sun to grow.
- Ask students to create a table in their SciTech journal and list the uses of each energy resource.

Sun (Solar)	Food	Petrol	Wind	Water (Hydro)

- Explain to the students that different energy resources produce different types of energy. When we metabolise our food, we make metabolic energy.
- Discuss the other types of energy that can be created. (mechanical, chemical, electrical)
- Have the students rub their hands together and then ask:
  - What type of energy did you use?
  - How did your hands feel?
  - (They used metabolic energy to form mechanical energy which formed heat energy)
- It is important to stress to the students that energy is not created and cannot be destroyed, it is just changed from one form to another.

Interactive Resources

click here to access the online resource

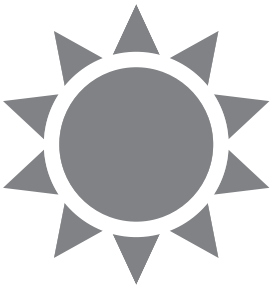
interactive whiteboard lesson 1

- Slide 5 – What is energy?
- Slide 6 – Energy resources table
- Slide 7 – Atoms and electrons
- Slide 8 – Diagram explaining keywords

3 Word Cards

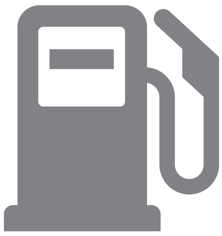
Attachment

sun

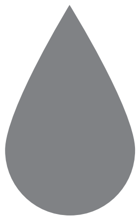


wind

petrol



water



food

3 STEM Design Challenge -Transferred Energy

TASK:
Work in a group to design a balance arm scales that demonstrates transferred energy.

Materials Provided

- Coat hanger
- Ruler
- Hole punch
- Plastic cups
- Marbles
- String
- Sticky tape
- Masking tape
- Scissors
- Marking pen

(You may add materials of your own to this list)

Success Criteria

- The balance arm scales must be fully functioning.
- You must include a design brief of your balance arm scales with all measurements.
- You must include photos of the stages of your design.
- You must include instructions for using the balance arm scales.
- Complete and submit Planning Page.
- Complete and submit Explanation Page.
- Complete and submit Student Reflection Checklist.

3 Planning Page -Transferred Energy

Attachment

Design Brief

Work in a group to design a balance arm scales that demonstrates transferred energy.

Team Members and Roles

Name	Role

Research Ideas (include websites your group used)

Labelled Design Sketches

3 Explanation Page -Transferred Energy

Attachment

Explain how your balance arm scales work using the correct terminology of transferred energy.

Describe some of the challenges that your group faced when designing your balance arm scales.

How did your group overcome these challenges?

3 Student Reflection Checklist - Transferred Energy

Attachment

	Yes	Some	No
Planning Page			
Roles of team members outlined			
Research outlined and websites included			
Labelled design sketch included			
Explanation Page			
Explanation of how balance arm scales work with correct terminology of transferred energy included			
Description of challenges included			
Explanation of how group overcame challenges included			
Balance Arm Scales Production			
Clear design brief with all measurements included			
Photos of production process included			
Balance arm scales well-made and sturdy			

4 Transforming Energy

TASK:
Identifying different forms of energy and how they can be changed.

A hands-on investigation to **explore** how energy can be changed.

Teacher Background Information

Energy can be found everywhere. There is potential energy in objects at rest and kinetic energy in objects that are moving. The molecules making up all matter contain a huge amount of energy. Energy can travel in electromagnetic waves, such as heat, light, radio, and gamma rays. Our body uses metabolic energy from our food. Energy is constantly flowing and changing form. If you take your metabolic energy and rub your hands together, you make mechanical energy. Your hands heat up and the mechanical energy is turned into heat energy.

If we place a scooter at the top of a hill, it has the potential energy to roll down. If a boy jumps on the scooter and pushes off, the scooter will begin to roll, changing potential energy into kinetic energy. The boy used metabolic energy to push the scooter and mechanical energy to keep the scooter moving. The metabolic energy came from a sausage he had just eaten. The sausage had stored chemical energy. That chemical energy entered the animal when it digested a plant and broke the bonds in its molecules. The plant made the molecules by using light energy from the Sun. The Sun's light energy came from electrons in its atoms lowering energy states, and releasing energy. The energy in the atoms came from the nuclear reactions in the heart of the Sun.

So energy can change form. The energy we use every day has always been with us since the beginning of the universe and will always be with us. It cannot be destroyed, it just changes form. That is called the law of conservation of energy.

Assessment

Diagnostic assessment of student's knowledge and understanding of energy is observed throughout this lesson.

Equipment

- Balloons (1 for each group)
- SciTech journals
- Butcher's paper

Activity Steps:

- Review previous lesson (What is energy?).
- Remind the students of the heat energy that was transformed when they rubbed their hands together.
- Divide the class into groups and ask each group to discuss examples of where energy is transformed from one type to another.

- Ask the groups to record their ideas on the butcher's paper.
- Have the groups re-join the class to discuss their ideas.
- Record the suggestions on one large class display.
- Divide the class into groups, assign roles (Chief Scientist, Safety Officer, Lab Technician, Science Journalist and Science Communicator) and hand out badges included at the end of this lesson.
- Explain to the students that they are going to carry out an investigation to determine whether a balloon has energy.
- Ask Lab Technicians to collect balloons.
- Ask the students to examine the balloon and decide whether in a deflated state the balloon has energy.
- Have the students inflate the balloon without tying the end closed.
- Ask the students if the inflated balloon has energy.
- Have the students release the balloon into the air and observe what happens.
- Does the balloon have energy? Has the energy changed?
- Now ask the students to inflate the balloon again and this time stretching the neck of the balloon while they release the air.
- Does the balloon have energy? Has the energy changed?
- Have the students write a science report (example attached at the back of this lesson) of their investigation in their SciTech journals.
- Ask the students to include a table of energy types in their report and annotated diagrams.

Balloon position	Type of energy
Deflated balloon	
Inflated balloon (stationary)	
Inflated balloon released	
Stretching neck	

Interactive Resources

click here to access the online resource

interactive whiteboard lesson 1

- Slide 9 – Car transforming energy
- Slide 10 – Interactive cloze passage
- Slides 11 to 12 – Find-a-word
- Slide 13 – Keyword match-up

4 How to organise a cooperative learning group

Attachment

Introduction

Students need to be taught how to work cooperatively. They need to work together regularly to develop effective group learning skills.

The benefits of cooperative learning include:

- more effective learning – students learn more effectively when they work cooperatively than when they work individually or competitively, and also have a better attitude towards their school work.
- improved self-confidence – students tend to be more successful when working in groups and this builds their self-confidence.
- better classroom management – when students work in cooperative groups they take responsibility for managing much of the equipment.

Structuring cooperative learning

Use the following ideas in planning cooperative learning with your class.

- Introduce group skills and group roles before starting the unit.
- Assign students to groups rather than allowing them to choose partners.
- Vary the composition of each group. Give students the opportunity to work with others who might have a different ability level, sex or cultural background.
- Keep groups together for two or more lessons so that students have enough time to learn to work together successfully.
- Keep a record of the students who have worked together as a group so that by the end of the year each student has worked with as many others as possible.

Group roles

Students are assigned roles within their groups (see below). Each group member has a specific role, but all members share leadership responsibilities. Each member is accountable for the performance of the group and should be able to explain how the group obtained its results. Students must therefore be concerned with the performance of all group members. It is important to rotate group jobs each time a group works together so that all students have an opportunity to perform different roles.

For this unit the groups consist of five students – Lab Technician, Science Communicator, Chief Scientist, Safety Officer and Science Journalist. Each member of the group wears a role badge. The badges make it easier for you to identify which role each student should have – and easier for the students to remember what they and their group mates should be doing. Use the template at the end of this Appendix to make role badges, or create your own.

It is better to divide your students into groups of three as it is often difficult for students to work together in larger groups. If you cannot divide the class into groups of three, form two groups of two rather than a group of four.

Lab Technician

The Lab Technician is responsible for collecting and returning the group's equipment. The Lab Technician also tells the teacher if any equipment is damaged or broken. All group members are responsible for clearing up after an activity and getting the equipment ready to return to the equipment table.

Science Communicator

The Science Communicator is responsible for asking the teacher or another group's speaker for help. If the group cannot resolve a question or decide how to follow a procedure, the Science Communicator is the only person who may leave the group and seek help. The Science Communicator shares any information they obtain with group members.

Chief Scientist

The Chief Scientist is responsible for making sure that the group understands the group investigation and helps group members focus on each step. The Chief Scientist is also responsible for offering encouragement and support. When the group has finished, the Chief Scientist helps group members check that they have accomplished the investigation successfully. The Chief Scientist provides guidance, but is not the group leader.

Safety Officer

The Safety Officer is responsible for making sure the group understands and follows the safe use of materials and equipment. The Safety Officer should be aware of all the electrical safety messages and ensure that the investigations are undertaken in a safe manner. By the end of the unit every student should have undertaken this role and be able to pass the safety test.

Science Journalist

The science journalist is responsible for writing up the investigation and recording observations.

Group skills

The use of cooperative groups focuses on social skills that will help students work together and communicate effectively.

Students will practise the following five group skills throughout the year:

- move into your groups quickly and quietly
- speak softly
- stay with your group
- take turns
- perform your role.

To help reinforce these skills, display enlarged copies of the group skills chart and the group roles chart (see the end of this attachment) in a prominent place in the classroom.

Even though the group skills seem simple, focus on one skill at a time. This will help you to monitor each group's use of the skill. Encourage students to use the skill by observing them as they work and providing them with feedback – this sends the message that working together effectively is important. Leave enough time at the end of cooperative activities to help groups assess their use of the skill.

Supporting equity

In SciTech lessons there can be a tendency for boys to manipulate materials and girls to record results. Try to avoid traditional social stereotypes by encouraging all students, irrespective of their sex, to learn to the maximum of their potential. Cooperative learning encourages each student to participate in all aspects of group activities, including handling the equipment and taking intellectual risks.

Observe students when they are working in their cooperative groups and ensure that both girls and boys are participating in the hands-on activities.

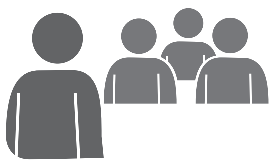
Group skills

1.	Move into your groups quickly and quietly
2.	Speak softly
3.	Stay with your group
4.	Take turns
5.	Perform your role

Group roles

Lab Technician
Collects and returns all materials the group needs.

Science Communicator
Asks the teacher and other group speakers for help.



Chief Scientist
Makes sure that the group understands the team investigation and completes each step.

Safety Officer
Makes sure that the group understands and follows the safe use of materials and equipment.

Science Journalist
Writes up the investigation and records observations.

Chief Scientist	Safety Officer	Lab Technician	Science Journalist	Science Communicator
Chief Scientist	Safety Officer	Lab Technician	Science Journalist	Science Communicator
Chief Scientist	Safety Officer	Lab Technician	Science Journalist	Science Communicator
Chief Scientist	Safety Officer	Lab Technician	Science Journalist	Science Communicator
Chief Scientist	Safety Officer	Lab Technician	Science Journalist	Science Communicator
Chief Scientist	Safety Officer	Lab Technician	Science Journalist	Science Communicator
Chief Scientist	Safety Officer	Lab Technician	Science Journalist	Science Communicator

4 Example of a Science Report

Attachment

Investigation

Does a balloon have energy?

Prediction

The balloon does have energy when inflated.

Equipment:

- Balloon

Method:

1. Place the deflated balloon on a table and observe.
2. Inflate the balloon without tying the end closed.
3. Holding the end tight, observe the balloon.
4. Release the balloon into the air.
5. Observe the balloons movement.
6. Inflate the balloon again and stretch the neck of the balloon while releasing the air.
7. Record your observations.
8. Draw annotated diagrams of your investigation.

Observation:

1. The deflated balloon does not move.
2. The inflated balloon sways from side to side.
3. When released, the inflated balloon pushes through the air and then spirals to the ground.
4. When the neck of the inflated balloon is stretched, a high pitched sound is produced as the air is released.

Results:

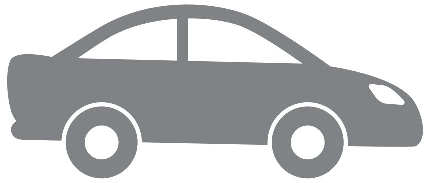
1. The deflated balloon does not possess energy.
2. The inflated stationary balloon possesses potential energy.
3. When released the potential energy is transformed into kinetic energy.
4. When the neck of the balloon is stretched, potential energy is transformed into sound energy and kinetic energy.

Conclusion:

Inflated balloons do have energy and the energy can be transformed from potential to kinetic energy.

4 Quiz – Types of Energy

Attachment



Name:____

- When you travel by car or bus, energy is required to make the transport go.
- The energy for a car or a bus comes from petrol and a battery.
- The petrol stores chemical energy and the battery stores electrical energy.
- When something stores energy, it is said to have potential energy.
- When the potential energy is used to make movement it is said to have kinetic energy.
- When we start the car, the engine changes this chemical energy and electrical energy into different types of energy.
- When the engine starts we can hear it. This is sound energy.
- When we drive about, the car is moving. This is mechanical energy.
- When we switch on the headlamps, we can see light. This is light energy.
- After the car has been running for a while the bonnet becomes warm. This is heat energy. Heat energy is always produced when things work. Just like when you run about, you get hot.

Answer the following questions in full sentences:

1. When something is moving, what type of energy is being used?

____

____

____

____

2. What types of energy resources do cars use?

____

____

____

____

3. What type of energy does petrol store?

4. When things are working, what type of energy is always given off?

5. If something stores energy, what type of energy does it have?

6. What is required to make something go?

4 Cloze Passage – Types of Energy

Attachment

Name:____

Types of Energy

When you travel by car or bus, ________________________is required to make the transport ___________. The energy for a car or a bus comes from _________________ and a _______________________. The petrol stores __________________ energy and the battery stores_______________ energy. When something stores energy, it is said to have ________________ energy. When the potential energy is used to make movement it is said to have ______________________ energy. When we _____________________ the car, the engine changes this chemical energy and electrical energy into different _____________ of energy. When the engine starts we can hear it. This is __________________energy. When we drive about, the car is moving. This is ______________________energy. When we switch on the headlamps, we can see light. This is _______________________ energy. After the car has been running for a while the bonnet becomes __________________. This is heat energy. ____________ energy is always produced when things work. Just like when you run about, you get ______________.

petrol	energy	warm	potential
mechanical	Heat	hot	battery
chemical	kinetic	electrical	sound
types	light	start	go

4 STEM Design Challenge -Transformed Energy

TASK:
Work in a group to design a balloon rocket using your knowledge of transformed energy.

Materials Provided

- Cardboard
- Balloon
- String
- Masking tape
- Scissors
- Cardboard tubes
- Straws
- Tape measure
- Marking pen

(You may add materials of your own to this list)

Success Criteria

- The balloon rocket must move.
- You must include a design brief of your balloon rocket and measurements of all pieces.
- You must include photos of the stages of your design.
- You must include instructions for launching the balloon rocket.
- You must include an estimate of the distance your balloon rocket travels in your explanation of how it works.
- Complete and submit Planning Page.
- Complete and submit Explanation Page.
- Complete and submit Student Reflection Checklist.

4 Planning Page - Transformed Energy

Attachment

Design Brief

Work in a group to design a balloon rocket capable of being launched using your knowledge of transformed energy.

Team Members and Roles

Name	Role

Research Ideas (include websites your group used)

Labelled Design Sketches

4 Explanation Page -Transformed Energy

Attachment

Explain how your balloon rocket works using the correct terminology of transformed energy.

Describe some of the challenges that your group faced when designing your rocket.

How did your group overcome these challenges?

4 Student Reflection Checklist -Transformed Energy

Attachment

	Yes	Some	No
Planning Page			
Roles of team members outlined			
Research outlined and websites included			
Labelled design sketch included			
Explanation Page			
Explanation of how balloon rocket works with an estimate of the distance travelled and correct terminology of transformed energy included			
Description of challenges included			
Explanation of how group overcame challenges included			
Balloon Rocket Production			
Clear design instructions and measurements of all pieces included			
Rocket launched			
Photos of production process included			
Balloon rocket well-made and sturdy			

5 Electricity Generation and Transmission

TASK:
To investigate how electricity is generated?
A hands-on lesson to discuss and **explore** the generation and movement of electricity.

Teacher Background Information

The fundamental principles of electricity generation were discovered in the 1820's by British scientist Michael Faraday. He generated electricity by moving a loop of wire between the poles of a magnet. This method is still used today.

Modern power plants generate electricity in a variety of ways. It is most often generated by heat engines fuelled by burning fossil fuels or radioactive elements, but it can also be generated by water, wind, solar and geothermal power.

Power plants generate steam to power a turbine which spins a huge magnet inside a copper wire, producing electricity. The electricity flows from the power plant through wires to the transformer. The transformer raises the pressure so it can travel long distances – it is raised as high as 500,000 volts in Australia.

The electric current then runs through the power lines to the substation transformer where pressure is lowered to between 11,000 and 132,000 volts. Electricity is then taken through the lines to a pole transformer and pressure is lowered again to between 240 and 415 volts. From here electricity comes into your home through a meter box. Wires take electricity around your home powering your lights and appliances.

Assessment

Formative assessment – monitoring students' learning and developing understanding via observation and providing feedback to extend learning.

Equipment

- Power transmission cards (1 set per group)
- Hand generator
- Light bulb and connecting wires
- SciTech journals

Activity Steps:

- Have students sit in a circle on the floor.
- Revise the information gathered in lesson 1 and ask the students where they think electricity comes from.
- Place picture cards in the circle and ask students to comment on each one. What are the pictures of? How are they included in our power supply?

- Divide the class into groups and give each group a copy of the pictures.
- Ask the groups to discuss and order their set of pictures to show the supply of electricity from the plant to our homes.
- Hand each group the power transmission word cards and ask them to sort them into their correct order.
- Encourage groups that are struggling to refer to their picture cards.
- Ask the students to return to the circle and discuss their results.
- Show the students the hand generator and explain that the magnet and copper wire inside is just like the generator in the power station. Your hand is providing the energy.
- Connect the light bulb to the hand generator and let the students generate electricity.
- Students draw an annotated drawing of the transmission grid, in their SciTech journals.
- Finally, take students through the interactive 'energy cycle diagram' located on Interactive Whiteboard.

Interactive Resources

click here to access the online resource

Interactive whiteboard lesson 3

- Slides 2 to 3 – Videos on generating electricity
- Slides 4 to 7 – Electricity generation
- Slide 8 – Video about solar energy
- Slide 9 – Interactive diagram about energy cycle to home
- Slide 10 – Picture match activity
- Slide 11 – Transportation of electricity

5 Power Transmission Cards

Attachment

Power Plant to the Home

The cards are currently in order. Jumble them and hand a set to each group.

The steam is sent through pipes to the turbine, which is a big fan. (Mechanical energy)

When the magnet spins 3,000 times a minute the generator makes electrical energy.

Inside the power plant, coal, oil or gas is burned in a furnace which heats water in a big boiler to create steam. If the plant is hydro-electric, the potential energy stored in the water is used to drive the turbine.

The steam goes through the turbine blades making them spin 3,000 times in one minute.

Power stations put the fuel into a boiler and set fire to it. (Heat energy)

The turbine is connected to the generator; this is a large magnet and lots of wire.

The chemical energy in the fuel is changed into heat energy in the form of steam.

The electricity generated at the power station is fed through transmission lines to zone substation transformers.

The electrical energy then travels along the distribution power lines to our homes, schools, hospitals, offices, factories, street lamps, traffic lights, cinemas, restaurants, fire stations and everything else that needs electrical energy to work.

It passes through an electricity meter that measures how much energy your family uses.

The electricity travels through wires inside the walls to outlets and switches all over your house.

Big high-voltage transmission lines carry electricity to your city or suburb.

It passes through zone sub-stations, where the voltage is lowered, then to transformers which lower it again to make it safe to use in our homes.

It travels through smaller power lines to your house.

You can use the electricity to switch on lights, watch TV, listen to music and cook dinner!

6 Exploring Electrical Circuits

TASK A:
Simulating open and closed circuits

A hands-on lesson where students will **explore** electrical circuits.

Teacher Background Information

- Both ends of the battery must be connected to the light bulb before it will glow.
- Metal connection points are called terminals.
- The metal side of the light bulb is one terminal and the bottom is the other.
- The top of the cell is positive (+ve) and the bottom of the cell is negative (-ve).
- The light bulb has to be connected in two places to complete the circuit.
- For the light bulb to glow there has to be a closed circuit joining the battery and the light bulb. This is called an electric circuit.
- When there is a gap or break in the circuit the light will not glow. This is called an open circuit.

Assessment

Formative assessment – monitoring students' learning and developing understanding via observation and providing feedback to extend learning.

Equipment

- Chalk
- Small boxes
- Counters

Activity Steps:

- Take the students into the playground and discuss what the students have learnt to date about circuits.
- Mark out a circuit in the playground using a chalk line and place a small obstacle along the circuit, e.g. a small box. Have one student stand near the obstacle.
- Ask several students to stand at regular intervals along the drawn circuit while the teacher stands opposite an obstacle with a bowl of counters.
- Have students walk along the circuit maintaining their distance from the person in front and jumping over the obstacle.
- As students jump over the obstacle, they should give a counter to the student standing near the obstacle.

- As students pass the teacher they each receive another counter.
- Continue the simulation until all the counters have been used by the students.
- Discuss the circuit activity.
- Identify the various representations of the activity such as the:

  – Chalk line representing wires.

  – Obstacle representing the light globe.

  – Teacher representing the battery.

  – Students representing electrons.

  – Counters represent the electrical energy.
- Discuss the function of each part of the circuit such as the wires to allow the flow of electrons, the battery which provides more energy to 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 it.
- Rub out a section of the chalk line. (Once the circuit is open, 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 by-passing the light bulb (obstacle). Ask students to walk the circuit again using the easiest path.
- Discuss with students the easier path is a short circuit (electrons will follow the path of least resistance to return to their energy source).
- Discuss how this can be dangerous.
- Return to the classroom and ask students to draw annotated diagrams of open and closed circuits in their SciTech journals.
- Have students make notes of the new terminology and concepts in their SciTech log books, add to the KWL chart and word wall. This should include descriptions of open, closed and short circuits.

TASK B:
Making electrical circuits

A practical lesson for students to create and **explore** circuits. This lesson will provide hands on experience to investigate various ways of connecting a battery, bulb and wire.

Assessment

- Formative assessment – monitoring students' learning and developing understanding via observation and providing feedback to extend learning.

Equipment

- Role badges from Lesson 4
- Each team member's SciTech journal
- 1.5 volt battery
- Light bulb
- 2 connecting wires

Activity steps

- Ask the students to explain what makes a light bulb glow.
- Discuss the ideas put forward by the students.
- Explain that the students will explore these ideas in groups, using the equipment.
- Divide the class into groups, assign roles (Chief Scientist, Safety Officer, Lab Technician, Science Journalist and Science Communicator) and hand out badges.
- Ask Lab Technicians to collect equipment.
- Have students use the battery and ONE connecting wire to make the light bulb glow.
- Have Science Journalist record the investigation and draw and label a diagram showing how they connected the battery and light bulb.

  – Discuss where the wire connects to make the light bulb glow.

  – How many different ways were there to make the light bulb glow?
- Have students make the light bulb glow using TWO connecting wires.
- Discuss the methods used to make the light bulb glow; guide students' attention to the formation of circuit created by the battery, wires and light bulb.
- Ask students to copy the record made by the science journalist for their group into their SciTech journals.
- Class discussion:

  – Ask some students to present their observations to the class.

  – What circuits made the light bulb glow?

– What did the circuits that made the light bulb glow have in common?

– What did the circuits that didn't work, have in common? (Introduce the terms open and closed circuit).

Interactive Resources

click here to access the online resource

interactive whiteboard lesson 3

- Slide 13 – Video about electrical circuits
- Slide 14 - Components of a simple circuit
- Slide 15 - Virtual experiment about exploring circuits
- Slide 16 - Quiz about circuits

6 STEM Design Challenge - Circuit Design

TASK:
Work in a group to design a board game that incorporates an electrical circuit. You will be required to use your knowledge of circuits and how they work to design your game.

Materials Provided

- Cardboard
- Light bulb
- Insulating wire
- Masking tape
- Battery
- Scissors
- Aluminium foil

(You may add materials of your own to this list)

Success Criteria

- The game must include a circuit.
- It must be a game with electricity as the theme.
- Your game must include a minimum of 10 questions and answers about electricity as part of the game. These could be game cards or landing places on the board.
- The board game must be accurately and neatly made using suitable geometrical techniques.
- You must include photos of the stages of your design.
- You must include instructions for playing the game.
- Complete and submit Planning Page.
- Complete and submit Explanation Page.
- Complete and submit Student Reflection Checklist.

6 Planning Page - Circuit Design

Attachment

Design Brief

Work in a group to design a board game that incorporates an electrical circuit. You will be required to use your knowledge of circuits and how they work to design your game.

Team Members and Roles

Name	Role

Research Ideas (include websites your group used)

Labelled Design Sketches

6 Explanation Page - Circuit Design

Attachment

Explain how your game works using the correct terminology of electrical components.

Describe some of the challenges that your group faced when designing the game.

How did your group overcome these challenges?

6 Student Reflection Checklist - Circuit Design

Attachment

	Yes	Some	No
Planning Page			
Roles of team members outlined			
Research outlined and websites included			
Labelled design sketch included			
Explanation Page			
Explanation of how board game works with correct terminology of electrical components included			
Description of challenges included			
Explanation of how group overcame challenges included			
Board Game Production			
A minimum of 10 Q & A's included			
Questions were applicable			
Answers were correct			
A circuit was included			
Circuit works			
Clear instructions for playing the game included			
Photos of production process included			
Board game is accurately and neatly made using suitable geometrical techniques and is appealing to buyers			

7 Investigating Conductors and Insulators

TASK:
Identify materials that conduct electricity and insulate electricity.

A hands-on student driven investigation to **explore** and determine the materials that conduct electricity.

Teacher Background Information

If an electric charge can easily flow through something, that something is referred to as a conductor. Most metals are considered conductors of electricity. Water is also a good conductor of electricity and that means so is the human body. Since our bodies are made up mostly of water, electricity can easily move through our bodies on its way to the ground. If an electrical current cannot easily pass through an object, that object is called an insulator. Most non-metallic items, like rubbers and plastics, are considered insulators. Electricity travels at the speed of light, so if a person comes in contact with electricity he/she will feel the electrical jolt immediately. Electric current flowing through your body can cause damage to your nerves and tissues, so it's important to be very careful around electricity.

Assessment

Formative assessment – monitoring students' learning and developing understanding via observation and providing feedback to extend learning.

Equipment

- Role badges used in Lesson 4
- Each team member's SciTech journal
- 1.5 volt battery
- Light bulb and lamp holder
- Multimeter (if available, but not essential for experiment)
- 3 connecting wires
- Variety of items for testing, e.g. paper-clips, aluminium foil, rubber band, string, texta, wooden ruler and other classroom items

Activity steps:

- Discuss with students how we know that electrons are flowing in a circuit.
- Ask students how they could test different materials for electrical conductivity.
  - Guide students to suggest constructing an open circuit that includes a battery, wires and a light bulb. The items being tested should then be used to complete the circuit. If the light glows, then the material is a conductor of electricity.
- Discuss with students:
  - The idea of a "fair test".
  - How can we ensure that the test is fair?
  - What variables must we keep the same? (length of wires, same battery, etc.)
  - How will we record our observations?

- Have students construct a table in their SciTech journal with a list of approximately ten objects in the left hand column. Have them predict conductivity. Example shown below:

Object	Material	Prediction: Will it conduct electricity? Yes/No	Does the light bulb glow?
Paper-clip	steel		
Plastic ruler	plastic		

- Divide class into groups, assign roles and hand out badges.
- Ask Lab Technicians to collect equipment.
- Ask each group to make a prediction about which materials will conduct electricity.
- Have students construct an open circuit.
- Ask students to test their circuit by using the object to complete the circuit. If the light globe glows then the object is a conductor of electricity. If the object did not allow the light to glow then it is an insulator.
- Have students test the provided objects. Ensure students record their observations.
- Have students present their findings to the class.
  - List the conductors and insulators.
  - Is there a pattern in the results?
  - Was the outcome different to their predictions?
  - Do the results support their prediction?
  - What difficulties did they experience when completing this investigation?
  - How could they improve this investigation?
- Have students suggest reasons why electrical wires are coated in plastic. Why should frayed electrical cords be replaced?
- Discuss:
  - Why is it useful to know which materials conduct electricity?
  - Will the human body conduct electricity? What injuries may happen to a person who has received an electric shock?

Extension Activity

- Ask the students to design their own switch. The switch must be safe and able to be switched on and off repeatedly.
- In groups students draw a labelled diagram of their design.
- Students construct and present their designs to the class.
- Students discuss the safety features incorporated in their designs and how their design could be improved.

Interactive Resources

click here to access the online resource

interactive whiteboard lesson 4

- Slide 2 – Virtual experiment to investigate conductors and insulators
- Slide 3 – Crossword

7 STEM Design Challenge - Energy Conductors

TASK:
Work in a group to design a test of conductivity for the materials listed below. You must use your knowledge of circuits, conductors and insulators to design your test.

Materials Provided

- Straw
- Screw
- Scissors
- Ruler
- Eraser
- Cork
- Nail
- Key
- Pencil
- Spoon
- Pen
- Washer
- Button

(You may add materials of your own to this list)

Success Criteria

- The test must include a circuit.
- You must include clear design instructions for your test.
- You must present the results of your test as a scientific report.
- You must include photos of the stages of your design.
- Complete and submit Planning Page.
- Complete and submit Table of Results.
- Complete and submit Explanation Page.
- Complete and submit Student Reflection Checklist.

7 Planning Page - Energy Conductors

Attachment

Design Brief

Work in a group to design a test of conductivity for the materials you have been given. You must use your knowledge of circuits, conductors and insulators to design your test.

Team Members and Roles

Name	Role

Research Ideas (include websites your group used)

Labelled Design Sketches

7 Explanation Page - Energy Conductors

Attachment

Explain how your test of conductivity works using the correct terminology of circuits, conductors and insulators.

Describe some of the challenges that your group faced when designing and carrying out your test.

How did your group overcome these challenges?

7 Table of Results Page - Energy Conductors

Attachment

Material	Conductor	Insulator

Questions

1. What percentage of the materials used were conductors? Show your working out.

2. What percentage of the materials used were insulators? Show your working out.

7 Student Reflection Checklist - Energy Conductors

Attachment

	Yes	Some	No
Planning Page			
Roles of team members outlined			
Research outlined and websites included			
Labelled design sketch included			
Explanation Page			
Explanation of how test of conductivity works with correct terminology of circuits, conductors and insulators included			
Description of challenges included			
Explanation of how group overcame challenges included			
Circuit Test Production			
Clear design instructions included			
Test includes a circuit			
Photos of production process included			
Completed table of results page included			
Scientific report well-written			

8 Investigating Series and Parallel Circuits

TASK A:
Creating a series circuit and a parallel circuit

A student driven, hands-on investigation to observe light bulbs connected in a series and parallel circuit. This lesson will **explain** and develop scientific explanations for observations.

Assessment

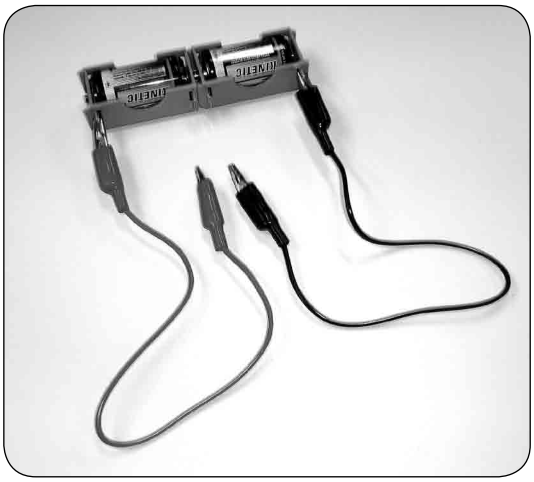
Formative assessment – monitoring students' learning and developing understanding via observation and providing feedback to extend learning.

Equipment

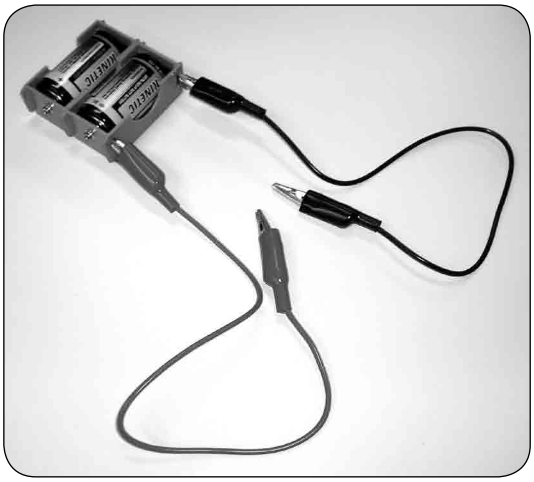
- Role badges used in Lesson 4
- Each team member's SciTech journal
- 2 x 1.5 volt batteries
- 1 light bulb
- 2 connecting wires

Activity steps

- Review previous session about exploring electrical circuits, refer to word wall and KWL chart.
- Ask the students what they know about series circuits and parallel circuits.
- Ask students what they think these terms could mean and what these circuits would look like.
- Students discuss and share what they would like to find out about series and parallel circuits and add to KWL chart.
- Divide the class into groups, assign roles (Chief Scientist, Safety Officer, Lab Technician, Science Journalist and Science Communicator) and hand out the role badges.
- Ask Lab Technicians to collect equipment.
- Students construct a closed circuit that includes 1 battery, 2 wires and a light bulb.
- Ask the students to place a dark coloured card behind the light bulb and observe its brightness.
- Students repeat step 1 using 2 batteries connected in series.



- Discuss with students what they observed and have students suggest explanations for their observations.
- Have students construct a closed circuit that includes 2 batteries set in parallel, 2 wires and a light bulb.
- Place a dark coloured card behind the light bulb and compare the brightness of the light bulb with the previous circuit.
- Ask students to place a third battery in parallel and compare the brightness of the light bulb.
- Discuss with the class:
  - Did the additional battery make the bulb glow brighter?
  - What do you think is happening to the flow of electrons in a series and parallel circuit?



TASK B:
Investigating the Voltage in a Series Circuit and a Parallel Circuit

A student driven, hands on investigation to determine the voltage in a series and parallel circuit. This lesson will explain and develop scientific explanations for observations.

Assessment

Formative assessment – monitoring students' learning and developing understanding via observation and providing feedback to extend learning.

Equipment

- Role badges used in Lesson 4
- Each team member's SciTech journal
- 2 x 1.5 volt battery
- Multimeter

Activity steps

- Review previous sessions (series and parallel circuits), refer to word wall and KWL chart.
- Ask the students what they know about the way electricity is measured.
- Introduce the term volts and discuss.
- Explain and demonstrate the use of the multimeter to the students.
- Have the students predict whether increasing the number of batteries will increase the voltage.
- Ask the students to conduct an investigation to test their prediction
- Divide the class into groups, assign roles (Chief Scientist, Safety Officer, Lab Technician, Science Journalist and Science Communicator) and hand out the role badges.
- Ask Lab Technicians to collect equipment.
- Students reconstruct their series and parallel circuits, replacing the light bulb with the multimeter to complete the circuit.
- Students construct a table to record their observations in their SciTech Journals (sample below).

Type of circuit	Number of batteries	Multimeter reading (DCV)/(DCA)
	One battery	
Series	Two batteries	
	Three batteries	

- Using a multimeter students measure record and compare the voltage and amps of each circuit.
- Students construct a graph using the collected data.
- Discuss with students what type of graph would best represent the data in a way that best addresses their prediction.
- What labels must they include on the X and Y axes?
- Once students have constructed their charts discuss the results and construct a statement summarising what they have learnt about batteries set in series and parallel circuits. Add the statements to the KWL chart and any new words should be added to the word wall.

Extension Activity

- Ask students to predict what may happen to the brightness of 2 bulbs if they were placed in series.
- Ask students to predict what may happen to the brightness of 2 bulbs if they were placed parallel.

Interactive Resources

click here to access the online resource

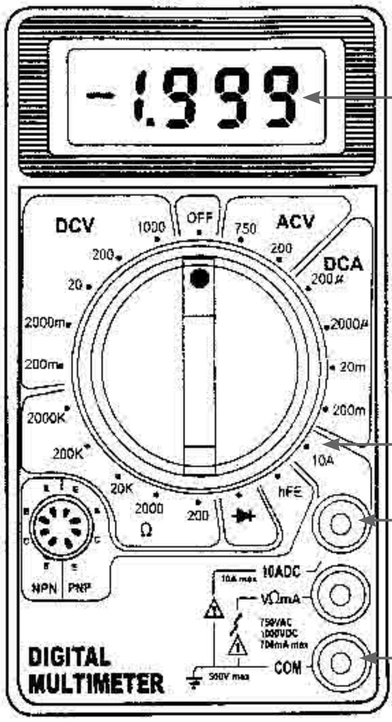
interactive whiteboard lesson 4

- Slide 5 – Virtual experiment to investigate parallel and series circuits
- Slide 6 – Discussion about parallel circuits

8 Using a Multimeter

Attachment

Measuring electric current



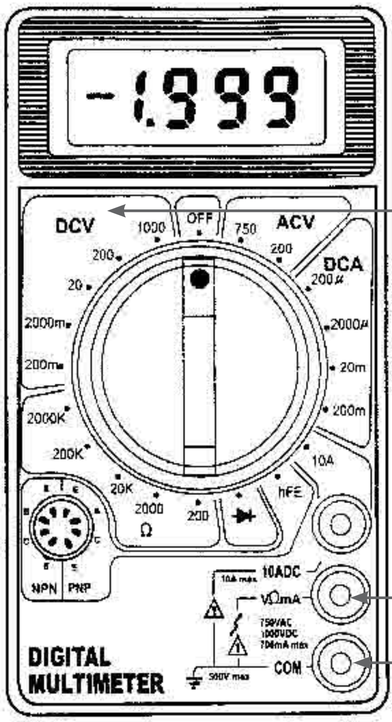
The display is measuring in amps.

Turn the dial to 10A. Use the probes from the jack leads to complete the circuit. To measure electric current, all the electricity must pass through the meter so it must be connected in series.

Insert the red jack lead here. Make sure it is tight into the fitting.

Insert the black jack lead here.

Measuring voltage



Turn the meter to the DCV quadrant depending on your voltage supply. Start at 20V then work down through the dial until you get a reading that makes sense on the display. Remember 2000 m is representing 2000 millivolts or 2V while 200 m is measuring 0.2V. Most batteries are 1.5V.

Connect the red jack here. Make sure it is tight into the fitting.

Connect the black jack here.

8 STEM Design Challenge - Series and Parallel Circuits

TASK:
Work in a group to design a safety vest for road workers to wear at night. Your vest must be reflective and include lights for maximum safety of the wearer. It must include both series and parallel circuits in its design.

Materials Provided

- Fabric, large sheets of strong paper, or strong garbage bags
- Masking tape
- Button batteries
- LED bulbs
- Copper tape
- Electrical tape
- Scissors
- Tape measure
- Marking pen

(You may add materials of your own to this list)

Success Criteria

- The vest must include a series circuit and a parallel circuit.
- It must be comfortable to wear.
- The circuits must include light bulbs as a safety feature.
- You must include all measurements of your vest in your planning.
- You must include photos of the stages of your design.
- Instructions for wearing the vest must be included.
- Complete and submit Planning Page.
- Complete and submit Explanation Page.
- Complete and submit Student Reflection Checklist.

8 Planning Page - Series and Parallel Circuits

Attachment

Design Brief

Work in a group to design a safety vest for road workers to wear at night. Your vest must be reflective and include lights for maximum safety of the wearer. It must include both series and parallel circuits in its design.

Team Members and Roles

Name	Role

Research Ideas (include websites your group used)

Labelled Design Sketches

8 Explanation Page - Series and Parallel Circuits

Attachment

Explain how your safety vest works using the correct terminology of series and parallel circuits.

Describe some of the challenges that your group faced when designing your safety vest.

How did your group overcome these challenges?

8 Student Reflection Checklist - Series and Parallel Circuits

Attachment

	Yes	Some	No
Planning Page			
Roles of team members outlined			
Research outlined and websites included			
Labelled design sketch with all measurements stated			
Explanation Page			
Explanation of how safety vest works with correct terminology of series and parallel circuits included			
Description of challenges included			
Explanation of how group overcame challenges included			
Safety Vest Production			
Clear instructions for wearing the vest included			
A series circuit is included			
A parallel circuit is included			
Photos of production process included			
Safety vest comfortable and well-made			
Light bulbs as a safety feature included			

9 Generating Electricity Investigation

TASK:
Constructing circuits to observe the generation of electricity

A lesson that will **elaborate** on Lesson 5 (Electricity Generation and Transmission) by extending understanding to a new context or making connections to additional concepts.

Assessment

Summative assessment of the science inquiry skills.

Equipment

Role badges handed out in Lesson 4 and SciTech journals

- 1.5 volt batteries
- Light bulb
- 2 connecting wires
- Electric motor
- Buzzer
- Hand-held electric generator

Activity steps

- Review previous lessons on energy transformation.
- Discuss with students how electricity is produced.
- Lead the discussion to include electric generators, solar cells and chemical reactions.
- Ask students if they are aware of any other ways electricity is produced.
- Students discuss and share what they would like to find out about electricity production and add to KWL chart.
- Divide the class into groups, assign roles (Chief Scientist, Safety Officer, Lab Technician, Science Journalist and Science Communicator and hand out the role badges.
- Ask Lab Technicians to collect equipment.
- Students view a working generator on the website: http://wvic.com/Content/How_Generators_Work.cfm
- Allow students to explore the hand-held electric generator.
- Allow students to construct a variety of circuits with a light, motor or buzzer. Have students use the hand-held electric generator to supply electricity power to their circuits.

- Ask students to research one method of generating electricity.
- Construct a class summary of the various methods used to make an electric generator turn.
- Revise and discuss with students energy transfers. Discuss the energy transfers involved in the generation of electricity.
  - What form of energy is used to turn the generator?
  - What form of energy is used to turn the generator in a power station?
  - Identify sources such as:

    coal burning .... chemical – heat – kinetic – electrical

    hydro.......................... potential energy – kinetic energy – electrical

    wind .... kinetic energy – electrical

    nuclear .... nuclear – kinetic energy – electrical

    solar .... light energy – electrical

    battery........................ chemical energy – electrical
- Have students draw diagrams in their SciTech journal to show each form of generating electricity. Identify where the processes are the same and different.

10 Transforming Electrical Energy Investigation

TASK:
Constructing circuits to observe the transformation of energy

A lesson to **explain** the transformation of electrical energy by developing scientific explanations for observations.

Teacher Background

Energy cannot be destroyed, but rather transformed, e.g. the sun's energy is used by plants to grow and produce fruit, humans then consume the fruit which can be used to maintain our body temperature and allows us to move, walk or run.

Assessment

Formative assessment – monitoring students' learning and developing understanding via observation and providing feedback to extend learning.

Equipment

- Role badges from Lesson 4
- Each team member's SciTech journal
- 1.5 volt batteries
- Light bulb
- 2 connecting wires
- Electric motor
- Buzzer

Activity steps

- Review previous sessions on circuits.
- Discuss with students the concept that energy cannot be destroyed.
- Ask students if they are aware of any other transformations of energy.
- Students discuss and share what they would like to find out about the transformation of energy and add to KWL chart.
- Divide the class into groups, assign roles (Chief Scientist, Safety Officer, Lab Technician, Science Journalist and Science Communicator) and hand out the role badges.
- Ask Lab Technicians to collect equipment.
- Students construct a closed circuit that includes 1 battery, 2 wires and a light bulb.

- Ask students how they think electrical energy transformed in the light bulb? (Electrical energy is transformed to light making the light bulb glow and heat.)
- Ask students to lightly touch the light bulb.
- What can they feel? – Heat.
- Students draw and label a diagram of their circuit indicating the transformation of electrical energy.
- Students replace the light bulb in their circuit with a buzzer.
- How is the electrical energy transformed? (Electrical energy is transformed to sound and heat.)
- Students draw and label a diagram of their circuit indicating the transformation of electrical energy.
- Students replace the buzzer in their circuit with an electric motor.
- Ask how the electrical energy transformed.
- (Electrical energy is transformed to movement, sound and heat).
- Students draw and label a diagram of their circuit indicating the transformation of electrical energy.

Interactive Resources

click here to access the online resource

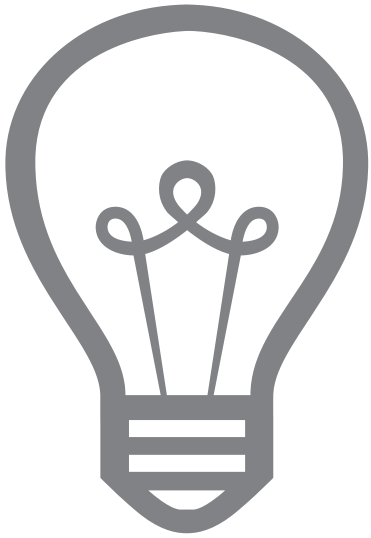
interactive whiteboard lesson 4

- Slide 7 – Virtual experiment to explore transformations of energy
- Slides 8 to 10 – Quiz to describe transformations of energy

10 Electricity Quiz

Attachment

Name:____



1. Who invented the electric light bulb?

a) Benjamin Franklin
b) Thomas Edison
c) Gough Whitlam

2. Which is a renewable energy source?

a) Coal
b) Solar
c) Nuclear power

3. Which is a good conductor of electricity?

a) Metal
b) Human body
c) Water
d) All of the above

4. Which is a good insulator of electricity?

a) Metal
b) Water
c) Plastic

5. Electricity is generated at a:

a) Substation
b) Transformer
c) Power line
d) Power station

6. How could your school reduce its electricity consumption?

____

____

____

7. How could you help to conserve electricity usage at home?

____

____

____

8. Why do houses have meter boxes?

9. Explain why energy cannot be destroyed.

10. What type of energy is stored energy?

11. List 4 different types of energy.

12. List 5 different energy resources.

13. Describe what an electrical circuit is.

14. Draw a closed electrical circuit in the box below.

11 Design Task

TASK:
Students demonstrate understanding gained through a scientific investigation by resolving a design brief.

A task for students to design and make a product that uses the ‘transformation of electrical energy’ as an essential feature of its design. The final phase provides an opportunity for students to **evaluate** and reflect on their own learning, new understandings and development of skills.

Assessment

Summative assessment of the science inquiry skills.

Explore and define

Define purpose of the product, develop criteria and find out what is currently available.

Design brief

- Students design and make a product that transforms electrical energy and solves a personal need.
- Students should consider:
  - What products exist that address similar problems or needs? How do they work?
  - What resources are available to construct our product?
  - How will they test and evaluate their design solution?
  - How they will manage the time available to develop the product?
  - Is there a ‘technical expert’ who can provide assistance?
  - Are there electrical safety issues?

Generate and develop ideas

- Students sketch initial ideas for their product and annotate their sketch to explain how the product works.
- Remind students to consider the circuit required to operate the product.
- Students identify the need addressed by the product or the sy, and the energy transformations involved in its operation.
- Suggestions of problems which could be solved with the design of a product:
  - 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.
  - How can I make a game that keeps my younger brother/sister amused?

Produce Solutions

- Ensure that students understand that their product must be housed in a suitable casing. Discuss what functions the casing must perform, e.g. hold the circuit in place, hold the working parts, protect the product from dirt and damage, be easy to handle, be aesthetically pleasing and 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

Product	Need / Purpose	Energy transformations
Home security alarm	Warn off intruders Dissuade intruders Protect people and property	Sensor (light/sound energy) > electrical energy > sound energy
Vacuum cleaner	Remove dust and dirt Remove dust mites that cause allergies	Electrical energy > mechanical energy
Stove	Heat or cook food	Electrical energy > heat energy
Solar garden lights	Provide lighting for paths Provide security Increase enjoyment of garden	Light energy > electrical energy > chemical energy (battery) > electrical energy > light energy

Evaluate

- Ask students to evaluate the design against the design brief and consider the effectiveness of the process.
- Provide students with questions to be used when reflecting on their task.
  - What part of the task was most enjoyable?
  - What part of the task was least enjoyable?
  - What did you learn?
  - What part of the learning was most important? Why is it important?
  - If you were to undertake the task again, what would you do differently and why?

OR

Students could:

- Review the sources of energy used to generate electrical energy.
  - Identify whether they are renewable or non- renewable.
  - Identify some of disadvantages of using the various energy forms.
  - Discuss ways we could reduce energy consumption around our school and home.
  - Discuss how electricity is measured in your home – meter.
- Have students complete the Energy Usage Calculator at essentialenergy.com.au/calculator
  - Have students modify their virtual home to reduce the amount of electrical energy used.
  - Discuss what appliance/s consume the most electrical energy in their home.
  - Identify some strategies they could use to reduce the consumption of electricity at school.
- Discuss or debate the issue – Why should we reduce the amount of electricity we use?

Interactive Resources

click here to access the online resource

interactive whiteboard lesson 4

- Slide 13 – Generate and develop ideas
- Slide 14 – Explore and define
- Slides 15 to 17 – Examples of products that have an electrical circuit
- Slides 18 to 19 – Produce solutions and evaluate
- Slides 20 to 23 – Metering, meter safety and energy efficiency

Glossary

AC or alternating current:	Electric current which repeatedly changes its direction from negative to positive and back again. Alternating current is usually created by a mechanical means, such as a generator.
Amp:	The Ampere or amp is a measure applied to the flow of electrons or flow of electric current.
Atom:	Primary basis of all matter. It has a nucleus consisting of protons and neutrons surrounded by orbiting electrons.
Battery:	A single electric cell for furnishing electric current or a group of such cells.
Circuit:	The complete path or part of the path of an electric current.
Charge:	The electrical property of electrons and protons that produces attraction and repulsion between them.
Conductor:	In a conductor electric current can flow freely. Simply stated, most metals are good electrical conductors. Some non-metals (e.g. trees, wood) can also conduct electricity.
Current:	The flow of electrons. Water flowing in a pipe is similar to an electric current. You need voltage to make the current flow, just like water pressure is needed to make the water flow. It's impossible to see an electric current, but it's there – and is used to run everything from a light to your CD player.
DC or direct current:	Electric current is where the flow of electrons is always in the same direction. Direct current is most commonly found in portable appliances such as cameras, iPods and mobiles phones.
Distribution lines:	The familiar 'poles and wires' that students can see down the street are part of the lower voltage distribution network that supplies electricity to customers.
Distribution sy:	The poles, wires, cables, substations and other equipment required to transport electrical energy from the transmission sy to people's homes.
Distribution network:	The overall network formed by the distribution sy.
Electron:	The basic particle that orbits the nucleus of an atom. It can be stimulated to movement by various forces like magnetism and has a negative charge.
Energy:	The capacity to do work, or vigorous activity fuelled by various sources.

Fuse:	A safety device with a metal wire or strip that will melt, breaking the electrical circuit when the current becomes too large.
Generator:	A machine for producing electrical current. (See Turbine)
Hydroelectricity:	In electrical generation, it is the use of the power from rushing water to push turbine blades, which turn shafts in generators that produce electricity.
Insulator:	A material (such as plastic or glass) that does not permit electricity to pass through it readily.
Kilowatt:	Equal to 1000 watts of electricity. It is a measure of electrical power.
Kilowatt hour:	Measurement of electrical energy equal to one kilowatt of power produced or used in one hour.
Kinetic energy:	The energy of an object in motion.
Lightning:	The flash of light which accompanies a static electricity discharge between two clouds or between a cloud and the Earth during a thunderstorm.
Magnet:	A piece of material that has the natural ability to attract iron.
Magnetic field:	The area around a magnet that is influenced by the magnet.
Mechanical energy:	The energy of motion used to perform work.
Megawatt:	1,000,000 watts of power or 1,000 kilowatts.
Meter (Power/Electricity):	A device which measures and records the production or consumption of electrical energy.
Nuclear power:	The energy produced by splitting atoms (such as uranium) in a nuclear reactor. Not currently used in Australia.
Ohm:	A unit of electrical resistance equal to that of a conductor in which a current of one amp is produced by a potential of one volt across its terminals.
Photovoltaic cell:	A device where light energy is converted to electrical energy. Also known as a solar cell.
Power point:	A hollow device which is used to connect a power source or an electrical device.
Solar energy:	The use of energy that reaches the Earth from the Sun.
Static electricity:	A type of electrical charge that can build up when two objects rub together. Friction removes some electrons from one object and deposits them on the other.

Transmission lines:	High voltage lines that carry electricity in bulk from the power stations to the point where distributors like Ausgrid, Endeavour Energy and Essential Energy take supply.
Turbine:	A fan like device that is connected to the generator to assist in the production of electricity.
Volt:	The volt is the unit of measure for electro-motive force required to pass one amp through resistance of one ohm.
Watt:	A unit for measuring electric power, e.g. 1 horse power = 746 watts. One Kilowatt = 1,000 watts. One Megawatt = 1,000,000 watts.
Wind turbine:	A machine that captures the energy of the wind and transfers the motion to a generator shaft.
Zone substation:	Zone substations take the high-voltage electricity and convert it, via step down transformers, into lower voltage electricity for further distribution via poles, wires and underground networks.

Appendix 1 Teacher Background Information

Physical phenomena

Teacher notes

Excerpts from the Physical Phenomena Resource Unit on Supporting SciTech in the primary classroom CD ROM

Basic conceptual ideas and understandings

Forms of energy

Energy is noticed in different ways when change occurs (these ways, or effects, have been called forms of energy).

Forms of energy include heat/thermal, chemical, light, gravitational, sound, elastic, movement/motion/kinetic, nuclear, gas and electrical.

Forms of energy that involve motion e.g. movement, heat and sound are examples of kinetic energy.

Some forms of energy are called potential (or stored) energy, e.g. chemical, elasticity, and gravitational. There is the potential for an energy transfer to occur. There really is no evidence of energy (transfer) present until a change occurs, e.g. a change in the height of an object or a change of state or a change in appearance as in a chemical reaction.

Electricity

A battery is a source of potential electrical energy in a circuit and a battery creates a flow of current.

Batteries vary in their ability to provide energy. A stronger battery provides more energy to the circuit.

Electric current is associated with energy transfer in a circuit.

A circuit must be closed (complete) for an electric current to flow.

There is the same amount of current in all parts of the circuit.

A switch in a circuit affects the flow of electricity in all parts of the circuit instantly. When open there is no current anywhere in the circuit; when closed there is current flowing everywhere at once.

The higher the voltage of a battery the greater the energy transferred to its circuit by the current.

The energy supplied by the battery is transferred to the bulb, increasing its energy.

Appendix 2 Progression of Students' Learning

Progression of students' learning

What do students, and in particular primary students (K-6), think about some of the ideas related to this strand and are there some with which primary students have difficulty?

It is not possible to say precisely what students of any age think about particular phenomena. However, there has been considerable research in the past 20 years that suggests how most learners think about phenomena and their associated explanations that help us to understand our world. What follows is an overview of what teachers might expect their classes to be thinking about the topics in this content strand, e.g. forms of energy and their uses in our lives. Some of your students will hold more acceptable scientific ideas than others.

Nursery learners (up to four years old) do not seem to recognise forms of energy, the transference of energy or that energy can be stored. They do, however, seem to appreciate that an action is required to initiate movement, and suggest that they see movement (action) as the same as energy. They also see movement as associated with something being alive. Early Stage 1 learners could be similar.

Alternative (non-scientific) views about energy held by some primary-age learners would include the following:

Energy (in general)

Students from the very youngest to those in upper secondary school (and probably beyond) tend most regularly to associate energy with living things. This tendency is reduced as students become older but will still be held by some secondary students.

Various alternative or limited views of energy are held by students. These include that energy is: stored in certain objects in order to cause things to happen, e.g. water to turn a water wheel; always linked with force and movement; a fuel; a fluid (that flows from one object to another); and an ingredient or a product (e.g. chemicals give off heat).

Specific forms of energy

Some alternative (or limited) conceptions held by students about some of the specific forms of energy are:

Electricity

Most early learners do believe that in a circuit batteries give something to the bulb. They may, however, have a unipolar idea of a battery (i.e. that only one end needs to be attached to the light bulb in a circuit). Also most upper-infants students are probably unable to suggest how a switch works in a circuit.

Circuit

Most students think of a circuit as a series of sequenced events (e.g. current flowing from the battery to the wire, to the light) rather than thinking of a circuit as a complete sy.

Battery

Most students have little or no idea of voltage in a battery. Many see batteries as storing a certain amount of electricity.

Current and voltage

Current and energy are often confused. Voltage is sometimes thought of as the strength or force of the current; some students see voltage as the current.

Circuit components

Many upper-primary students do not seem aware that various circuit components, e.g. buzzer and a motor, can be connected in the same way.

Appendix 3 Designing and Making

Designing and making

Technology education: more than computers

Students today live in a world of unprecedented technological change. Being technologically capable is no longer about knowing a prescribed set of technical skills or processes but about being adaptable, creative, innovative and risk-taking, and being able to apply learning from one situation to a new or different context or setting.

What is technology?

Technology is about know-how and know-why. Know-how is created and applied through processes of designing and producing or making. Know-why is created through processes of investigating.

Technology is more than the objects created by technological processes such as computers, tools and other equipment. An important part of technology involves human values, skills, knowledge, techniques and processes.

Technology is concerned with the purposeful and creative use of resources in an effort to meet perceived needs or goals… (Science and Technology K-6 syllabus page 1).

Technology education aims to develop know-how and know-why through students learning to apply a design process to design and make solutions to identified needs and opportunities. In NSW primary schools the Science and Technology K-6 syllabus provides the focus for technology education.

What is design?

Design can be used as both a noun and a verb. Design (verb) can be defined as the syatic process of creating and implementing ideas to solve identified needs or opportunities. Design involves analysing needs, exploring and generating ideas, evaluating alternatives, and managing ideas to a workable solution. Design (noun) can be defined as the outcome of a syatic process of designing.

Design is future oriented and involves students being proactive about how things can be done differently. Design is not about predetermined solutions and there is rarely, if ever, a single correct solution. Design is about making compromises and considered choices between competing needs, values, ideas and options. Most importantly design is about asking questions and testing ideas.

Design is an effective process for developing students' capacity to be creative, innovative, critical thinkers and effective communicators.

What is making?

Making (verb) can be defined as the syatic process of planning and implementing a predetermined solution.

Making involves exploring and evaluating available resources, including materials and equipment, practising techniques, and managing resources to a completed quality product or sy.

Making is an effective process for developing students' capacity to learn and refine specific techniques and manage actions to successful completion.

Typically in technology education the process of designing and making results in a product, service, sy or environment; or a part of a product, service, sy or environment.

How can we assist students to design effectively?

A design process attempts to describe the way designers typically work to create and produce effective solutions. There are a vast array of diagrams such as cycles and models that attempt to represent the design process. In the Science and Technology K-6 syllabus the process is illustrated as a flowchart.

Regardless of the way the design process is represented, the process is not lock-step and will vary when applied in each design situation.

The syllabus describes four broad areas of design process activity. These areas of activity occur in a design process regardless of whether the designer is in kindergarten or Year 12 or is a professional architect, engineer or industrial designer.

When teaching students to design, the teacher takes the role of facilitator, typically guiding and structuring student work through posing questions for students to explore, generate and test ideas, regenerate and retest ideas, until a solution is reached. Knowing the types of question a designer might ask is important.

Over a stage students should experience a number of design tasks. From task to task it is important that the learning focus of the design task varies.

Planning a design task

Here are some tips for planning a design task.

1. Identify the syllabus outcomes on which you want to focus student learning. For example, the syllabus outcomes may be designing and making and the built environment.

2. Identify the stage at which students are working and what these learning outcomes would look like. Look at the Big ideas provided on the website Supporting SciTech in the primary classroom for a better understanding of the outcomes.

3. Choose a design task that best enables you to focus on the selected outcomes and big ideas.

4. Choose authentic design tasks that students will find relevant, engaging and significant in their lives. For example, a teacher had to address designing and making and the built environment in the programmed Science, and Technology unit of work. At the time the SRC and P&C had been requesting sheltered play areas, so the class decided together to design and model a weather protection structure for a part of the playground.

5. The more you can choose a design task with which students already have a lot of experience, the more effectively students will be able to explore the task, identify the needs of the users and establish sound criteria for judging the effectiveness of the final solution.

6. Remember it is not that the design task should be suited to Early Stage 1 or Stage 3 students. In the example of the shade structure above, students from K-12, university students studying architecture and professional architects and engineers would be challenged by this task. The expectations about the sophistication of the response and the complexity of the considerations and the assessment criteria would, however, vary.

7. Not all aspects of the design process need to be open ended for students. There are many questions that can be considered in a design process. What parts of the design process do you want to leave open for the student to work through in detail and what parts will be closed or teacher directed so that students can move through them more directly? The answer to this question relates to tips 2 and 3 above. Be clear about what you want student learning to focus upon and allocate teaching time accordingly.
8. Allow sufficient teaching time in your programme to enable the students to have clearly established criteria for success for the design solution. How will I know that my solution is successful or not? Try doing this as a class or group brainstorming activity, then work together to negotiate priorities. Try to limit the number of success criteria to one or two in Early Stage 1 and perhaps have three or four criteria by Stage 3. For example, the success criteria for Early Stage 1 might focus on the ability to provide shade to students at lunch time, whereas by Stage 3 students might also be considering budget, local council building requirements and the use of environmentally sustainable materials.
9. Once your students have clearly established success criteria, all their decision-making should refer back to the negotiated success criteria. For example, an Early Stage 1 student asks: Should we use this material or that one for the shade cover? The teacher could reply: Which one will give better shade protection and how do you know that?
10. When students are learning a new skill they require explicit teaching, so initially the skill will need to be modelled, then practised and guided before students will be capable of working independently.
11. Safety is always an important consideration for the teacher. Use risk management processes to identify and control risks.
12. Designing is time consuming. Allow sufficient time for students to test, refine and retest their ideas repeatedly if you want them to achieve a quality solution. A task that occurs as a one-off activity, such as design a flag in a lesson, will require little design skill and is probably more a colouring-in activity than a design task. Students need to revisit their ideas over time to design effectively. Rather than doing many design tasks, do fewer in greater depth over the stage.

Appendix 4 Questions to Guide Designing & Making Tasks

Questioning techniques are important for assisting students to become creative, critical, innovative and enterprising as they engage with the design and make process.

Asking questions is a skill that teachers will continue to refine throughout their teaching, adapting according to the learning area or the task. Questions should not be limited to closed questions that require only a simple answer, but be more open ended to allow a wide range of ideas to be generated and explored.

There are many models that can be used. One example is Fran Peavey's strategic questioning. She refers to 'short lever' questions that restrict options and assume solutions and hard truths and 'long lever' questions that create options, question assumptions and allow for the free flowing of ideas.

The design and make model below has questions added to help guide students through the process. Some will be questions for the teacher and others for the students.

Exploring the task

(find out what are the requirements of the users, develop criteria and find out what is currently available)

The need or opportunity

- Is there a product, a sy or an environment that is not doing its job effectively?
- Can we think of ways to do it better? (Cheaper, stronger, more attractive etc.)
- Is there something we can use in a new way or for a different purpose?
- Is there a need that has no practical solution?

The user

- Who will use the design?
- How will they use the design?
- What qualities (aesthetic) will the design need for the user to appreciate it?

The client

- Who has requested the design? Why?
- What will the design have to do to meet the client's requirements? (Functional and aesthetic.)

Resources

- What is the budget?
- How much time is available?
- What other resources are available? (Skilled people, information, materials, processes, equipment etc.)

Social and environmental considerations

- Who else might the design affect? How?
- Is there an environmental impact?
- Are there laws, rules or regulations that you need to consider?

Criteria for success

- What will the design have to do to be successful?
- What are the essential success criteria and which are desirable?
- What is the priority order for the success criteria?

Defining the task

- How can we bring all these considerations together into a clear and concise statement of the design task or design brief?

Generating ideas and realising solutions

(explore and refine options, decide upon a design option, choose resources and equipment to plan and produce the design)

Generating ideas

- What design solutions exist that address similar needs, problems or opportunities?
- What are the advantages and disadvantages of these solutions?
- What creative thinking techniques can we use to generate new ideas?
- What ideas can we come up with?

Representing ideas

- What techniques can we use to represent ideas (sketching, story-boarding, drawing, modelling, flowcharts, diagrams etc.)?
- Who is the audience (me or others) and what is the purpose of the representations (rough ideas, resolving ideas, presenting ideas etc.)?
- Which techniques can we use to represent ideas as they become more resolved?
- How can we improve skills in representing ideas?

Investigating resources

- What materials, processes, equipment, etc. could be used for the design?
- What resources are available?
- What are the performance properties of the design?
- What risks (safety, cost, environmental) are associated with using the materials, processes, equipment, etc.?
- How can we test the suitability of the materials, processes, equipment?
- How can we improve our skills in using the materials, processes, equipment, etc. proficiently and safely?
- If we are unable to use the materials, processes, equipment, etc., can someone else help?
- Which materials, processes, equipment, etc. will we choose and how do they relate to the success criteria?

Resolving ideas

- What are the advantages and disadvantages of each idea in relation to the success criteria?
- Have we considered the long-term (social and environmental) as well as the short-term (money, time, appearance) consequences of the design?
- What do the client and user think?
- What design idea/s will we choose and why?
- Will the chosen design meet the success criteria? (Essential? Desirable?)
- Do we need any further modifications to the design?

Finalising the proposal

- Do we know exactly what is involved in producing the design?
- Do we need to further detail the design? (Technical construction drawings, pattern pieces, layout, storyboarding, flowcharts, models.)
- What equipment and material are required?
- How much will it cost?
- What is the step-by-step sequence that will need to occur to produce the design?
- Do we have the skills needed to do each step or will we need more time to practice?
- How long is each step likely to take?
- Who is responsible for each step?
- Do our proposed time plan and budget meet the success criteria?
- Will modifications be required?

Managing safety risks

- What safety risks can we identify? (User capability and behaviour, materials, equipment, facility, teacher expertise.)
- Where can we find sound advice?
- How can we eliminate or control the risks?
- If the risks cannot be controlled, how will we modify the design?

Managing production

- Have the necessary information, materials and equipment been acquired?
- Is the equipment set up safely and working effectively?
- How will we (and who will) manage storage and equipment maintenance issues?
- Do we need particular skills to be modelled (demonstrated) or reviewed with us or are we able to proceed independently?

- Do we need an expert to supervise our work?
- Is the production proceeding according to time plan and budget?
- Is the quality of production work appropriate to the success criteria?
- What modifications do we need to make to the planned design and production?

Evaluating products and processes

(evaluates success of the design against the criteria and considers effectiveness of the process)

Evaluating throughout the design process

- Is there a product, a sy or an environment that is not doing its job effectively?
- Is there a need that has no practical solution?
- What will the design have to do to meet the user's requirements?
- What will the design have to do to meet the client's requirements?
- Who else might the design affect? How?
- Is there an environmental impact?
- What will the design have to do to be successful?
- What design solutions exist that address similar needs, problems or opportunities?
- How can we improve skills?
- What risks (safety, cost, environmental) are associated with using the materials, processes, equipment, etc.?
- What are the advantages and disadvantages of each idea in relation to the success criteria?
- Have we considered the long-term (social and environmental) as well as the short-term (money, time, appearance) consequences of the design?
- Will the chosen design meet the success criteria?
- What modifications do we need to make?
- Do our proposed time plan and budget meet the success criteria?
- What safety risks can we identify?
- Is the quality of production work appropriate to the success criteria?

(Note – these questions are a sample selected from the preceding Exploring, Generating and Using sections.)

Reflecting on learning after the design process

Design solution

- What did we produce as a result of the design process?
- Does it work for the client and user? Do they like it?
- In what ways did our design solution achieve each success criteria?
- What aspects of the design solution did not achieve the success criterion?
- How would we do it differently next time?

Design process

- What was the design process we used?
- How could the design process be improved?
- Was our documentation processes helpful? Why or why not?
- Did we meet the requirements of the design task ? Why or why not?
- What skills did I gain or further develop?
- Did the group work well as a team?

Learning outcomes

- Which syllabus outcomes were we focusing on?
- How well have I progressed towards achieving each outcome?
- What experiences do I need to improve in my progress?