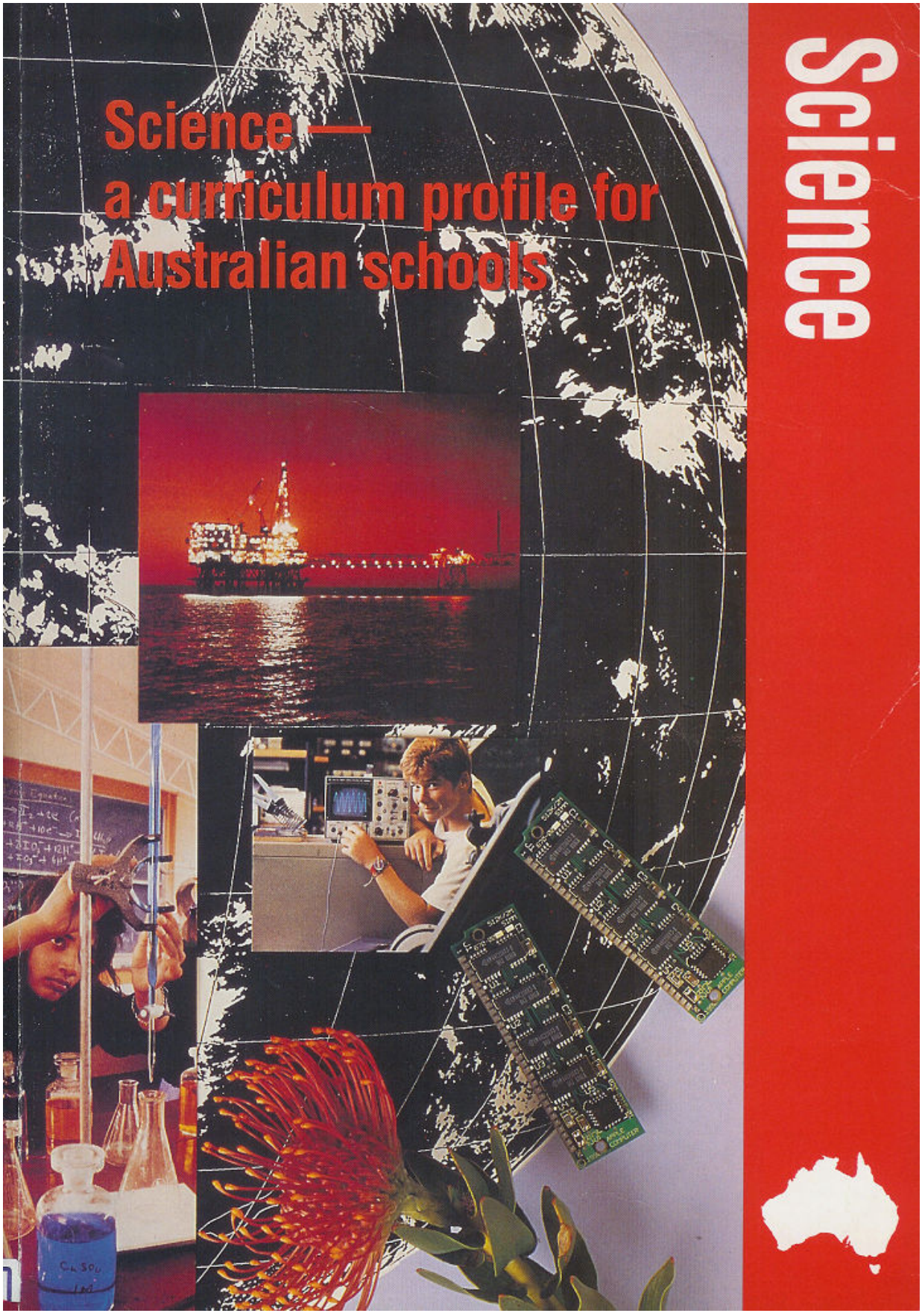
Science — a curriculum profile for Australian schools



Science

Science — a curriculum profile for Australian schools

A joint project of the States, Territories and the Commonwealth of Australia initiated by the Australian Education Council

Curriculum
CORPORATION

Published by Curriculum Corporation
St Nicholas Place
141 Rathdowne St
Carlton Vic 3053
Australia
Tel: (03) 639 0699
Fax: (03) 639 1616

ACN 007 342 421

National Library of Australia
Cataloguing-in-publication data
Science: a curriculum profile for Australian schools.

ISBN 1 86366 208 1.

1. Science — Study and teaching — Australia.
2. Curriculum planning — Australia.
3. Students — Australia — Rating of.
I. Australian Education Council.
II. Curriculum Corporation (Australia).
III. Title: Statement on science for Australian schools.
507.1094

Designed by Marketing Partners

Printed in Australia by A E Keating (Printing) Pty Ltd

Foreword

This volume is one of a series of documents which together represent the most significant collaborative curriculum development project in the history of Australian education.

National collaboration has produced sixteen documents: a statement and a profile in each of eight areas of learning — English, mathematics, science, technology, languages other than English, health and physical education, studies of society and environment, and the arts. The sixteen documents are published in seventeen volumes, since the mathematics profile is published in two volumes.

In April 1989 the State, Territory and Commonwealth Ministers of Education endorsed ten common and agreed national goals for schooling in Australia. Over the following years, work proceeded on the development of statements and profiles. This work was undertaken at the direction of the Australian Education Council (AEC), the national council of Ministers of Education.

The statements in the eight areas of learning provide a framework for curriculum development by education systems and schools. They are divided into strands which reflect the major elements of learning in each area. Further, they are structured in four bands, roughly corresponding to the stages of schooling: lower primary, upper primary, junior secondary and post-compulsory. The statements do not provide a syllabus. Rather, they provide a foundation for courses which will meet students' needs and reflect advances in our knowledge — both of the learning area to which the statement is related and of how students learn. The statements encourage innovation and experimentation so that students have a positive experience of each learning area.

The profiles are designed to assist in the improvement of teaching and learning and to provide a common language for reporting student achievement. They are divided into strands for each learning area. Within each strand, eight achievement levels have been developed. Overall, the eight levels reflect the full range of student achievement during the compulsory years of schooling (Years 1–10). The Australian Council for Educational Research (ACER) has validated the levels. The profiles have also been subject to intensive trialling in Australian schools.

The project was managed by the AEC Curriculum and Assessment Committee (CURASS), chaired most recently by the New South Wales Director-General of School Education, Dr Ken Boston. CURASS included representation from the Commonwealth, States and Territories, New Zealand, Catholic and independent schools, parents, teachers, the AEC Secretariat, ACER and Curriculum Corporation. CURASS was supported by a secretariat with representation from all States and Territories and the Commonwealth.

Project teams were established to undertake the writing, while specialist staff from States and Territories and the Commonwealth assisted with development. In each learning area consultants were appointed with responsibility for ensuring that gender equity and Aboriginal and Torres Strait Islander perspectives were reflected in the documents. Throughout the writing process, nationwide consultations occurred with groups such as parents, teachers (from both government and non-government sectors), teacher educators, professional associations, subject and discipline specialists, curriculum developers, community groups, employers and unions.

At its meeting in July 1993, the AEC agreed that the publication of statements and profiles shall be the prerogative of each State and Territory. The Board of Curriculum Corporation in accordance with the wish of member systems is publishing, disseminating and marketing these materials developed through national collaborative processes.

David Francis

David Francis
Executive Director

Contents

List of work samples

* These work samples also show achievement at level five.

Work samples usually take their title from the concept strand they illustrate. However, as shown above, many of the work samples illustrate achievement of outcomes in the process strand, Working scientifically, as well as in one of the concept strands.

Introduction

The States, Territories and the Commonwealth have, since 1989, worked together on a major national educational initiative to produce statements and profiles in eight broad areas of learning:

The arts	English
Health and physical education	Languages other than English
Mathematics	Science
Studies of society and environment	Technology.

The Australian Education Council (AEC), made up of the education ministers of the States, Territories and Commonwealth, commissioned the work.

Statements provide a framework for curriculum development in each area of learning. They define the area, outline its essential elements, show what is distinctive about it and describe a sequence for developing knowledge and skills.

Statements provide an account of the strands and bands of each learning area. Strands are groupings of understandings of a learning area's content, processes and concepts. Bands are the broad stages in a sequence for developing knowledge, understandings and skills in a learning area. Each statement has four bands. Generally, Bands A and B will be covered in primary schooling, C in secondary school to year 10, and D in the post-compulsory years.

Profiles describe the progression of learning typically achieved by students during the compulsory years of schooling (Years 1–10) in each of the areas of learning. Their purpose is twofold: to help teaching and learning and to provide a framework for reporting student achievement. Profiles are divided into strands, usually the same as those in the statement, and into eight levels of achievement.

Profiles and statements are linked. The profiles show the typical progression in achieving learning outcomes, while statements are a framework of what might be taught to achieve these outcomes.

Structure of the science profile

The profile maps science outcomes in five strands, each of which is divided into organisers:

STRAND	ORGANISER
Earth and beyond	• Earth, sky and people
	• The changing Earth
	• Our place in space
Energy and change	• Energy and us
	• Transferring energy
	• Energy sources and receivers
Life and living	• Living together
	• Structure and function
	• Biodiversity, change and continuity

Natural and processed materials	• Materials and their uses • Structure and properties • Reactions and change
Working scientifically	• Planning investigations • Conducting investigations • Processing data • Evaluating findings • Using science • Acting responsibly

Each organiser develops knowledge, skills and understandings related to a particular idea (in the concept strands) or skill (in the process strand). The organisers and strands interlock at each successive level to complement and reinforce one another, providing a consistent definition of science competence at that level.

The major purpose of the profile is to provide a framework for reporting student achievement during years 1–10. It is expected that by the end of year 10 many students will achieve level 6 outcomes, but few will achieve level 8. Year 10 marks the end of compulsory schooling, after which students proceed to a variety of options. Some will continue in specialised studies like physics, geology, or agricultural science, and some will continue with general studies of science. For some, year 10 will be their last formal study of science.

Unifying ideas

Ideas across strands

The profile is based on a number of ideas, which cut across strands. They are that:

- To understand something or to solve a problem, it is helpful to analyse its parts.
- Change occurs because of interaction.
- Interaction and change are the result of energy transfer between the objects or systems that are interacting.
- Science is conducted partly to create meaning in our world and partly to improve the world.
- Working scientifically is an effective way of generating understanding and solving problems.

Ideas within strands across levels

Each organiser in the profile is based on a unifying idea, which is developed progressively through the eight levels. These are shown in the table below, along with examples of content in the organiser.

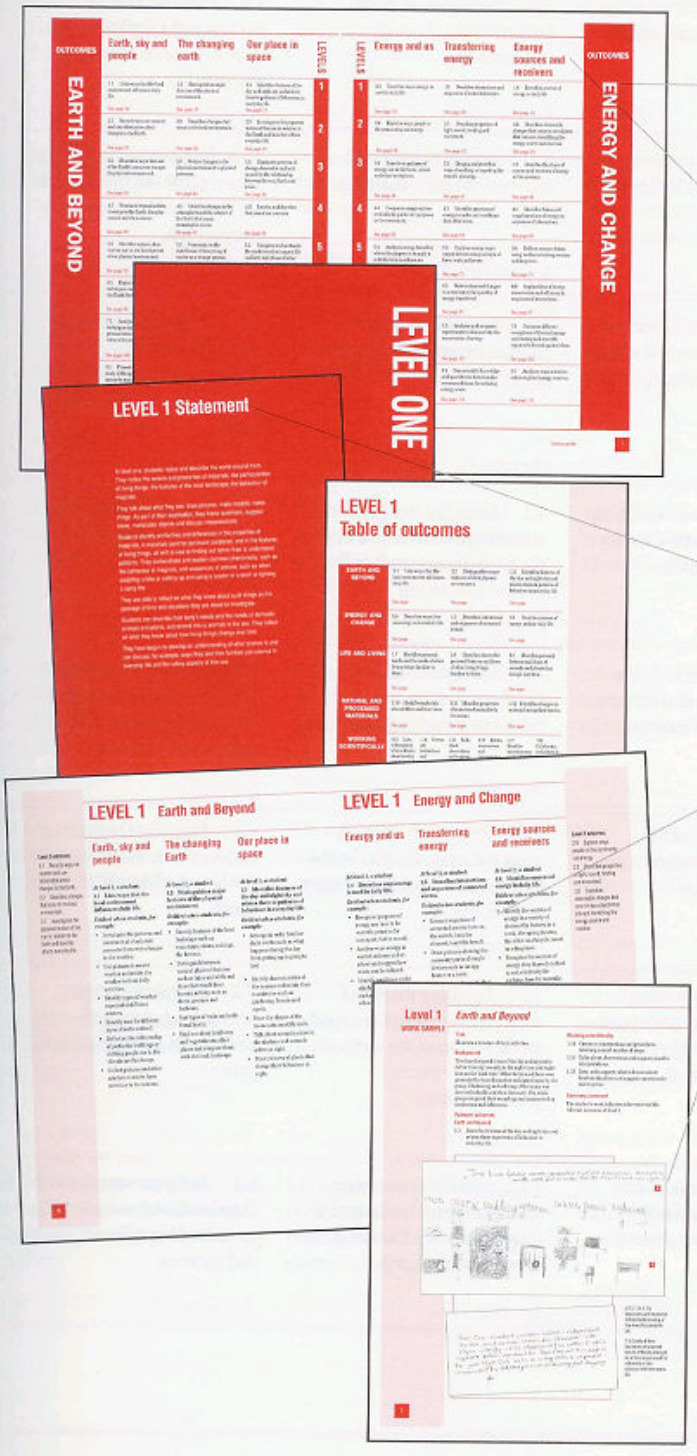
Strand	Organiser	Unifying idea	Examples of content
Earth and beyond	Earth, sky and people	Our lives depend on air, water and materials from the ground; the ways we live depend on landscape, weather and climate.	Management and use of earth materials, earth formations, weather, climate, catastrophic events.
	The changing Earth	The Earth is composed of materials that are altered by forces within and upon its surface.	Origins of rocks, minerals and soils, features of the physical environment, geological processes, weathering, evolution of the Earth, plate tectonics.
	Our place in space	The Earth and life on Earth are part of an immense system called the universe.	Solar system, day and night, seasons; stars, galaxies and constellations, stellar evolution, space travel.
Energy and change	Energy and us	Energy is vital to our existence and our quality of life as individuals and as a society.	Renewable and non-renewable sources, patterns of energy use, energy transformations.
	Transferring energy	Interaction and change involve energy transfers; control of energy transfer enables particular changes to be achieved.	Change and interaction, processes of energy transfer; machines, circuits, optics and other transfer systems; force, work and power.
	Energy sources and receivers	Observed change in an object or system is indicated by the form and amount of energy transferred to or from it.	Forms of energy and the changes they relate to, principles of energy conservation and efficiency.
Life and living	Living together	Organisms in a particular environment are interdependent.	Ecosystems, interrelationships, energy and matter cycles.
	Structure and function	Living things can be understood in terms of functional units and systems.	Functional systems and units, life processes and organisation.
	Biodiversity, change and continuity	Life on Earth has a history of change and disruption, yet continues from generation to generation.	Life cycles, classification, inheritance, reproduction, evolution, extinction.
Natural and processed materials	Materials and their uses	The properties of materials determine their uses; properties can be modified.	Uses and properties of materials, altering materials, making materials.
	Structure and properties	The substructure of materials determines their behaviour and properties.	Structure and behaviour of matter, elements, compounds and mixtures, particle theories of matter.

Strand	Organiser	Unifying idea	Examples of content
	Reactions and change	Patterns of interaction of materials enable us to understand and control those interactions.	Physical and chemical changes, factors affecting rates of change, conservation of matter, manufacturing processes.
Working scientifically	Planning investigations	Working scientifically is a powerful way of generating, understanding and solving problems.	Analysing a situation, defining questions and goals, proposing explanations and solutions, designing tests, considering limitations.
	Conducting investigations		Carrying out procedures, using equipment, observing, gathering information, recording and reporting results.
	Processing data		Interpreting observations, seeing ramifications, identifying patterns, forming generalisations, drawing conclusions, considering accuracy and reliability.
	Evaluating findings		Relating findings to other situations, suggesting improvements to plans, assessing whether purposes have been achieved, relating conclusions to other knowledge.
	Using science		Generating understanding, making connections, explaining, applying ideas and skills; solving problems.
	Acting responsibly		Taking responsible action using science information and skills.

To assist in meeting outcomes and ensure the participation of all students, please note:

- Students with disabilities may need drawing kits,templates,CCTV (closed-circuit TV) and other magnification aids, for example, hand-held magnifier, telescope for distance work.
- Physical help may be needed where tasks include designing, building, modelling, drawing, sorting, collecting.
- Reference to language such as 'discuss', 'describe', 'talk', 'tell', etc. should include all forms of verbal and non-verbal communication, for example, signed communication (Signed English, Auslan) communication aids (boards Compic, Cannon Communicators).
- Students with marked vision impairment may:
  - require materials and books in alternative formats, for example, brailled, taped, large print, raised graphs, tactile diagrams.
  - require sighted assistance when involved in activities such as 'drawing','observing', 'investigating', 'collecting data'.
  - "read" using mediums such as talking books and braille.

Elements of the profile



Strand display

Strands are the major organisers of a learning area. They can be groupings of content, process and/or conceptual understanding. There are five strands in the science profile. These are Earth and beyond, Energy and change, Life and living, Natural and processed materials and Working scientifically.

Strand organisers are organisers of content, process and/or conceptual understanding within a strand. The strand organiser is indicated by the number after the decimal point in the number sequence before each outcome.

Level display

Levels indicate progression in student learning. There are eight levels covering the compulsory years of schooling (Years 1–10). The level is indicated by the number before the decimal point at the beginning of each outcome.

Level statements are general descriptions of student performance at each of the eight levels within the profile.

Outcomes describe in progressive order the various skills and knowledge that students typically acquire as they become more proficient in the area. They are the building blocks of the profile.

Pointers are indicators or signals of the achievement of an outcome. Unlike outcomes, pointers are only examples. Other pointers not mentioned could also indicate achievement of the outcome. Bracketed sections are examples that further develop pointers. The brackets indicate a sample from a larger set of items.

Annotated work samples show student work that demonstrates the achievement of one or more outcomes at a level. The samples are annotated to show the reasons for this judgement.

OUTCOMES

EARTH AND BEYOND

Earth, sky and people	The changing Earth	Our place in space	LEVELS
1.1 Lists ways that the local environment influences daily life. See page 18	1.2 Distinguishes major features of the physical environment. See page 18	1.3 Identifies features of the day and night sky and relates them to patterns of behaviour in everyday life. See page 18	1
2.1 Records ways we monitor and use information about changes to the Earth. See page 32	2.2 Describes changes that occur in the local environment. See page 32	2.3 Investigates the apparent motion of the sun in relation to the Earth and how this affects everyday life. See page 32	2
3.1 Illustrates ways that use of the Earth's resources changes the physical environment. See page 44	3.2 Relates changes in the physical environment to physical processes. See page 44	3.3 Illustrates patterns of change observable on Earth caused by the relationship between the sun, Earth and moon. See page 44	3
4.1 Examines ways scientists investigate the Earth, the solar system and the universe. See page 58	4.2 Identifies changes in the atmosphere and the interior of the Earth that cause catastrophic events. See page 58	4.3 Locates and describes features of our universe. See page 58	4
5.1 Identifies science ideas that we use in the development of our physical environment. See page 70	5.2 Comments on the significance of the cycling of matter as a change process. See page 70	5.3 Compares and contrasts the conditions that support life on Earth with those of other planets and our moon. See page 70	5
6.1 Explains scientific techniques used in monitoring the Earth from space. See page 86	6.2 Prepares evidence to support current theories on the formation and geological history of the Earth. See page 86	6.3 Identifies the stage our sun is at in its evolution and predicts the future of life on Earth. See page 86	6
7.1 Analyses how scientific techniques used to extract and process resources affect the value of the resources. See page 100	7.2 Describes the role of science in assessing the impact on the surface of the Earth of human intervention in particular places. See page 100	7.3 Examines possible scientific solutions to the problems of supporting life in space. See page 100	7
8.1 Presents a critical case study of the application of science to managing a resource. See page 110	8.2 Identifies and explains indirect measurements used to support scientific theories of the structure of the Earth. See page 110	8.3 Analyses ways in which theories of astronomy have contributed to different cultures and societies. See page 110	8

OUTCOMES

ENERGY AND CHANGE

LEVELS	Energy and us	Transferring energy	Energy sources and receivers
1	1.4 Describes ways energy is used in daily life. See page 19	1.5 Describes interactions and sequences of connected events. See page 19	1.6 Identifies sources of energy in daily life. See page 19
2	2.4 Explains ways people in the community use energy. See page 33	2.5 Describes properties of light, sound, heating and movement. See page 33	2.6 Describes observable changes that occur in two objects that interact, identifying the energy source and receiver. See page 33
3	3.4 Reports on patterns of energy use in the home, school and other workplaces. See page 45	3.5 Designs and describes ways of enabling or impeding the transfer of energy. See page 45	3.6 Identifies the chain of sources and receivers of energy within systems. See page 45
4	4.4 Compares energy options available for particular purposes in the community. See page 59	4.5 Identifies processes of energy transfer and conditions that affect them. See page 59	4.6 Identifies forms and transformations of energy in sequences of interactions. See page 59
5	5.4 Analyses energy transfers where the purpose is to apply a suitable force to achieve an outcome. See page 71	5.5 Explains energy input-output devices using concepts of force, work and power. See page 71	5.6 Defines common forces using mathematical expressions and diagrams. See page 71
6	6.4 Describes systems whose purpose is to obtain and transfer information efficiently. See page 87	6.5 Relates observed changes in a receiver to the quantity of energy transferred. See page 87	6.6 Applies ideas of energy conservation and efficiency to sequences of interactions. See page 87
7	7.4 Analyses ways that scientific developments have influenced energy use through the ages. See page 101	7.5 Analyses and compares experiments to demonstrate the conservation of energy. See page 101	7.6 Discusses different conceptions of thermal energy and heating and scientific arguments for and against them. See page 101
8	8.4 Reports on ways that scientific research is addressing questions of energy production and use. See page 111	8.5 Uses scientific knowledge and quantitative data to make recommendations for reducing energy waste. See page 111	8.6 Analyses ways scientists estimate global energy reserves. See page 111

OUTCOMES

LIFE AND LIVING

Living together	Structure and function	Biodiversity, change and continuity	LEVELS
1.7 Identifies personal needs and the needs of other familiar living things. See page 20	1.8 Identifies observable personal features and those of other familiar living things. See page 20	1.9 Identifies personal features and those of animals and plants that change over time. See page 20	1
2.7 Describes the types of relationships between living things. See page 34	2.8 Links observable features to their functions in familiar living things. See page 34	2.9 Compares and contrasts similarities and differences within and between groups of familiar living things. See page 34	2
3.7 Maps relationships between living things in a habitat. See page 46	3.8 Identifies external and internal features of living things that work together to form systems with particular functions. See page 46	3.9 Explains why some living things have become extinct and identifies current endangered species. See page 46	3
4.7 Identifies events that affect balance in an ecosystem. See page 60	4.8 Explains the functioning of systems within living things. See page 60	4.9 Explains how living things have changed over geological time, using evidence from various sources. See page 60	4
5.7 Describes the role of living things in cycling energy and matter. See page 72	5.8 Presents evidence that plants and animals are made up of functional units called cells. See page 72	5.9 Identifies features of groups of living things that enable them to compete successfully in their environments. See page 72	5
6.7 Analyses the effects of environmental change on living things and ecosystems. See page 88	6.8 Explains how living things obtain, store and transport nutrients, transform energy and manage wastes. See page 88	6.9 Describes how genetic continuity is maintained from generation to generation. See page 88	6
7.7 Evaluates scientific evidence about the long-term impact on ecosystems of human intervention. See page 102	7.8 Identifies milestones in the development of our understanding of cell structure and comments on their significance. See page 102	7.9 Outlines evidence for a scientific theory of evolution. See page 102	7
8.7 Identifies the role of scientific disciplines in an interdisciplinary approach to understanding and managing ecosystems. See page 112	8.8 Describes scientific interventions into life processes and assesses their impact. See page 112	8.9 Examines the importance of biodiversity to the survival of life on the planet. See page 112	8

OUTCOMES

NATURAL AND PROCESSED MATERIALS

LEVELS	Materials and their uses	Structure and properties	Reactions and change
1	1.10 Identifies materials and their uses. See page 21	1.11 Identifies properties of materials discernible by the senses. See page 21	1.12 Identifies changes in materials using the senses. See page 21
2	2.10 Lists the ways materials are used for different purposes. See page 35	2.11 Describes the substructure of some common materials. See page 35	2.12 Distinguishes between changes that cannot be readily reversed and those that can. See page 35
3	3.10 Demonstrates how the performance of common materials is altered by combining them with other materials. See page 47	3.11 Makes connections between the structure of common materials and their properties. See page 47	3.12 Illustrates ways natural materials are processed and the consequences for humans and the environment. See page 47
4	4.10 Identifies factors that determine the choice of materials for particular purposes. See page 61	4.11 Uses models of the substructure of materials to explain their properties and behaviour. See page 61	4.12 Recognises and describes conditions that influence reactions and change in materials. See page 61
5	5.10 Assesses the effectiveness of materials used for particular purposes. See page 73	5.11 Uses simple models of atoms to explain chemical reactions. See page 73	5.12 Examines classes of chemical reactions and predicts their applications. See page 73
6	6.10 Describes techniques and underlying principles used in the production of some useful materials. See page 89	6.11 Relates physical and chemical properties to underlying structure within families of chemicals. See page 89	6.12 Identifies and explains chemical reactions important in the environment. See page 89
7	7.10 Analyses scientific approaches to the development and testing of new materials. See page 103	7.11 Identifies landmarks in the identification of elements and patterns in their structure and properties. See page 103	7.12 Uses the properties of reactants to predict the products of unfamiliar chemical reactions. See page 103
8	8.10 Identifies and describes the response of Australian scientists to world demand for materials. See page 113	8.11 Reports on ways scientists have applied their understanding of the substructure of molecules to alter their properties. See page 113	8.12 Reports on scientific approaches to monitoring and improving the quality of air, water, soil and sunlight. See page 113

	Planning investigations	Conducting investigations	Processing data
LEVEL 1	1.13 Lists, with support, what is known about familiar situations and suggests questions for investigation. See page 22	1.14 Carries out instructions and procedures involving a small number of steps. See page 22	1.15 Talks about observations and suggests possible interpretations. See page 22
LEVEL 2	2.13 Formulates questions to guide observation and investigations of familiar situations. See page 36	2.14 Conducts simple tests and describes observations. See page 36	2.15 Identifies patterns and groupings in information to draw conclusions. See page 36
LEVEL 3	3.13 Suggests ways of doing investigations, giving consideration to fairness. See page 48	3.14 Organises and uses equipment to gather and present information. See page 48	3.15 Argues conclusions on the basis of collected information and personal experience. See page 48
LEVEL 4	4.13 Identifies factors to be considered in investigations, controls which may be needed, and ways of achieving control. See page 62	4.14 Collects and records information as accurately as equipment permits and investigation purposes require. See page 62	4.15 Draws conclusions linked to the information gathered and the purposes of the investigation. See page 62
LEVEL 5	5.13 Selects an appropriate pathway for an investigation, given its purposes and the resources available. See page 74	5.14 Uses instruments and techniques to provide accurate and reliable results. See page 74	5.15 Selects ways to present information that clarifies patterns and assists in making generalisations. See page 74
LEVEL 6	6.13 Plans procedures to investigate hypotheses and predictions for situations involving few variables. See page 90	6.14 Selects instruments and techniques to collect useful quantitative and qualitative information. See page 90	6.15 Uses information as a stimulus for further investigation or analysis. See page 90
LEVEL 7	7.13 Identifies advantages and limitations of controlled experiments and describes alternatives. See page 104	7.14 Takes account of the limitations of techniques and instruments and their influence on the accuracy and reliability of an investigation. See page 104	7.15 Identifies the limitations of particular forms of information and analysis. See page 104
LEVEL 8	8.13 Identifies and considers ethical implications of investigative procedures. See page 114	8.14 Assesses dangers in particular procedures and equipment, taking responsibility for their safe and accurate use. See page 114	8.15 Demonstrates rigour in handling of data. See page 114

OUTCOMES

WORKING SCIENTIFICALLY

Evaluating findings	Using science	Acting responsibly
1.16 Relates observations and interpretations to other situations. See page 23	1.17 Identifies ways science is used in daily life. See page 23	1.18 Collaborates with others in the care of living things. See page 23
2.16 Cooperatively suggests possible improvements to investigations in the light of findings. See page 37	2.17 Describes the ways people in the community use science. See page 37	2.18 Explains ways that applications of science protect people. See page 37
3.16 Evaluates the fairness of a test designed and carried out. See page 49	3.17 Compares ways of solving problems and finding explanations. See page 49	3.18 Identifies ways science is used responsibly in the community. See page 49
4.16 Reviews the extent to which conclusions are reasonable answers to the questions asked. See page 63	4.17 Describes techniques used to extend the senses. See page 63	4.18 Identifies the information needed to make decisions about an application of science. See page 63
5.16 Identifies and considers factors that influence confidence in a conclusion. See page 75	5.17 Identifies factors that influence people's perceptions of science. See page 75	5.18 Proposes and compares options when making decisions or taking action. See page 75
6.16 Assesses conclusions in relation to other evidence and sources. See page 91	6.17 Reports on factors that have made possible or limited the work of particular scientists. See page 91	6.18 Analyses costs and benefits of alternative scientific choices about a community problem. See page 91
7.16 Discusses the limitations of conclusions. See page 105	7.17 Analyses the influence certain scientists have had on the ways we think about the world. See page 105	7.18 Reports on actions taken by scientists over concerns about responsible applications of science. See page 105
8.16 Evaluates the implications of investigation for other people and the environment and considers ethical questions. See page 115	8.17 Analyses the interactions between scientific developments and the beliefs and values of society. See page 115	8.18 Identifies and reports on the information needed to make a responsible decision about a scientific endeavour. See page 115