# Power to the people	**Stage 5** **Gifted and talented**	**Duration:** 10 weeks

Unit context

Modern society's dependence on technology and its present and future needs for efficient, safe and portable energy sources provide the context for this unit. The focus of learning in this unit is a student research project in which students apply their understanding about chemical and physical principles and processes to solve a problem related to an aspect of portable energy sources. This unit seeks to extend students' understanding of the contribution of scientific research to finding innovative solutions to problems of efficient, sustainable energy production facing our society and their role in making responsible decisions to use energy wisely in their everyday lives.

Target outcomes

A student:

SC5-3VA	demonstrates confidence in making reasoned, evidence-based decisions about the current and future use and influence of science and technology, including ethical considerations
SC5-4WS	develops questions or hypotheses to be investigated scientifically
SC5-5WS	produces a plan to investigate identified questions, hypotheses or problems, individually and collaboratively
SC5-6WS	undertakes first-hand investigations to collect valid and reliable data and information, individually and collaboratively
SC5-7WS	processes, analyses and evaluates data from first-hand investigations and secondary sources to develop evidence-based arguments and conclusions
SC5-8WS	applies scientific understanding and critical thinking skills to suggest possible solutions to identified problems
SC5-9WS	presents science ideas and evidence for a particular purpose and to a specific audience, using appropriate scientific language, conventions and representations
SC5-11PW	explains how scientific understanding about energy conservation, transfers and transformations is applied in systems
SC5-16CW	explains how models, theories and laws about matter have been refined as new scientific evidence becomes available
SC5-17CW	discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

Unit overview: Power to the people

Unit description

In this unit students analyse the chemical processes involved and evaluate the efficiency and safety issues in using one modern source of portable power, eg in motor vehicles, the space shuttle, international space station, nuclear submarines or portable electronic devices. The suggested teaching/learning activities provide the core learning through which students develop an understanding of the unit and their student research project (SRP).

The teaching and learning activities in the unit have been developed to run concurrently with the Stage 5 individual SRP. Class time is allocated within the unit for students to work on their SRP.

In their individual SRP students engage in using and applying their skills in Working Scientifically and their knowledge and understanding of solving a problem related to an aspect of portable energy sources. They present an overview of their SRP to an audience at a Science fair that they have planned.

The adjustments in the unit include a range of suggested strategies (Attachment A: Teacher background – Strategies for gifted and talented students) to extend and cater for the needs of gifted and talented students. The strategies suggested in the adjustments relate to the content addressed in the unit and provide flexibility for students to engage in teamwork, self-paced learning and a challenging and relevant personal interest project of their choice. In collaboration with the teacher, a selection of the suggested core and/or the adjusted activities may be identified for a differentiated learning program appropriate to the interests, needs and ability of the gifted or talented student.

Unit activities	Student research project process
Introducing the student research project Secondary-source investigations into batteries as examples of technology being developed for portable energy sources	*Defining* the project, clarify the nature of the problem to be solved. Begin background research.
Investigating chemical reactions involving energy First-hand investigations of chemical reactions involving energy changes related to batteries	*Planning* the project, choose the most appropriate strategies to solve the problem. Select resources.
Researching the development of the atomic theory and the industrial and medical uses of radioisotopes	*Conducting* the investigation, modify the plan and process if necessary. Complete progress reports.
Investigating conservation, transfer and transformation of energy Practical and secondary source investigations into: • energy conservation, transfers and transformations • the efficiency of devices using electricity • a comparison of different methods of electricity	*Reviewing* the project, complete an appropriate report. Plan the presentation of the SRP.
Presenting solutions to an identified problem Students present an overview of their SRP at a Science fair and an SRP report for teacher evaluation	*Evaluate* the presented SRP plan, strategies, processes and products/models used to develop a solution to the problem.

Content – Working Scientifically Skills	Content – Knowledge and Understanding	Suggested teaching, learning and assessment experiences (include evidence of learning)	Adjustments for gifted and talented students
WS4 Students question and predict by: a. formulating questions or hypotheses that can be investigated scientifically (ACSIS164, ACSIS198) b. predicting outcomes based on observations and scientific knowledge WS5.1 Students identify data to be collected for an investigation by: a. describing the purpose of an investigation b. explaining why certain types of information need to be collected in a range of investigation types c. selecting possible sources of data, including secondary sources, relevant to the investigation WS5.2 Students plan first-hand investigations by: a. planning and selecting appropriate investigation methods, including fieldwork and laboratory experimentation, to collect reliable data (ACSIS165, ACSIS199) b. describing a logical procedure for undertaking a range of investigation types WS5.3 Students choose	CW4 Different types of chemical reactions are used to produce a range of products and can occur at different rates and involve energy transfer. (ACSSU187) Students: e. describe examples to show where advances in science and/or emerging science and technologies significantly affect people's lives, including generating new career opportunities in areas of chemical science such as biochemistry and industrial chemistry (ACSHE161, ACSHE195)	**Introducing the student research project** **Teacher background** *In this learning sequence students are introduced to the individual student research project (SRP) in which they identify, plan and conduct investigations to solve a problem about an aspect of portable energy sources. To assist students in undertaking their SRP, they review their understanding of using and applying the processes of Working Scientifically to explain phenomena and solve problems. Throughout the unit students are allocated class time to conduct some of their investigations and work on the SRP. The teacher provides a timeline identifying dates when each student will present evidence in their SRP logbook of the progress and development of their project. At the end of the unit each student will present a brief overview of their project to the school community at a Science fair. Students will also maintain a portfolio throughout the unit in which they record findings, data/information, scientific concepts and ideas from their learning experiences in the class activities.* **Class activity** Students review their understanding about the processes of planning and conducting investigations including identifying, collecting and processing data/information. The teacher introduces the timeline and individual SRP in which students are to solve an identified problem related to an aspect of portable energy sources. **Group activity** As a stimulus for group discussion and developing ideas for the SRP, students work in groups of two to three to read the following statement: The ultimate miracle battery is nowhere in sight and the battery remains the 'weak link' for the foreseeable future. As long as the battery is based on an electro-chemical process, limitations of power density and short life expectancy must be taken into account. We must adapt to this constraint and design the equipment around it. – *BatteryUniversity.com, 2005* Students use a range of teacher-provided resources to answer the following questions: • What do the words in the statement, such as power density and short life expectancy, mean? • What are some of the chemical, physical and economic reasons behind our dependence on electrochemical cells? • What are the current areas of chemistry where scientists and engineers are being employed in the industry to develop battery technology?	Where appropriate, this unit could be developed as a self-paced learning module, completed individually or in small groups. If the learning program were to include an individual personal interest project, the problem/question to be investigated would be negotiated with the student to allow for student choice. Guide the student to think creatively about a range of problems that are of interest before making their selection. Encourage the student to apply critical thinking in selecting a problem that will provide them with an appropriate level of challenge. Allow students a choice in determining the format for their project presentation, which may include multimedia, handouts, demonstrations and/or class discussions. **Batteries** Students: • develop a set of criteria to evaluate the quality of a battery based on their own experiences with mobile phones and tablets • create a chart to compare a dry battery with a wet battery • conduct a debate to consider the use of primary and secondary batteries • produce a creative writing exercise on being a different type of battery in a heart pacemaker, a camera, a toy train or a portable telephone.

Content – Working Scientifically Skills	Content – Knowledge and Understanding	Suggested teaching, learning and assessment experiences (include evidence of learning)	Adjustments for gifted and talented students
equipment or resources for an investigation by: a. identifying appropriate equipment and materials c. selecting equipment to collect and record reliable data or information, using digital technologies as appropriate, eg data loggers WS6 Students conduct investigations by: c. selecting and using appropriate equipment, including digital technologies, to systematically and accurately collect and record data (ACSIS166, ACSIS200) d. using appropriate units for measuring physical quantities WS8 Students solve problems by: a. describing strategies to develop a range of possible solutions to an identified problem WS9 Students communicate by: c. using appropriate units for physical quantities and symbols to express relationships, including mathematical ones		• How has the development of the battery, as an example of a chemical reaction involving energy transfer, affected the students' lives? In a class discussion students compare their answers and record additional information in their individual portfolios, as appropriate. **Class activity** In this activity, students: • discuss and record how they could apply the processes of Working Scientifically to develop creative solutions to problems • brainstorm and record a range of ideas and interesting problems related to portable power sources that could be investigated in their individual SRPs. Examples that could be discussed might include: – a portable device that uses an energy source that does not rely on electricity from the grid – the chemistry involved in the transfer of energy, and evaluating safety issues and longevity for a portable power source – researching an energy source under development. Students should be encouraged to address problems relevant to their lives and interests, to use creative thinking to develop ideas and possibilities that are new, and to consider designing and making a prototype to demonstrate a novel or innovative concept. **Group activity** The teacher introduces the activity with the idea that batteries pre-date electricity generators in providing mains power to the electricity grid, and have been refined and miniaturised into sources of portable power. Students research and present their findings on the development of one modern source of portable power, eg batteries as a source of electricity such as lithium-ions, fuel cells and/or atomic fusion batteries. In groups of two to three, the students: • identify a question related to the development of the battery as a source of electricity that the group will investigate, such as: – Why is scientific research about the development of batteries important to our use of energy? – Why are there different types of batteries? – What are the properties of an effective portable battery? – What are some of the future designs for batteries?	Students may be given the choice of self-selecting their groups, or the teacher may determine the groupings according to ability/aptitude and give each group a question that will provide an appropriate challenge. Alternatively, more able students could be positioned as experts within each of the groups across the class.

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		– What facts must be considered when disposing of or recycling used batteries? – Are there risks and/or ethical issues that need to be considered? • plan their investigation and decide on the method of recording and presenting their data/information to the class in a mini Science fair • use teacher-provided and other relevant resources to conduct their research, including relating the characteristics of a battery to its use and considering safety and environmental concerns. In the mini Science fair, each group presents to the class the information gathered. The class provides feedback and collates the findings of each group in their portfolios. **SRP individual activity** Based on the information gathered and presented by the class, each student develops a KWL chart. This will form part of their SRP logbook to map prior knowledge, clarify the purpose of their project and identify possible areas of research and resources. The completed KWL chart could also be used by the students to self-assess their learning and to evaluate their planning and progress towards completing their project. Students begin to develop the plan for their SRP, clearly identifying the problem to be investigated, what data/information will need to be gathered, a range of strategies that could be used to solve the problem and the relevant risk assessments and safe practices.	
WS6 Students conduct investigations by: a. individually and collaboratively using appropriate investigation methods, including fieldwork and laboratory experimentation, to collect reliable data (ACSIS165, ACSIS199) b. safely constructing, assembling and manipulating identified equipment e. reporting data and information, evidence and findings, with accuracy and honesty WS7.1 Students process data	CW4 Different types of chemical reactions are used to produce a range of products and can occur at different rates and involve energy transfer. (ACSSU187) Students: a. identify that chemical reactions involve energy transfer and can be exothermic or endothermic b. compare combustion and respiration as types of chemical reactions that release energy but occur at different rates c. describe the effect of factors, eg temperature and catalysts, on the rate of some common chemical reactions	**Investigating chemical reactions involving energy** **Teacher background** *To assist students develop their understanding of batteries, they perform experiments to observe simple chemical reactions that demonstrate transformation of energy and the conditions that affect the rate of chemical reactions. They relate their findings to the operation of batteries of different types and the need for a sustained delivery of electricity.* *Each student presents a draft plan for their SRP for teacher comment.* **Group activity** Students conduct first-hand practical experiences to investigate energy changes in some chemical reactions and record their findings. Examples could include: • making a model wet cell, using zinc and copper electrodes and fruit or appropriate solutions, to demonstrate the production of an electric current • dissecting a typical dry cell to demonstrate one way an electrochemical	**Energy changes in chemical reactions** Students research individually or in pairs: • the relationship between heat energy and temperature • a range of chemical reactions in which energy is released in forms other than heat energy, eg chemical luminescence • the energy changes and chemical reactions in heat/cold packs and/or glowsticks • the factors that increase the rate of reaction • the structure of small portable

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and information by: a. selecting and using a variety of methods to organise data and information including diagrams, tables, models, spreadsheets and databases c. accessing data and information by using a range of appropriate digital technologies e. identifying data which supports or discounts a question or hypothesis being investigated or a proposed solution to a problem WS7.2 Students analyse data and information by: d. using knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS170, ACSIS204) WS8 Students solve problems by: b. assessing strategies that have been identified as possible solutions to an identified problem d. using cause-and-effect relationships to explain ideas		cell is made portable • performing a variety of teacher-supplied investigations set up at workstations around the room to show both exothermic and endothermic reactions, and observing the temperature changes involved, eg the action of acids on metals and bases; dissolving potassium nitrate in water; combustion reactions • using secondary sources to identify energy changes in photosynthesis. **Class activity** Each group shares their findings and discusses the limitations of using reactions such as those observed to produce controlled amounts of energy as required in batteries. **Individual activity** Students record their findings and review their understanding of the operation of batteries and the need for a sustained delivery of electricity. They relate relevant scientific concepts and ideas to the problem they are investigating in their SRP. **Group activity** Students conduct a variety of first-hand investigations to show the effect of various factors on the rates of reactions, selecting and using appropriate methods to organise data/information. Examples could include: • effect of temperature and/or concentration on the reaction of hydrochloric acid with sodium thiosulfate • effect of a catalyst (copper) on the reaction of zinc and hydrochloric acid, comparing it to the reaction without the catalyst • effect of surface area by comparing the reaction of dilute acid with marble chips and powdered calcium carbonate • combustion of glucose in a gas jar of air using a deflagrating spoon and comparing it with its combustion in a gas jar of oxygen (generated by adding manganese dioxide to hydrogen peroxide) • use of secondary sources to outline the process of cellular respiration and compare the rapid oxidation of glucose in combustion with slow oxidation of glucose in cellular respiration • demonstration/website video of an iodine clock reaction. **Assessment for learning activity** The teacher observes and provides feedback to students on their skills in conducting first-hand practical tasks. **Class activity**	electrochemical cells, eg mercury cells and rechargeable batteries. Students present their findings using multimedia options, eg a You Tube video, for each of the different factors investigated.

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		Students compare their results and discuss how factors such as temperature, concentration and catalysts affect the rates of chemical reactions. They relate scientific knowledge to their ideas about energy and batteries, and summarise their findings in their portfolios. **SRP individual activity** Students review their ideas and findings about chemical reactions and energy, and relate these ideas to the problem they are investigating in their SRP. Each student finalises their project plan and presents the draft for review and discussion with the teacher.	
WS7.1 Students process data and information by: b. selecting and extracting information from tables, flow diagrams, other texts, audiovisual resources and graphs, including histograms and column, sector or line graphs WS7.2 Students analyse data and information by: d. using knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS170, ACSIS204) f. evaluating conclusions and evidence, including identifying sources of uncertainty and possible alternative explanations (ACSIS171, ACSIS205) g. critically analysing the validity of information from secondary sources (ACSIS172, ACSIS206) WS8 Students solve problems by:	CW1 Scientific understanding changes and is refined over time through a process of review by the scientific community. Students: a. identify that all matter is made up of atoms which are composed of protons, neutrons and electrons (ACSSU177) b. describe the structure of atoms in terms of the nucleus, protons, neutrons and electrons c. outline historical developments of the atomic theory to demonstrate how models and theories have been contested and refined over time through a process of review by the scientific community d. identify that natural radioactivity arises from the decay of nuclei in atoms, releasing particles and energy (ACSSU177) e. evaluate the benefits and problems associated with medical and industrial uses of nuclear energy	**Researching the development of the atomic theory and the industrial and medical uses of radioisotopes** **Teacher background** *To assist students in explaining their observations about electricity and the operation of batteries, they research the development of the atomic theory. They review how changes in scientific understanding of atoms developed around the turn of the twentieth century and resulted in theories to explain the structure of the atom. They identify how theories are contested and refined as new evidence becomes available. Students develop their understanding about the importance of analysing and interpreting valid and reliable scientific data/information in constructing and presenting evidence-based arguments.* **Group activity** In groups of three to five, students participate in a jigsaw activity. Students from each jigsaw group form temporary 'expert groups' to access and use a range of secondary sources to research the: • role of Democritus, Dalton, Lenard, Thomson, Rutherford, Bohr and Chadwick in the development of the atomic theory, and • discoveries of radiation and natural radioactivity made by Curie, Roentgen and Becquerel in developing our understanding of the structure of atoms. The students re-form their jigsaw groups and share the information gathered in the 'expert groups'. In their individual portfolios students construct a timeline to summarise their findings about the development of the atomic theory. **Class activity** Through teacher demonstrations or suitable websites, students observe the properties of cathode rays and radioactive sources. They discuss and record how the observed properties led to changes in the theories of atomic structure.	**Atomic theory** Students: • role-play a television interview, design a web page or blog in which each contributing scientist discusses their findings • investigate the properties of the different types of radioactive emissions and show how these are consistent with the current atomic theory • present a piece of creative writing or role-play for a scenario related to radioactivity, eg How would you feel about being injected with radioactive material? • debate the use of nuclear energy as a source of electricity in Australia.

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f. applying critical thinking in considering suggested proposals, solutions and conclusions, including a consideration of risk WS9 Students communicate by: a. selecting and using in presentations, for different purposes and contexts, appropriate text types including discussions, explanations, expositions, procedures, recounts or reports e. presenting scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations for specific audiences (ACSIS174, ACSIS208)		Students conduct a 'particle party' based on the data/information they have gathered to present role-plays about the major components of the discovery associated with the development of the atomic theory of famous scientists. **Individual activity** Students review the timeline constructed by their jigsaw group. They revise, as necessary, to record and annotate other significant events in the development of the atomic theory identified in the class discussion. **Group activity** Students use the information collected and access appropriate additional resources to summarise their findings about: • how an understanding of the properties of electrons led to changes in the model of the atom and explained electricity • the industrial and medical uses of radioisotopes and the advantages and disadvantages of using this type of technology. In their groups the students discuss the question: Is radiation always bad? They collate, analyse and interpret scientific data/information to provide relevant evidence to support their answer. Each group prepares their short evidence-based argument and presents their answer to the class. In their presentation they should identify how they decided on the evidence, its importance in supporting their answer, and how their evidence fits with the accepted scientific data/information. As a class, the students review the ideas and information presented by each group, and individually record the range of views in their portfolios. **SRP individual activity** Students modify their SRP plan and process based on teacher feedback. They select resources and conduct their investigations, recording findings and modifying their procedures as necessary. They begin drafting their SRP reports and finalising any products/models.	
WS5.2 Students plan first-hand investigations by: c. designing controlled experiments to collect valid first-hand data d. specifying the dependent and independent variables for controlled experiments e. accounting for the use of an	PW4 Energy conservation in a system can be explained by describing energy transfers and transformations. (ACSSU190) Students: a. apply the law of conservation of energy to account for the total energy involved in energy transfers and transformations	**Investigating conservation, transfer and transformation of energy** **Teacher background** *The students engage in a class discussion to plan and prepare for their Science fair at which they will present an overview of their SRPs to an appropriate audience.* *Students review their knowledge and understanding of electricity and relate this to electrochemical cells and the atomic theory. They account for how usable energy is reduced and the system is not 100% efficient in energy transfers and transformations in everyday devices, They consider the*	**Energy transfer and transformation** Students: • prepare a report for a government agency to show why LEDs and CFLs should be used as sources of lighting in government or other high usage commercial buildings

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experimental control as appropriate WS5.3 Students choose equipment or resources for an investigation by: b. identifying the appropriate units to be used in collecting data c. selecting equipment to collect and record reliable data or information, using digital technologies as appropriate, eg data loggers d. assessing risks and addressing ethical issues associated with these methods (ACSIS165, ACSIS199) WS6 Students conduct investigations by: c. selecting and using appropriate equipment, including digital technologies, to systematically and accurately collect and record data (ACSIS166, ACSIS200) WS7.1 Students process data and information by: a. selecting and using a variety of methods to organise data and information including diagrams, tables, models, spreadsheets and databases d. applying numerical procedures and mathematical concepts	b. describe how, in energy transfers and transformations, a variety of processes can occur so that usable energy is reduced and the system is not 100% efficient c. discuss, using examples, how the values and needs of contemporary society can influence the focus of scientific research in the area of increasing efficiency of the use of electricity by individuals and society (ACSHE228, ACSHE230) d. discuss viewpoints and choices that need to be considered in making decisions about the use of non-renewable energy resources CW4 Different types of chemical reactions are used to produce a range of products and can occur at different rates and involve energy transfer. (ACSSU187) Students: d. analyse how social, ethical and environmental considerations can influence decisions about scientific research related to the development and production of new materials	*impact of scientific research on the needs of society and its use of electricity. Students further develop their skills in constructing and presenting evidence-based arguments to justify their explanations.* **SRP class activity** Students plan and allocate roles and responsibilities for organisation of the Science fair. They agree on the audience and how they will present an overview of their SRP for evaluation at the Science fair. The students discuss the criteria to be used to evaluate the presentations, including evidence-based arguments and using appropriate scientific language. **Class activity** Students review their ideas from Stage 4 about energy transfer and transformation in simple electric circuits and everyday devices, eg toaster, electric fan, solar hot water heater, computer, radio, mobile phone and/or photovoltaic cell. **Group activity** At a series of workstations, students select and use appropriate methods to plan and/or conduct and record results of first-hand practical experiences to investigate the: • law of conservation of energy of a toy car rolling down a ramp • production of unwanted energy by everyday devices • energy efficiency of light bulbs, using a data logger. The data collected could include the amount of heat lost by each type of globe over a given period of time • energy efficiency of two appliances of the same power rating, such as electric kettles. **Individual activity** Students use the Australian Standard Energy Efficiency Rating system to undertake first-hand investigations to: • compare the efficiency of a variety of household appliances including refrigerators, washing machines, hot water heaters, air conditioners and television sets • propose explanations for the reduction of usable energy in transfers and transformations in a range of different types of light globes, including light-emitting diodes (LEDs), compact fluorescent lamps (CFLs) and incandescent globes • analyse data and draw conclusions consistent with gathered data/ information. **Class activity**	• design a slogan to encourage people to use LEDs and CFLs for lighting • investigate the changes over time in energy demand in a community • debate the use of renewable and non-renewable energy sources for both domestic and industrial uses • investigate the energy efficiency of appliances and relate this to a household or business energy account.

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and using digital technologies, where appropriate WS7.2 Students analyse data and information by: c. assessing the validity and reliability of first-hand data d. using knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS170, ACSIS204) e. synthesising data and information to develop evidence-based arguments f. evaluating conclusions and evidence, including identifying sources of uncertainty and possible alternative explanations (ACSIS171, ACSIS205) g. critically analysing the validity of information from secondary sources (ACSIS172, ACSIS206) WS9 Students communicate by: b. selecting and constructing an appropriate table, type of diagram, table or graph (histogram or sector, column or line graph) to present information and show relationships clearly and succinctly using digital technologies as appropriate e. presenting scientific ideas and information for a particular purpose, including		The students: • compare their findings with those of other groups to evaluate their conclusions and evidence, including sources of uncertainty • use scientific knowledge to suggest explanations for possible causes of loss of usable energy • develop and present evidence-based arguments that could inform decisions about the current and future use of technology related to energy conservation. **Group activity** Students select, extract and analyse data/information collected from a range of secondary sources, focusing on current and future resources that may be used to generate electricity. Each student keeps a record of the group findings in their individual portfolios. Students: • select possible sources of data/information to access, using digital technologies as appropriate • select, extract and organise data/information about the different methods that can be used to produce electricity, considering the use of both renewable and non-renewable resources including coal burning power stations, hydroelectricity, photovoltaic cells, waves, winds, nuclear power and/or geothermal power • evaluate the efficiency, portability, longevity and environmental impact of each method used to produce electricity • consider how scientific and/or technological developments in the use of portable energy sources often involve and draw on knowledge from across branches of science such as physics and geochemistry (eg the ‘Mr Fusion’ battery used in the *Back to the Future* trilogy of movies from the 1980s, in which household garbage is used as a fuel for a portable energy source in a car) • summarise the information collected by selecting and using appropriate text types and/or constructing an appropriate table, diagram or graph to represent their findings in their portfolios. **Class activity** As a class, the students review and collate the ideas and information presented by each group. Individually, students modify and include additional data/information, as appropriate, to that recorded in their portfolios. **SRP individual activity**	

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constructing evidence-based arguments and using appropriate scientific language, conventions and representations for specific audiences (ACSIS174, ACSIS208)		Students include in their SRP logbook, ideas and information from their investigations about energy conservation, transfer and transformation relevant to their SRP.	
WS5.3 Students choose equipment or resources for an investigation by: c. selecting equipment to collect and record reliable data or information, using digital technologies as appropriate, eg data loggers WS6 Students conduct investigations by: f. evaluating the effectiveness of the planned procedure, considering risk factors and ethical issues, and suggesting improvements as appropriate WS7.1 Students process data and information by: f. describing specific ways to improve the quality of the data (ACSIS171, ACSIS205) WS7.2 Students analyse data and information by: f. evaluating conclusions and evidence, including identifying sources of uncertainty and possible alternative explanations (ACSIS171, ACSIS205)		**Presenting solutions to an identified problem** **Teacher background** *Students review the agreed plan, timeline and allocated roles and responsibilities for the organisation of the Science fair. Individually and as members of a team, they negotiate and accept specific roles and responsibilities to complete the required tasks to set up the Science fair. Individually, students prepare their SRP overview for presentation and complete their SRP report.* **SRP individual activity** Students : • complete conducting their investigations, making final adjustments and modifications to the process and/or product/model, as appropriate • prepare their SRP overview for presentation at the Science fair using the agreed method and a format that clearly outlines the problem investigated, the strategy used to develop a solution to the problem and the conclusions reached, based on the evidence collected • complete their SRP report for teacher evaluation. **Class activity** Students: • organise and set up the Science fair for members of the school community • present the overview of their SRP to an appropriate audience at a Science fair. **Reflection/evaluation** Students reflect on their learning experiences by reviewing their portfolios and SRP logbooks, focusing on elements such as: • comparing the skills required in both individual and group work • identifying feedback that made a significant difference to the quality of work they produced or to a different learning style • evaluating current and future developments in technology that increase	Students should be encouraged to make and present prototypes of models of the device they design that could be used as a portable source of power.

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WS8 Students solve problems by: c. applying the processes of Working Scientifically in developing creative solutions to problems g. evaluating different approaches used to solve problems (ACSIS172, ACSIS206) WS9 Students communicate by: d. proposing ideas that demonstrate coherence and logical progression		usable energy in transfers and transformations • describing their understanding of how accepted scientific evidence is used to answer questions, support claims or explain why an explanation is valid • how evidence presented changed ideas/thinking about how they could reduce their use of energy by a more efficient use of devices/technology • how social, ethical and environmental considerations can influence decisions about scientific research related to the development and production of new materials.	

Resources
The Miracle battery http://batteryuniversity.com/parttwo-54.htm **Clock reactions** www.youtube.com/watch?v=TdXamAGRHe4 www.youtube.com/watch?v=vb9FefEFPDY www.youtube.com/watch?v=Tv6_IsdnaGg **Radioactive sources** www.youtube.com/watch?v=oFdR_yMKOCw www.youtube.com/watch?v=o-9yt7OAYmE www.youtube.com/watch?v=ec8iomUS34U www.youtube.com/watch?feature=endscreen&v=ZlFz3AAwwBQ&NR=1 www.youtube.com/watch?v=3E-MtWKJ22g **Sustainable energy** www.greenlearning.ca/re-energy# www.energyforeducators.org/mathunits/mathematics.shtml **Energy efficiency** www.picotech.com/experiments/bulb_efficiency

Attachment A

Teacher background – Strategies for gifted and talented students

The definition most commonly used to distinguish gifted students from talented students is that of Françoys Gagné (2003):

> Gifted students are those whose potential is distinctly above average in one or more of the following domains of human ability: intellectual, creative, social and physical. Talented students are those whose skills are distinctly above average in one or more areas of human performance.

Giftedness implies the possession and use of outstanding *natural* abilities or aptitudes. Talent designates the outstanding mastery of systematically developed abilities, called competencies. (Gagné, F 2005)

Students with high intellectual potential are found in all cultures, geographic locations and socio-economic levels. The further the student's ability or potential is from his/her age peers, the greater the need for enrichment of the curriculum for that student. Talent emerges from ability as a result of the student's learning experiences. An underachieving child of high potential can be acknowledged as a gifted student whose abilities have not yet developed as talents.

Identifying gifted and talented students

The Board's document *Guidelines for Accelerated Progression* (revised 2000) lists not only some typical attributes and characteristics of gifted and talented students but also objective and subjective approaches to assist with the assessment of a student as gifted and/or talented.

These include:

- professional observation of performance
- parent observation
- peer observation
- checklists of traits and characteristics
- cumulative school history
- anecdotal evidence
- interviews
- interest surveys
- standardised achievement tests
- tests of cognitive/intellectual ability
- teacher-devised tests.

The *K–10 Curriculum Framework* is a standards-referenced framework that describes, through the syllabus and other documents, the expected learning outcomes for students. In accordance with the *K–10 Curriculum Framework*, the *Science K–10 (incorporating Science and Technology K–6) Syllabus* takes into account the diverse needs of all students. Teachers are able to use syllabus standards as a reference point to assist them in identifying talented students in science and in adopting special provisions such as differentiation within the classroom, as a means of meeting the needs of these students.

It is important that gifted and talented students are recognised early as these students frequently learn to conceal their abilities across subject areas or within specific classes. Whitmore (1980) provides an excellent reference on underachievement and lack of motivation among gifted students and identifies a number of characteristics associated with gifted underachievers.

Catering for the gifted and talented student in science

The following are examples of some of the strategies available to assist teachers to meet the needs of gifted and talented students.

Differentiating the curriculum in the regular classroom

The term *differentiation* when applied to curriculum simply means providing different work to suit individual needs. In the case of gifted and talented students, differentiation should allow scope not only for remembering, understanding and applying ideas and information but also for analysing, evaluating and creating from the material being covered (Anderson & Krathwohl 2001). The work presented and/or negotiated with gifted students should require higher-order thinking skills beyond the interest and ability of the majority of age peers.

Pre-testing, at the beginning of a unit of work or teaching sequence to determine the student's prior knowledge and skills is a tool that may assist in identifying students who would benefit from a differentiated learning program. This form of diagnostic assessment should examine similar subject matter to that which would be assessed at the end of a unit of work. Students who display a high level of prior knowledge could undertake a differentiated unit on the same topic, or negotiate work in another area of interest. The differentiated unit might build on the knowledge and skills already demonstrated and/or expand knowledge and skills into a complementary area.

The syllabus content is designed so that the typical student can realistically address it in the indicative course time. In Stages 4 and 5, additional knowledge and understanding content is provided in recognition that some students will need to extend their learning by engaging with content beyond the syllabus. The additional content can be addressed in either Stage 4 or Stage 5 and is not prerequisite knowledge for the Stage 6 Science courses. It should not be considered to be an exhaustive list and schools may select other science content appropriate to the interests of the student. However, this must not include the mandatory content from any of the Stage 6 Science courses. Additional content may be selected and incorporated into units of work to extend gifted and talented students' learning into areas of specific interest or to broaden and deepen their knowledge, understanding and skills.

Curriculum compacting

This option is used in conjunction with other modifications such as extension work or as part of the process of acceleration. As the regular curriculum is designed to meet the needs of the majority of students in a particular age group, some material may be repeated, both within units of work and from year to year. Gifted and talented students need:

- less repetition
- to work at a faster pace
- work that is intellectually challenging, eg problem-solving, manipulating abstract ideas.

The earlier the compacting of the curriculum and accelerated progression occur for gifted and talented students, the greater the opportunity for these students to broaden and deepen their learning and interests beyond the core curriculum.

Personal interest projects

Personal interest projects, including the Stage 4 and Stage 5 student research project, provide opportunities for students to investigate particular areas of interest and to extend their understanding of the content addressed in the units of work they have studied. By engaging in scientific inquiry through applying the processes of Working Scientifically to relevant questions and problems, students broaden their understanding of science ideas and concepts, how scientific knowledge is refined over time and the significance of scientific evidence in evaluating claims, explanations and predictions.

Projects can provide gifted students, in particular, with the opportunity to demonstrate their ability to synthesise and evaluate their findings, their understanding of the provisional nature of scientific explanations and of the complex relationship between evidence and ideas. Team projects could be used to provide opportunities for gifted and talented students to participate in a variety of team roles, including accepting greater responsibility for leading and/or managing a group.

Communicating with an appropriate audience provides a focus for consolidation of the research itself and recognition of the student's abilities and effort. Students may be required to communicate the results and analysis of research and personal interest projects to an audience, eg small groups of students and/or staff or larger groups such as school assemblies, parent groups and/or the broader community. Results and interpretation of research undertaken in the local environment could be presented, using an appropriate medium, to the local council or government with suggestions for improvement.

Students may be given the opportunity to enter some of the many subject-related competitions available throughout the year. These competitions are often flexible in terms of content and may provide opportunities for gifted and talented students to collaborate with mentors and peers and to further develop areas of interest.

Mentoring

Mentoring links a student with community members who share a fascination or expertise in the student's particular area of interest. Mentorships offer gifted and talented students a level of expertise not usually available in the regular school setting. These programs need careful coordinating and monitoring and must address all school policies and procedures relating to student safety and welfare. It is also important that appropriate protocols are in place and adhered to by students when they are communicating with mentors and peers using digital technologies.

Mentorships may be arranged as an extracurricular activity or as part of a modified program for gifted students. The mentoring process for gifted and/or talented students generally leads to high task interest, creativity, cognitive flexibility and positive feelings of self-worth (Reilly 1993).

External courses

Most major universities in New South Wales offer some form of program in science for gifted and talented students. These opportunities allow gifted high school age students to work with a university faculty member in their area of expertise, usually over a couple of days. They also provide an opportunity for gifted students to meet, work and socialise with age peers who have similar interests and abilities. Information on these courses is usually sent to schools or is available from the universities. Some schools also offer weekend or holiday courses or camps that are open to students from other schools, such as those advertised on the website produced by the New South Wales Association for Gifted and Talented Children.

Acceleration

If a student demonstrates ability well above age peers across subject areas and indeed the whole cohort, acceleration is an option. Acceleration acknowledges the rapid rate of a child's cognitive development and involves delivering appropriate curriculum and services at a level commensurate with a gifted child's demonstrated readiness and needs. It permits students to move through syllabus content at a faster rate.

Early identification of students for whom acceleration may be an appropriate option is essential. The Board of Studies *Guidelines for Accelerated Progression* (revised 2000) includes a detailed discussion of the general principles, types of programs, selection of students and policies related to acceleration. Psychometric testing and, if appropriate, self, peer, parental and teacher nomination may form part of the identification process.

In science there are two main options for a student who demonstrates that acceleration is required:

1 The student remains in an age cohort grouping for all other subjects and moves into a higher cohort group for classes in science. This may be possible if:

   a. science classes for the year above are timetabled at the same time as the cohort from which the student is moving, or

   b. the student attends science classes at the level above and completes work in subjects missed during that time when age cohort has classes for science.

2 A student is given work at an accelerated level within their age cohort science class. This option would also require the student to work independently at least some of the time. This work would be completed instead of, not in addition to, the regular class work.

To be successful, both of these options require long-range planning, financial commitment and a school timetable that accommodates the accelerants in the school community. Working with the accelerants is essential and of vital importance. Catching up on work missed with peers can often be difficult, especially if it is not in the student's area of 'talent'. While many gifted and talented students are able to learn faster and have a higher capacity for complex thought, they may need help with basic skills, processes and procedures (such as organisation, methods and scaffolds), particularly if they have moved into a higher cohort group.

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NSW Association for Gifted & Talented Children, http://nswagtc.org.au/index.php

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This thesis investigates the professional knowledge and views about gifted education held by teachers working in a suburban primary school in Melbourne, Australia, http://bit.ly/LHGG5E

'For Educators: Gifted Education Professional Development', GERRIC, UNSW, http://gerric.arts.unsw.edu.au/for-educators/

IMSA Problem-Based Learning Network
Helpful ideas and resources for using problem-based learning as a way of extending gifted students in Mathematics and Science, http://pbln.imsa.edu

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