Statements of Learning for Science

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Foreword

At the July 2003 MCEETYA meeting, Ministers agreed to the development of Statements of Learning for Science that 'define and deliver common curriculum outcomes to be used by jurisdictions to inform their own curriculum development'. The development of the Statements is a response to concerns about the lack of consistency that exists in curriculums across the nation and the impact this is having on an increasingly mobile student population.

The Statements of Learning for Science have been developed collaboratively by State, Territory and Australian education authorities. They provide a description of knowledge, skills, understandings and capacities that all students in Australia should have the opportunity to learn. The development of the Statements has involved identification of what is common amongst State and Territory curriculums as well as what is essential for all students to learn.

For the many students and their families who move school within or across jurisdictions, greater consistency in learning opportunities for children at particular stages of schooling will assist in alleviating the educational and emotional impacts associated with such moves.

In line with impacts being felt across all areas of Australian society, our students are increasingly operating in a national and global society and economy. It makes sense that education jurisdictions across Australia have worked collaboratively to identify the body of knowledge, skills, understanding and capacities which are essential for that context. Jurisdictions will need to consider how they integrate these elements into their own curriculums in a manner which suits the diversity of students' needs and schools across the country.

These statements represent significant collaboration between education authorities at a State, Territory and National level, and will inform future decisions by Education Ministers on the further work to be undertaken on English, Mathematics, Science, Civics and Citizenship, and Information and Communication Technologies.

Ken Smith
Chair, National Consistency of Curriculum Outcomes Steering Committee
Australian Education Systems Officials Committee

Statements of Learning for Science

Introduction

This document, *Statements of Learning for Science*, is the result of collaborative work by Australian education jurisdictions to achieve greater consistency in curriculum. It sets out the knowledge, skills, understandings and capacities that students in Australia should have the opportunity to learn and develop in the science domain.

Statements of Learning for Science is not a curriculum in itself. Instead, it contains a series of statements about essential opportunities to learn in this particular domain which education jurisdictions have agreed to implement in their own curriculum documents. As such, this document is primarily intended for curriculum developers. It is not the express intent that the document is promoted directly with teachers or the general community.

Statements of Learning for Science is not a list of all possible opportunities to learn within the science domain. It contains only those opportunities which all education jurisdictions agree should be consistent across Australia. Jurisdictions' own individual curriculum documents will likely include additional aspects of science.

Statements of Learning for Science contains two critical elements: the Statements themselves and their professional elaborations, which work together as a package, with the Statements also represented in expanded form in the professional elaborations. The Statements are written in a plain English form which allows them to be engaged with by a broad audience if required. As the name suggests, the professional elaborations use the professional language of the Science curriculum domain.

Underpinning the Statements and professional elaborations package within the *Statements of Learning for Science* is the idea of an opportunity to learn. The opportunities to learn set out in this document are those opportunities seen as reasonable, challenging and appropriate. 'Reasonable' means it is realistic to expect that most students will have actually achieved the learning within a reasonable period of their first having the opportunity to learn. Up to two years can be considered reasonable for students. 'Challenging' means that the opportunities will be a stretch and thus they represent somewhat more than a proficient student could be expected to learn initially. 'Appropriate' means that the opportunities are suitable for the majority of young Australians to experience.

The opportunities to learn in the Statements and professional elaborations sections have been developed for four year junctures – the end of years 3, 5, 7 and 9. Most of the curriculum documents of Australian education jurisdictions are organised in bands, levels or stages rather than in year junctures and so the opportunities to learn in this document will most likely be included in jurisdictions' curriculum documents in the band, level or stage where the year juncture falls.

The opportunities to learn in the Statements and professional elaborations sections are also structured around broadly defined aspects of science, known as organisers. These organisers provide coherence and structure for this document. In implementing the opportunities to learn, jurisdictions will use whatever organisers suit their curriculum documents best.

Science and Science education

Science is a dynamic, forward-looking, collaborative human endeavour that provides a distinctive way of thinking about and explaining the events and phenomena in the world. Science education endeavours to foster students' curiosity, imagination and wonder.

The rapid advances in science, including emerging and future science areas and technology and their impact on society and the environment, requires science education to develop students who are scientifically literate and therefore 'have the capacity to be interested in and understand the world around them, can engage in the discourses of and about science, be sceptical and questioning of claims made by others about scientific matters, be able to identify questions and draw evidence-based conclusions and make informed decisions about the environment and their own health and wellbeing'.[1]

This enables them to become active, informed citizens who can confidently contribute to debates and make reasoned judgements about moral, ethical and social issues and the role of science and technology in shaping their lives.

The study of science has led to an evolving body of knowledge which has been, and continues to be, built up over time and revised as new evidence comes to light through the practice of science. It provides explanations for a variety of phenomena that enable us to make sense of the biological, physical and technological aspects of our world, predict future events, as well as develop and implement technologies that improve the quality of life. Science education helps students reach a scientific understanding of their world. It provides them with the skills and cognitive abilities to access the ever expanding body of knowledge in order to better understand themselves, local and global sustainability and other issues. Science education involves students using a range of technologies, including ICT to explore their world.

Science is a process of inquiry which involves questioning, predicting, hypothesising, investigating and gathering evidence, organising data to elicit patterns, testing and refining ideas, developing explanations for natural phenomena and communicating these to others. As students acquire the skills of working scientifically they develop an understanding of evidence and the nature and practice of science. Working both individually and in teams, students are engaged in critical and creative thinking, to solve problems and clarify ideas.

Science is concerned with testing ideas and theories against evidence. Thus it has a key role to play in developing in students the ability to draw logical, evidence-based conclusions, use problem-solving strategies and accept the provisional nature of scientific explanations.

While people involved in science seek to be objective, they are part of the world they study, so their observations and inferences are influenced by their prior experiences, values and understandings. Science knowledge has been influenced and constrained by societies as people from different backgrounds and cultures experience and interpret their environment differently. Science education should assist students to appreciate the human aspect of science and how it has shaped and been shaped by societies and cultures.

The nature and practice of science has given rise to values that in turn govern good scientific practice. The values include openness to new ideas, intellectual honesty, critical and sceptical evaluation of data and arguments, and ways of working that are ethical, fair and respectful of others. Science education aims to encourage in students a willingness to engage with, articulate and use accepted ethical practices in their own research.

1. Goodrum, Hackling, Rennie; 'The Status and Quality of Teaching and Learning of Science in Australian Schools', 2001, DEST

Science curriculums in Australia

The Statements of Learning and their professional elaborations take account of the following aims which are a synthesis of introductions, rationales, aims and objectives from Science curriculums across Australia.

Science curriculums in Australia seek that students have the opportunity to:

- develop their scientific literacy so, as global citizens, they can make informed and ethical decisions about the applications of science to local and global issues and their own health and wellbeing
- use the processes of working scientifically, reflection and analysis to investigate and test ideas, refine knowledge and pose new questions
- develop understandings of the importance of critical thinking, objectivity, logical reasoning and ethical practices in science research
- experience the excitement and creativity of the ever-expanding scientific enterprise recognising that new and multidisciplinary areas are continually being developed as scientific questioning and curiosity seeks to make sense of phenomena
- use appropriate ways of representing and communicating their science understandings and viewpoints to audiences for a range of different purposes and thereby contribute to and engage in public debate and decision making
- recognise the developing and changing nature of science and scientific knowledge as a human endeavour with its own histories and ways of contributing to society
- become aware of current Australian research and achievements and their contribution to the community, and so realise that science offers rewarding career pathways and opportunities for life-long learning
- acknowledge that aspects of scientific thinking are carried out by all people in different cultural, environmental and economic contexts and that this influences how scientific knowledge develops and is used within those cultures
- develop an understanding of science concepts and use these to explain and predict events of the physical and biological worlds.

Features of Statements of Learning for Science

The *Statements of Learning for Science* describe the knowledge, skills, understandings and capacities that all young Australians should have the opportunity to learn and develop in science.

The professional elaborations build on the Statements of Learning by providing more specific detail and by making use of the technical language related to science for the profession.

As systems over time will integrate the *Statements of Learning for Science* into their curriculum documents, teachers' application of them will be through their own State or Territory curriculums.

The *Statements of Learning for Science* are organised by year level and are structured around three broadly defined aspects of Science curriculums that are considered essential and common – Science as a Human Endeavour, Science as a Way to Know and Science as Body of Knowledge. They articulate a common set of learning opportunities that all students in Australia should have relating to knowledge, skills, understandings and capacities.

The choice of organisers and sub-organisers is for the purpose of clearly presenting the aspects of science curriculum for national consistency. The organisers are interdependent and integrate in a variety of ways depending on many factors including the learner, the nature of the task and teaching and learning strategies. Figure 1 represents this integration and interdependence. Depending on the context for learning, the prominence of the organisers involved will vary.

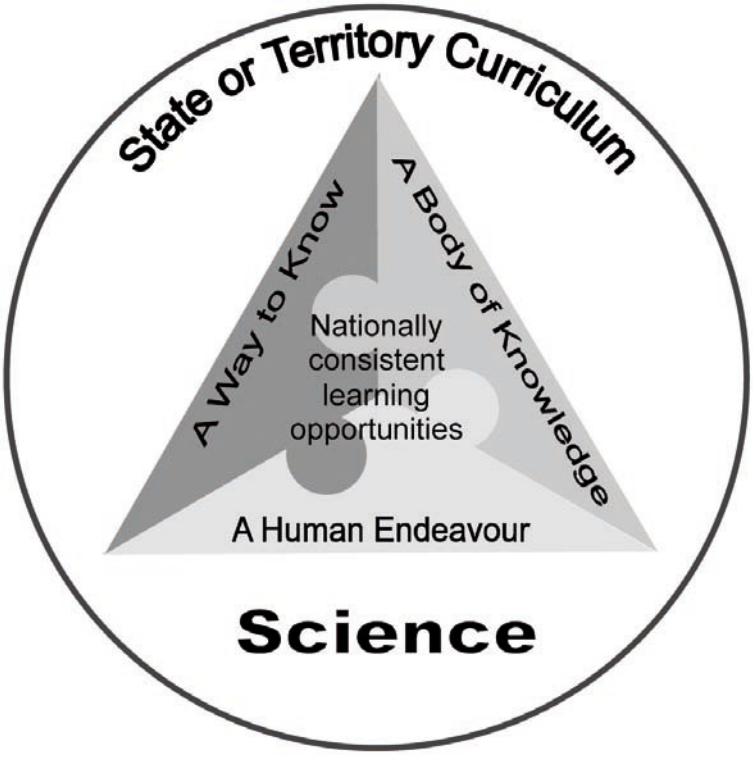

Figure 1 The nationally consistent learning opportunities (represented by the triangle) are embedded within but constitute only part of the total curriculum (represented by the circle) in each State or Territory.

Science as a human endeavour

This organiser is about the way science influences society through its way of thinking and world view as well as the way societal challenges or social priorities influence the development of scientific research. It highlights the need for informed, evidence-based decision making about current and future applications of science that impact on society and the environment and on other social and ethical issues. It acknowledges that science has advanced through, and is open to, the contributions of many different people from different cultures at different times in history and offers rewarding career paths. It acknowledges that in decisions about science and its practices, moral, ethical and social implications must be taken into account.

It is intended that students will use their scientific understanding to engage in a future-oriented way with relevant local or global issues in addition to sustainability. However, this document does not seek to specify what these issues might be, since what is current and relevant will change over time.

This organiser draws on the conceptual framework of *Science as a body of knowledge* to provide opportunities to develop understandings about the applications of science and their impacts on human activity. This organiser also draws on the principles of scientific investigation as developed in the organiser *Science as a way to know*. The terms 'sustainability' and 'environment' are used in the broad sense, referring to the natural environment including both biotic and abiotic and the natural, built and/or social environment.

Science as a way to know

This organiser is about scientific investigation and the way in which scientific explanations are established. It includes posing questions, planning and conducting investigations, collecting and analysing evidence and communicating findings. It is concerned with evaluating investigations and claims and making valid conclusions. It also recognises that scientific explanations change as new or different evidence becomes available from investigations. Investigations are also informed by and explore concepts from the organiser *Science as a body of knowledge*.

While fair testing and controlled experiments are emphasised, it is anticipated that students would also experience other forms of individual and collaborative investigation such as field work, the use of models and simulations, examination of second-hand data or information research. Students at all times demonstrate responsibility for their own and others' safety by following and explaining safety procedures appropriate to the level at which they are working. They use information and communication technologies suitable to the purposes of the investigation and the ICT capabilities they are developing at that time.

The opportunities to understand the processes described in this organiser are central to addressing the issues outlined in *Science as a human endeavour*.

Science as a body of knowledge

This organiser is about the body of evolving scientific knowledge. It describes opportunities to engage with and increase understandings of scientific concepts, explanations and theories. These concepts, explanations and theories are drawn from physics, chemistry, biology and geosciences and for the purposes of this document are presented here under the sub-organisers Energy and force; Matter; Living things; and Earth and space. It is anticipated that in practice learning opportunities be integrated across sub-organisers and organisers and embedded in meaningful and relevant contexts for learners.

Opportunities to understand the concepts described in this organiser may need to be integrated with opportunities to develop the processes of *Science as a way to know* and placed in the contexts of the issues and applications included in *Science as a human endeavour.*

Within the Earth and space sub-organiser, 'Earth' includes the three major components, geosphere, hydrosphere and atmosphere. Within Energy and force, it is expected that curriculum documents will include opportunities for students to have considered a variety of forms of energy, including at least heat, sound, light and electricity, by the end of the stage, level or band in which the year 9 juncture falls. However, it is left to each jurisdiction to determine which forms are encountered at each stage, level or band.

Reading the Statements of Learning and the professional elaborations

The *Statements of Learning for Science* have been designed to describe progressions of opportunities to learn. In broad general terms this progression is from the more concrete, personal, familiar and simple to the more abstract, global, new and complex.

Each Statement of Learning and professional elaboration subsumes the knowledge, skills, understanding and capacities of the Statements and elaborations that precede it. It is important for curriculum writers to consider the Statements of Learning in Science and the professional elaborations as a whole, in conjunction with the Introduction.

As noted above, the professional elaborations expand on and provide more specific detail that clarifies the intent of the Statements of Learning by making use of the technical language of science.

Whenever examples are included they are for the purpose of clarification only and should not be taken as prescriptive. They have been incorporated to assist curriculum writers to clearly identify the intended depth and breadth.

The *Statements of Learning for Science* do not attempt to address pedagogical issues. Learning experiences may include a variety of strategies to support the learners.

Year 3 Statements of Learning for Science

Year 3 Science as a human endeavour

Students recognise scientific aspects of their everyday activities, applications of science in their own lives and the place of science in the work of people in their community.

Students show that they share responsibility for the quality of their immediate environments and for resource conservation.

Year 3 Science as a way to know

Students begin asking questions and making predictions related to their everyday experience.

Students plan and conduct simple investigations and learn how to use appropriate tools and equipment. They follow suggestions to collect, record and present data.

Students revisit their questions in light of their results. They share findings, talk about the way in which the investigation could be changed and begin to consider fairness of tests.

Year 3 Science as a body of knowledge

Energy and force

Students explore how pushing and pulling objects affects their motion and shape.

Students use intuitive notions about energy being needed to get things done. They explore different forms of energy and their use in everyday situations.

Matter

Students examine and compare the observable properties of common materials in a variety of everyday objects.

Students observe and describe how changing familiar materials changes their properties.

Living things

Students identify obvious features of a variety of plants and animals. They distinguish between living and non-living things using basic criteria.

Students describe some of the changes that take place as living things grow while realising that offspring are similar to their parents.

Students identify some ways in which living things depend on the environment and each other.

Earth and space

Students observe and describe changes on Earth and in space (for example phases of the moon), recognising that some are predictable. They explore relationships between distance and apparent size of objects to an observer.

Students begin to understand the ways in which they and other living things depend on the Earth and are affected by its changes.

Year 5 Statements of Learning for Science

Year 5 Science as a human endeavour

Students apply their scientific understanding to their experiences and describe how products (eg *hair gel, sunscreen, protective clothing*) and tools (eg *egg beater, hairdryer*) have been developed.

Students consider appropriate ethical issues relevant to them and they also consider the consequences of human activity. They investigate how their actions contribute to sustainability of resources and local environments.

Students think about how science is used in work and leisure.

Year 5 Science as a way to know

Students derive, from their interests or experience, questions and predictions for testing. They contribute to planning a variety of investigations, recognising where comparisons might be fair or unfair. They collect data, checking and repeating observations while conducting their investigations.

Students present data in appropriate ways and then identify patterns. They discuss and compare results with predictions and draw conclusions. Students communicate their ideas and understandings and suggest improvements to the investigation.

Year 5 Science as a body of knowledge

Energy and force

Students compare the effects that different-sized forces have on the shape and/or motion of objects. They explore the idea that some forces, for example magnetism, may act at a distance while others need to be in contact with the object to affect it.

Students investigate how energy can be transferred between objects. They identify different forms and sources of energy used in their communities.

Matter

Students compare properties of an object with those of the material of which it is made. They consider how and why materials are chosen for particular purposes.

Students find and observe the smaller visible parts that make up the material under examination.

Students identify a variety of changes that materials may undergo.

Living things

Students identify structures of living things and describe the relationship between structure and function. They use observable characteristics to sort living things into groups.

Students compare differences in life cycles and reproductive processes in living things.

Students describe some interactions between living things, and between living things and their environment.

Earth and space

Students include current information from space exploration as they build an understanding of the planets and other objects in the solar system. They learn that things on or above the Earth's surface are pulled towards it by gravity.

Students describe identifiable causes for some of the changes to the surface of the Earth or the atmosphere.

Students look at the way Earth's resources are used in the community.

Year 7 Statements of Learning for Science

Year 7 Science as a human endeavour

Students use their scientific understandings to consider and respond to appropriate ethical and social issues relevant to them such as those related to health and wellbeing.

Students explain and evaluate how the use of science and technology has changed the ways people live.

Students examine issues of the sustainability of the natural, built or social environment, extending from local to global perspectives.

Students realise that individuals engage in and find scientific work rewarding for a variety of reasons. They cite contemporary Australian work in science.

Students recognise that scientific understandings have changed over time and that different cultures may have different views in relation to scientific practice, for example the value placed on traditional cultural practices in areas such as medicine.

Year 7 Science as a way to know

Students pose questions and make predictions that can be investigated scientifically. They plan and conduct investigations demonstrating that they understand the requirements of fair testing. They undertake systematic observation and data collection, taking steps to minimise error.

Students use appropriate means of presenting data and communicate effectively using scientific terminology. They offer explanations for patterns in their data. They draw conclusions from that data and make general suggestions for improving the investigation after considering their own and their peers' findings.

Students review their understandings in light of new information.

Year 7 Science as a body of knowledge

Energy and force

Students realise that forces may act in the same or different directions on objects and so support or oppose each other.

Students describe ways in which different forms of energy can be transferred or stored. They compare the use of renewable and non-renewable energy sources.

Matter

Students explore relationships between properties, composition and use of different materials.

Students observe and describe the features of physical and chemical changes

Living things

Students recognise that the basic unit of all living things is the cell. They recognise the importance of biological classification systems and apply them.

Students examine why some living things are better suited to their environment than others.

Students construct and interpret food chains and webs to model relationships within living communities.

Earth and space

Students examine the relationships between the Earth, Moon and Sun. They learn that gravitational attraction exists between all the objects in the solar system.

Students recognise that Earth's changes occur over different time scales. They use geological evidence to interpret past events.

Students investigate which of Earth's resources that they use are reusable, renewable or neither.

Year 9 Statements of Learning for Science

Year 9 Science as a human endeavour

Students apply relevant scientific understandings to make responsible, ethical and informed decisions about issues including the applications of science, implications of research and about sustainability.

Students appreciate that science provides rewarding careers. They recognise that the work of contemporary scientists is often multi-disciplinary and collaborative.

Students cite instances in which social priorities have had an impact on or have been influenced by science.

Students appreciate that people of diverse cultures have contributed to and shaped the development of science.

Year 9 Science as a way to know

Students formulate questions or hypotheses and plan their own investigations taking into account the principles of fair testing. They use appropriate techniques to improve reliability.

Students explain trends and patterns in data and present information using appropriate formats.

Students use language, appropriate forms of representation and conventions specific to the discipline to communicate their investigations and understanding of scientific issues.

Students reflect on discrepancies when drawing conclusions or evaluating an investigation. They then suggest specific improvements.

Students relate their own experiences to the way the scientific community modifies its concepts and models as evidence becomes available from investigation.

Year 9 Science as a body of knowledge

Energy and force

Students consider effects on the motion and energy of objects in situations where several forces are acting.

Students explore how and why the movement of energy varies according to the medium through which it moves. They recognise that energy is conserved.

Matter

Students use scientific models and terms to explain the properties of materials, the changes materials undergo and the conservation of matter.

Students distinguish between physical and chemical changes in terms of particle arrangement. They explore factors that affect chemical changes and relate these to everyday situations.

Living things

Students examine how an organism's body systems interact to meet its needs.

Students examine the theory of evolution by natural selection to explain the diversity of living things. They also examine how inherited characteristics are passed from parent to offspring.

Students use scientific concepts and models to explain the interdependence of populations of organisms and the environment. They predict the consequences of changes to an ecosystem.

Earth and space

Students consider scientific theories of the origin of the universe.

Students use the theory of plate tectonics to explain global patterns of geological activity and they explore the causes and consequences of global atmospheric changes.

Year 3 Professional Elaborations – Opportunities to Learn for Science

Year 3 Science as a human endeavour

Students have the opportunity to:
- explore how they are engaging in science in their interests and activities within and beyond school
- identify applications of science they encounter in their daily lives
- demonstrate their shared responsibility for the quality of their immediate environments and in conserving resources
- engage with some people whose work involves science.

Year 3 Science as a way to know

Students have the opportunity to:
- engage with their world by asking questions about familiar situations and making predictions based on their everyday experience
- plan and carry out investigations that involve a small number of steps related to their questions and predictions, including the collection of required data
- use appropriate equipment to make measurements and record and present data as directed
- share and communicate observations, results, ideas and understandings
- compare results with their initial ideas
- identify what went well and where difficulties and sources of unfairness were encountered and to then suggest how and why they would do things differently in future.

Year 3 Science as a body of knowledge

Energy and force

Students have the opportunity to:
- explore ways in which pushes and pulls (*forces*) act in everyday situations to make things stop, move or change shape
- explore a number of different forms of energy (eg *heat, sound*) and the way they are used in their everyday lives.

Matter

Students have the opportunity to:
- examine and compare observable properties of the materials of which a variety of everyday products are made
- investigate how changing a material may change its observable properties.

Living things

Students have the opportunity to:

- investigate the obvious structural features of a variety of living things including both plants and animals
- distinguish between living and non-living things by considering their characteristics and basic needs
- explore how different organisms change in different ways as they grow while realising that offspring are similar to their parents
- recognise that the basic needs of living things must be met for survival in an environment.

Earth and space

Students have the opportunity to:

- observe changes in the land, water, atmosphere or in space (eg *weather, night and day, soil erosion, phases of the Moon*) and recognise that some of these changes are more predictable than others
- explore the relationship between distance and apparent size of objects (for example a large object looks smaller as you move away from it)
- examine how they and other living things depend on the Earth and are affected by changes at the Earth's surface.

Year 5 Professional Elaborations – Opportunities to Learn for Science

Year 5 Science as a human endeavour

Students have the opportunity to:

- apply their scientific understanding to make sense of their day-to-day experiences and interests
- consider ethical issues in science-related contexts relevant to this age group
- describe how products (eg *hair gel, sunscreen, protective clothing*) and tools (eg *egg beater, hairdryer*) have been developed through the application of science
- investigate how their actions can contribute to sustainable resource use
- explore the consequences of human activity for the sustainability of their local natural, built or social environments
- describe how people in a wide range of occupations and cultures use science in their work and leisure.

Year 5 Science as a way to know

Students have the opportunity to:

- create from their interests or experiences, appropriate questions and predictions for testing
- contribute to designing the method to be used in conducting various forms of investigation, identifying sources of fairness and unfairness
- collect and record data, checking and repeating observations or measurements as appropriate
- identify patterns in data
- present data in different ways including graphing, and reflect on how useful these were
- discuss and compare the results of the investigation with their predictions, offer conclusions and communicate ideas and understandings
- suggest improvements to the investigation by reflecting on what went well and where difficulties were encountered.

Year 5 Science as a body of knowledge

Energy and force

Students have the opportunity to:

- compare the effects of large and small forces on the motion and/or shape of an object
- explore some forces which act at a distance and do not require direct contact between objects (eg *magnetism*), and other forces which do require direct contact (eg *hitting a ball*)
- investigate how some different forms of energy (eg *heat, sound, light, electricity*) are transferred and used in their community and research the sources of those forms of energy.

Matter

Students have the opportunity to:

- explore the properties of an object in relation to the properties of the materials of which it is composed (eg *eggs and sugar compared with meringue; sand and cement compared with concrete*)
- examine how the selection of material for a specific purpose depends on the selection criteria as well as the properties of the materials being considered
- observe that materials are composed of parts (for example grains or fibres) some of which may not be visible with the naked eye but may be visible with a magnifying glass
- investigate different types of changes materials can undergo.

Living things

Students have the opportunity to:

- describe the relationship between the structures of living things and the functions these structures perform
- group living things on the basis of observable characteristics
- compare the reproductive processes and life cycles of a variety of living things
- explore ways in which living things interact with each other and the environment.

Earth and space

Students have the opportunity to:

- research current information from space exploration about other planets and compare the regular and predictable motions of various objects in the solar system (eg *by modelling*)
- investigate the effects of gravity as the force that causes objects to fall towards the Earth
- suggest causes of some of the changes which occur at the surface of the Earth or in the atmosphere
- investigate a variety of different Earth resources used in the community for a variety of purposes.

Year 7 Professional Elaborations – Opportunities to Learn for Science

Year 7 Science as a human endeavour

Students have the opportunity to:

- use their scientific understandings to predict consequences of and suggest creative solutions to issues relevant to them
- consider and respond to ethical and social issues in science-related contexts relevant to this age group
- consider the impact of applications of science and technology on themselves, society and the environment
- investigate current, and explore possible future, impacts of their communities on the sustainability of their natural, built or social environments
- make connections between local and global environmental and resource issues
- examine the reasons people engage in science as a worthwhile and exciting career and examine current work of Australian scientists
- recognise that scientific understandings have changed over time
- consider reasons different cultures may have different views in relation to scientific practice.

Year 7 Science as a way to know

Students have the opportunity to:

- formulate, clarify and refine questions or predictions suitable for testing
- devise a method that will collect the data required to answer the question or test the prediction
- recognise that conditions must be the same for a fair comparison, identifying the variable to be changed and the variable to be measured
- collect relevant data in ways that minimise measurement error and explain the purpose of using repeat trials.
- discuss and summarise patterns in data and provide some explanation
- communicate ideas and understandings using appropriate representations including graphs, models and diagrams and use scientific terminology in familiar contexts
- reflect on the appropriateness of methods of presenting data in terms of clarity and/or ease of analysis
- draw reasonable conclusions that are suggested by the data
- compare their results with those of others for the same investigation, suggest reasons for the differences, and offer general suggestions to improve their investigations or conduct further investigations
- assess their understanding in light of new data or reconsideration of existing data.

Year 7 Science as a body of knowledge

Energy and force

Students have the opportunity to:

- investigate the effects of forces supporting or opposing each other (eg *floating and sinking, simple machines, speeding up and slowing down*)
- explore how forms of energy differ in the way they can be transferred or stored (eg *electric circuits*, *batteries*)
- compare how different renewable and non-renewable energy sources are used.

Matter

Students have the opportunity to:

- explore how the properties of materials can vary according to the proportion of the substances of which they are composed and how that may alter their suitability for a specific use (eg *strengths of mud bricks, rusting of different iron alloys*)
- investigate physical and chemical changes and the reversibility of the change.

Living things

Students have the opportunity to:

- recognise the cell as the basic unit of all living things
- apply accepted systems of scientific classification to living things based on their structures
- explore how the survival of organisms within a particular environment is dependent on their suitability to that environment
- construct and interpret food chains and webs to model relationships between organisms within an ecosystem.

Earth and space

Students have the opportunity to:

- model the orbits of the Earth, Moon and Sun with relation to each other and explore the effects observable from Earth
- extend their understanding of gravity as the force that keeps the objects of the solar system in their orbits
- compare some processes that occur over a shorter time scale (eg *evaporation and precipitation in the water cycle*) with some that take longer (eg *rock formation*)
- interpret past events in particular places using geological evidence
- investigate which of Earth's resources that they use are reusable or renewable and which are not.

Year 9 Professional Elaborations – Opportunities to Learn for Science

Year 9 Science as a human endeavour

Students have the opportunity to:

- give due consideration to relevant scientific understandings and processes when making informed, responsible and ethical decisions about real-world situations (eg *salinity, nuclear energy production, land degradation*)
- develop an enhanced understanding of current issues that involve implications of research, applications of science or future sustainability (eg *Human Genome project*)
- investigate how people working with science often draw on concepts and processes across scientific disciplines in multidisciplinary teams and recognise science can provide rewarding career pathways
- consider instances in which progress in science can be affected by and influence social issues and priorities (eg *water purification, alternative energy sources, space exploration, ethics of biotechnology*)
- recount scientific advances that challenged understandings and practices in science and everyday life (eg *causes of disease*)
- recognise that scientific understandings throughout history have been and will continue to be shaped by individuals and groups from diverse cultures.

Year 9 Science as a way to know

Students have the opportunity to:

- formulate hypotheses or questions suitable for testing
- decide on the most suitable form of investigation to test an hypothesis or a question, design an appropriate method and control variables
- include repeat trials and replication with appropriate sample sizes to improve reliability of data
- explain trends, patterns or relationships in data in ways consistent with their scientific understanding
- use accepted formats and conventions to present information and data
- communicate ideas and understandings using scientific terminology correctly and in context and using appropriate representations including graphs and models
- draw conclusions that are consistent with the data and address hypotheses
- identify discrepancies in results, evaluate the reliability of their data, evaluate conclusions and suggest changes to investigations in order to reduce uncertainty
- relate their own investigative experiences to the way in which scientists use empirical evidence to propose and modify explanations.

Year 9 Science as a body of knowledge

Energy and force

Students have the opportunity to:

- investigate the effect of several forces on the motion and energy of an object
- explore how and why the movement of energy (eg *light, sound*) varies according to the medium through which it is transferred
- recognise that when energy is transformed and transferred it is also conserved.

Matter

Students have the opportunity to:

- use a particle model to explain properties of states of matter
- identify that matter may be composed of elements or compounds
- explain physical and chemical changes in terms of arrangement and type of particle involved, understanding that matter is not created or destroyed in these processes
- investigate how chemical changes differ according to the conditions under which they occur (eg *factors that affect rate*) and apply these to everyday situations.

Living things

Students have the opportunity to:

- explore how complex organisms depend on interacting body systems to meet their needs
- recognise that inherited characteristics are the result of genetic information being passed from parent to offspring
- examine the theory of evolution by natural selection to explain the diversity of living things
- explore the consequences of changes on the living and non-living components of an ecosystem (eg *using simulations and considering matter and energy flow*).

Earth and space

Students have the opportunity to:

- explore scientific theories of the origin of the universe
- use the theory of plate tectonics to explain global patterns of geological activity
- consider the consequences of changes to the atmosphere (eg *global warming*) resulting from natural and human activities.