Science (1999)

Years 1 to 10
Sourcebook Guidelines
(Part 3 of 8)

Note: The PDF version of this document has been split into sections for easier download. This file is Part 3 of 8.

Queensland Government
Queensland Studies Authority
Partnership and Innovation

Scope and sequence of learning outcomes

Outcomes approach

An outcomes approach to education defines the end product of education in terms of what it is that students know and are able to do. It is based on a belief that there are certain things that all students should learn and that these things, expressed as outcomes, should be made explicit to all concerned. This approach accepts that learning is progressive, and that stages along a continuum leading to the desired outcome can be identified. It emphasises the provision of developmentally appropriate experiences which give students opportunities to learn, and to demonstrate this learning. This approach places a high importance on real-life, learner-centred contexts, as well as on how and what students learn. These contexts are used to develop the knowledge, processes, skills and attitudes they need for now and, as lifelong learners, for the future.

In an outcomes approach to education, the emphasis is on what students learn, rather than on what they have been taught. Progressive monitoring of students' demonstrated outcomes is fundamental to ensure that curriculum programs can be personalised to meet the particular needs of students, based on their current demonstrations of specific outcomes.

Principles of an outcomes approach

The principles of an outcomes approach include:

- a clear focus on learning outcomes;
- high expectations for all students;
- a focus on development;
- planning curriculum with learners and outcomes in mind;
- expanded opportunities to learn.

Clear focus on learning outcomes

This involves:

- focusing on demonstrations of learning outcomes, rather than on the content being used in the activity;
- students, teachers, parents, carers and appropriate members of the community knowing the outcomes that students are working towards;
- students understanding the reasons for learning what they are learning.

High expectations for all students
This involves:

- recognising that all students can succeed;
- challenging students to achieve high standards by providing experiences that promote learning;
- giving students time to produce work of a high standard;
- establishing clear expectations of student performance, including criteria, and referring to these when monitoring the progress of student learning.

Focus on development
This involves:

- a knowledge of students' progression along the outcomes continuum;
- providing opportunities for self-assessment so that students can monitor their own progress;
- a knowledge of the different preferred learning styles of students;
- the use of a wide range of strategies to cater for the developmental differences and prior knowledge and skills of students;
- building comprehensive and cumulative developmental assessment using the techniques of observation, consultation, focused analysis and peer- or self-assessment to monitor student progress and to facilitate further learning.

Planning curriculum with learners and outcomes in mind
This involves:

- planning assessment at the same time as planning experiences that promote learning;
- using assessment to inform future planning and to provide opportunities to learn;
- planning activities for students that provide them with opportunities to progress and be assessed in their demonstration of outcomes;
- valuing students' backgrounds, interests, prior understandings, experiences and learning styles, and considering these when planning activities;
- recognising the different ways and settings in which learning and assessment take place;
- identifying and overcoming barriers that might limit students or groups of students in their progression and in their demonstrations of outcomes;
- maintaining a learner-centred approach to learning and teaching.

Expanded opportunities to learn
This involves:

- giving students opportunities to progress and to demonstrate core learning outcomes in more than one context;
- developing activities, units and programs that are sufficiently flexible to cater for the different characteristics and learning needs of students;
- involving students in planning, assessment and evaluation processes.

Learning outcomes

Key learning area outcomes

The key learning area outcomes highlight the uniqueness of the Science key learning area and its particular contribution to lifelong learning. During the compulsory years of schooling in the key learning area, students:

- understand and appreciate the evolutionary nature of scientific knowledge;
- understand the nature of science as a human endeavour, its history, its relationship with other human endeavours and its contribution to society;
- understand that scientific knowledge has been organised by the scientific community into disciplines based on recognisable patterns in the phenomena studied;
- apply scientific knowledge to explain and predict events and to reconstruct their understandings of the physical and biological worlds;
- use the practices and dispositions of scientific investigation, reflection and analysis to refine knowledge and pose new questions;
- develop dispositions such as intellectual honesty and commitment to scientific reasoning;
- use scientific language to communicate effectively;
- use decision-making processes that include ethical considerations of the impact of science on people and the environment;
- use the practices and dispositions of 'working scientifically' in all the disciplines of the scientific enterprise.

Strands

The concepts of the key learning area are organised into strands. Each of these strands makes an equivalent contribution to the key learning area. Students develop their understanding of the concepts in the strands throughout the compulsory years of schooling.

The five strands are:

- Science and Society;
- Earth and Beyond;
- Energy and Change;
- Life and Living;
- Natural and Processed Materials.

Science and Society

Science as a 'way of knowing' is shaped by the ways in which humans understand natural phenomena. On the basis of these understandings, humans make decisions about science and its applications have short- and long-term implications for the entire planet.

Students study the relationship between the nature and direction of science and society's perspectives and values. They construct understandings of the manner in which scientific knowledge is developed and the influence of historical and cultural factors on science.

The key concepts of the Science and Society strand are:

- Historical and cultural factors influence the nature and direction of science which, in turn, affects the development of society.
- Science as a 'way of knowing' is shaped by the ways that humans construct their understandings.
- Decisions about the ways that science is applied have short- and long-term implications for the environment, communities and individuals.

Earth and Beyond

The universe, of which the Earth is a part, has many components. Students explore ideas about the dynamic nature of the Earth, solar system and universe. They develop an understanding of the scales of time and space over which events on the Earth and in the universe occur. They investigate the many ways in which living things use the Earth, solar system and universe as resources and recognise the effects of this use.

The key concepts of the Earth and Beyond strand are:

- The Earth, solar system and universe are dynamic systems.
- Events on Earth, in the solar system and in the universe occur on different scales of time and space.
- Living things use the resources of the Earth, solar system and universe to meet their needs.

Energy and Change

Our world has been moulded by forces which influence the motion, shape, behaviour and energy of objects. The efficient control of energy transfer and transformation is integral to the organisation and development of life.

Students explore the effects of forces in their lives. They consider methods of harnessing energy, the way energy is used, and the social and environmental consequences of energy use.

The key concepts of the Energy and Change strand are:

- The forces acting on objects influence their motion, shape, behaviour and energy.
- In interactions and changes, energy is transferred and transformed but is not created or destroyed.
- There are different ways of obtaining and utilising energy and these have different consequences.

Life and Living

Living things have great diversity of structure and lifestyle; they interact with each other and with the world in which they live.

Students collect information about the ways organisms live in order to develop an understanding of those structures which enable living things to function effectively in their environments. Students identify patterns of interactions within environments. They recognise that these interactions contribute to the dynamics of environments.

The key concepts of the Life and Living strand are:

- The characteristics of an organism and its functioning are interrelated.
- Evolutionary processes have given rise to a diversity of living things which can be grouped according to their characteristics.
- Environments are dynamic and have living and non-living components which interact.

Natural and Processed Materials
Properties of materials are determined by their underlying structure. Materials can be grouped according to different properties.

Students study the ideas that scientists have about the structure of materials. They investigate the properties of materials, how these properties can be changed, and the effect of changes on the usefulness of materials. They interpret data on factors which affect the rate at which materials react.

The key concepts of the Natural and Processed Materials strand are:

- The properties and structure of materials are interrelated.
- Patterns of interactions between materials can be identified and used to predict and control further interactions.
- The uses of materials are determined by their properties, some of which can be changed.

Levels

The levels outlined on the following pages indicate progressions of increasing sophistication and complexity in learning outcomes. A level statement is included for each level of each strand of the syllabus. The level statement summarises learning outcomes at each level and provides the conceptual framework for developing activities through which students can demonstrate the core and discretionary learning outcomes.

Within the scope of the outcomes, there is a sense of sequencing from a fundamental understanding through to a high-order demonstration of the knowledge, practices and dispositions of science. There is a progression from:

- novice to expert;
- familiar context to unfamiliar context;
- self to community;
- concrete to abstract;
- consideration of a single aspect to consideration of multiple aspects;
- simple to complex concepts;
- far past to immediate time and from present time to far future time;
- immediate location or circumstance to a distant location or circumstance.

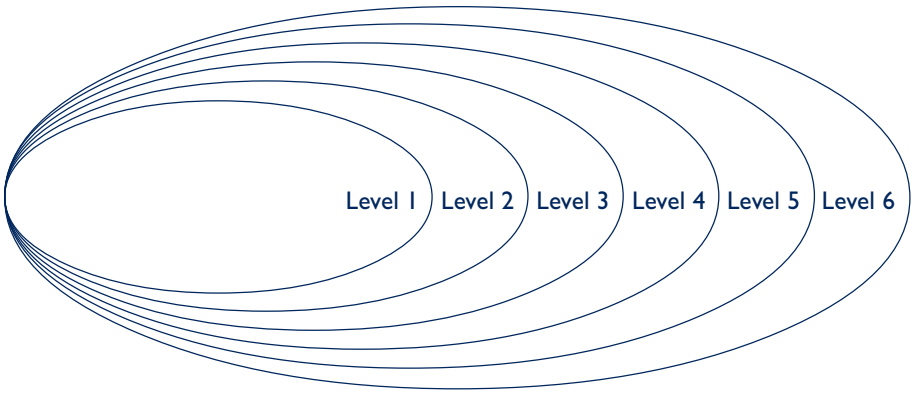
Core and discretionary learning outcomes

Core and discretionary learning outcomes describe what students know and can do with what they know. The core and discretionary learning outcomes in the Science syllabus are organised according to the five concept strands of the Science key learning area. The core learning outcomes are sequenced conceptually in six progressive levels along a continuum, and the discretionary outcomes into seven levels.

The conceptual dimensions of the core learning outcomes are elaborated in the core content of the strands, while the 'doing' or processes dimension of the core and discretionary outcomes is elaborated in the 'Working scientifically' section of the syllabus (pp. 32–33).

Three core learning outcomes are described for each level of each strand — one for each key concept for each strand. The core learning outcomes allow a wide range of approaches to learning and teaching to cater for diverse student needs.

Each corresponding learning outcome requires, at each subsequent level, an increasing sophistication and complexity of conceptual understanding and ability to use the components of 'working scientifically' — there is a sequencing from level to level. The sequencing of core learning outcomes is such that each level is 'nested' within the level above it, as shown in the following diagram.



Progression of conceptual development of outcomes

Elaborations of core learning outcomes

Levels 1–6

The tables on pp. 16–30 contain elaborations to help teachers understand the intent of core learning outcomes. They suggest possible content and contexts through which students might demonstrate core learning outcomes. These elaborations have informed the development of the activities in the modules.

Foundation Level

The level statements at Foundation Level (see Appendix 1) have been developed for students demonstrating a level of understanding before that of Level 1. These statements can be used to develop specific learning outcomes that are tailored to the individual needs of students with disabilities and learning difficulties and related to their individualised curriculum programs.

Appendix 1 provides examples of learning outcomes for Foundation Level. They have been developed from the level statements of the syllabus and are included to assist teachers to develop specific outcomes for students who are unable to demonstrate outcomes from other levels of the syllabus. The examples of outcomes are intended to be personalised to meet the specific needs of individual students.

The examples of Foundation Level learning outcomes link with the sequence of core learning outcomes in Levels 1–6. For example, the first example outcome at the Foundation Level (F.1) aligns with the first core learning outcome at Level 1 (1.1) in each of the respective strands. The second example outcome at the Foundation Level (F.2) aligns with the second core learning outcome at Level 1 (1.2), and so on.

Foundation Level	→ Level 1	→ Level 2	→ Level 3
F.1	→ 1.1	→ 2.1	→ 3.1
F.2	→ 1.2	→ 2.2	→ 3.2

Sequence of core learning outcomes with elaborations for Levels 1–6

The tables on pp. 16–30 present elaborations of each core learning outcome in sequence from Level 1 through to Level 6. This presentation shows how the conceptual understandings become broader, deeper and more sophisticated at each successive level.

Sequence of core learning outcomes with elaborations

Science and Society

Historical and cultural factors influence the nature and direction of science which, in turn, affects the development of society.

1.1 *Students discuss their own thinking about natural phenomena.*	***2.1*** *Students discuss their own ideas about the ways in which science can be described and compare their ideas with those of others.*
Different ideas about natural phenomena: • comparing ideas • discussing why there are different ideas **Natural phenomena for example:** • sunrise/sunset • stars • weather — wind and rain • floating and sinking • where food comes from — milk, sugar, fruit and vegetables	**Descriptions of science and scientists in the media:** • television, film and video • stereotypes of science and scientists **Scientists in the local area:** • medical laboratories • mines • food processing and testing **How people learn about phenomena:** • oral history, stories • authority sources • trial and error; experimentation • traditional, cultural and religious practices

Science as a 'way of knowing' is shaped by the way humans construct their understandings.

1.2 *Students collect information about natural phenomena and recognise that some ways of collecting information are more appropriate than others in different situations.*	***2.2*** *Students identify some ways scientists think and work.*
Different ways of collecting information: • senses • text — books, electronic resources, magazines, newspaper articles • discussion • experimentation • resource people — librarian, education officer **Considerations affecting choice of method:** • safety • availability of resources, equipment	**Ways scientists think and work:** • experimenting, observing, questioning, intuition and hunches • problem solving, decision making • fields of work — research, technical • work locations — laboratory, field, industry, school, home • 'working scientifically' — investigating, understanding, communicating

Decisions about the ways that science is applied have short- and long-term implications for the environment, communities and individuals.

1.3 *Students illustrate different ways that applications of science affect their daily lives.*	***2.3*** *Students explain some of the ways that applications of science affect their community.*
Examples of applications of science in daily life: • providing electrical energy — cooking, entertainment (TV, film, computers, music) • clothing — manufacture, synthetic fibres • in the garden — chemical and organic fertilisers, how and where to grow plants • cleaning products — soap and detergent, toothpaste	**Ways that applications of science affect the community:** • food production and packaging • diagnosis and treatment of illness and disease • improved forms of transport — quicker, more environmentally friendly • local industry — mining, chemical manufacture, agriculture • changes in community as a result of computer technology • recreation — chemicals in swimming pools, streamlining of water sports equipment

Sequence of core learning outcomes with elaborations

Science and Society

Historical and cultural factors influence the nature and direction of science which, in turn, affects the development of society.

3.1 *Students relate some of the ways that people of various historical and cultural backgrounds construct and communicate their understandings of the same natural phenomena.*	***4.1*** *Students outline some contributions to the development of scientific ideas made by people from different cultural and historical backgrounds.*
Different ways of constructing and communicating understanding: • approaches of different cultural groups to problem solving • different beliefs about the formation of the Earth which stem from traditions, religious beliefs, superstitions • naming of stars and constellations by different cultural groups • ways different cultures use natural resources to meet their needs — food, clothing, shelter, medication • use of story, dance, ritual	**Value of traditional science:** • medicines • oral traditions, including Dreamtime stories • use of astronomy — Incas, Chinese **Chinese science:** • medicine • gunpowder • paper • ceramics **Western scientific tradition:** • ancient Greeks • alchemists • influential scientists, including women • organisation into disciplines

Science as a 'way of knowing' is shaped by the way humans construct their understandings.

3.2 *Students recognise the need for quantitative data when describing natural phenomena.*	***4.2*** *Students use the elements of a fair test when considering the design of their investigations.*
Importance of quantitative data: • difference between quantitative and qualitative data • communication of information • comparison — not open to personal opinion **Collection of quantitative data:** • measurement • use of appropriate tools for taking different measurements — telescope, microscope, meters, gauges • correct use and care of tools • appropriate display of data for identification of patterns • need to repeat experiments	**Elements of a fair test:** • develop a researchable question • dependent and independent variables • control of variables — only one changes • measurement of change • presentation of results to suit different purposes

Decisions about the ways that science is applied have short- and long-term implications for the environment, communities and individuals.

3.3 *Students make predictions about the immediate impact of some applications of science on their own community and environment, and consider possible pollution and public health effects.*	***4.3*** *Students present analyses of the short- and long-term effects of some of the ways in which science is used.*
Impact of applications of science on the community: • changed disease patterns — immunisation, health awareness, improved hygiene • water treatment • local industry practices — air and water quality, cost of products to the consumer • packaging of materials — more environmentally friendly, easier to use, child-safe, cost of products to the consumer • impact on building — research leads to changed approaches and better materials • caring for the environment — breeding threatened species, conserving areas where threatened species live	**Short-term effects:** • improved products for the consumer; cost of products for the consumer • improved lifestyle and medical care • greater security • pollution and habitat loss • production of non-biodegradable items • increased toxicity in plants and animals • greater understanding of processes occurring on Earth and in the universe • alternative ways of using and conserving non-renewable resources **Long-term effects:** • greenhouse effect, ozone depletion, reduced biodiversity, depletion of non-renewable resources • many long-term effects unknown

Sequence of core learning outcomes with elaborations

Science and Society

Historical and cultural factors influence the nature and direction of science which, in turn, affects the development of society.

5.1 *Students consider how and why scientific ideas have changed over time.*	***6.1*** *Students evaluate contributions to the development of scientific ideas made by individuals and groups in the past and present, and consider factors which have assisted or hindered them.*
Changes in scientific ideas over time: • disease — causes and treatment • structure of the Earth • organisation of the solar system • origin of life on Earth • structure of the atom **Why scientific ideas change:** • improved technology for collecting and interpreting information — telescopes, microscopes, computers, probes, lasers • improved approaches to investigations — controlled experiments, validity, reliability	**Societal constraints on the acceptance of theories:** • Darwin — evolution by natural selection • Copernicus, Galileo, Brahe, Kepler — relationships in the solar system **Ethical issues:** • reproductive technologies, genetic manipulation • production of chemicals and wastes • use of uranium and other sources of nuclear energy **Research funding:** • societal and political influences • role of lobby groups — conservationists **Influence of media:** • impact on the public view of science

Science as a 'way of knowing' is shaped by the way humans construct their understandings.

5.2 *Students refine investigations after evaluating variations and inconsistencies in experimental findings.*	***6.2*** *Students design and perform controlled investigations to produce believable evidence.*
Using variations and inconsistencies in experimental findings to identify: • sources of error • lack of precision • inappropriate use of tools • lack of evidence in support of hypotheses **In light of the above, suggest changes to:** • hypotheses being tested • experimental design • type of equipment used and how it is used • how data may be displayed to highlight patterns	**Consideration of the elements of design:** • hypothesising • controlling variables • measurement techniques • data recording techniques **Analysis of results:** • reliability and validity • identification of sources of error • supporting evidence for hypotheses • further investigation pathways

Decisions about the ways that science is applied have short- and long-term implications for the environment, communities and individuals.

5.3 *Students analyse relationships between social attitudes and decisions about the applications of science.*	***6.3*** *Students use scientific concepts to evaluate the costs and benefits of applications of science (including agricultural and industrial practices).*
Green movement: • awareness of environmental concerns • community action — Clean up Australia • pressure on industry to change practices • global action — to reduce CFC and CO_2 emissions **Affluence of Western society:** • increased demand for consumer goods • increased awareness of health issues • urbanisation — pressure on environment and available space **Global economy:** • optical fibre technology, instant communication • electronic age • worldwide transport of food **Ethical and moral concerns:** • genetic and reproductive technologies • organ transplant technology	**Needs and wants of societies:** • consumer society • affluence and the demand for luxury • increasing gap between Western and third world nations **Agricultural practices:** • increased food production • pollution and habitat destruction/degradation **Industrial practices:** • treatment and re-use of water • 'scrubbing' of air before release • waste treatment • recycling • research into environmentally friendly products **Medicine:** • reduced illness and death due to immunisation • cost of an ageing population • changed disease patterns due to affluent society

Sequence of core learning outcomes with elaborations

Earth and Beyond

The Earth, solar system and universe are dynamic systems.

1.1 *Students identify and describe obvious features of the Earth and sky (including landforms and clouds).*	***2.1*** *Students identify and describe changes in the obvious features of the Earth and sky (including changes in the appearance of the moon).*
Features of the Earth: • land — soil, rocks, mountains, beaches, playgrounds, farms • bodies of water — rivers, oceans, dams, lakes; tides, currents, wave action • air — winds, clouds • ice — glaciers, icebergs • built environment **Features of the sky:** • sun, moon, stars, star groups • sky colours, amount of light, shadows	**Changes in features of the Earth:** • land — rearrangement, movement, submersion of soil, rocks, sand • waterways — rise and fall, change in direction of flow of water • air — cloud size and movement, wind direction and magnitude • seasons, climate, weather **Changes in features of the sky:** • sun — time and position of sunrise and sunset at different times of the year • colour changes; day, night • moon — appearance, when and where • position of stars and star groups • eclipses

Events on Earth, in the solar system and in the universe occur on different scales of time and space.

1.2 *Students describe obvious events (including day and night) that occur on the Earth and in the sky.*	***2.2*** *Students identify and describe short- and longer-term patterns of events (including weather and seasons) that occur on the Earth and in the sky.*
Obvious events on the Earth and in the sky: • changes to land, water and air • changes to built environment • day and night • visibility of sun and stars • colour of the sky • temperature and winds • animal activity	**Patterns of events on the Earth:** • weather, climate, seasons • activity of plants and animals • fires • storms • erosion • tidal changes **Patterns of events in the sky:** • when and where objects are visible — sun, moon, stars and star groups • daily and longer changes in direction and time that objects are visible • sunrise, sunset

Living things use the resources of the Earth, solar system and universe to meet their needs.

1.3 *Students discuss the uses they make and the care they take of the Earth.*	***2.3*** *Students discuss how their community uses resources and features of the Earth and sky.*
Using and caring for: • own home and yard, schoolyard, local waterways, parks and other places visited by - walking in designated areas - disposing of wastes appropriately - taking care of plants and animals	**Use of resources and features of the Earth:** • playgrounds, public spaces, schoolyards, backyards, waterways, farms, forests, built environment • winds and clouds — predicting weather changes • air — hang gliding, parachuting, transport, aerial spraying **Use of features of the sky:** • navigation • appreciation of its beauty **Use of Earth's resources by living things:** • food, water, air, living space

Sequence of core learning outcomes with elaborations

Earth and Beyond

The Earth, solar system and universe are dynamic systems.

3.1 *Students identify and describe some interactions (including weathering and erosion) that occur within systems on Earth and beyond.*	***4.1*** *Students recognise and analyse some interactions (including the weather) between systems of Earth and beyond.*
Interactions within Earth systems: • layers of the Earth — lithosphere, hydrosphere, atmosphere • rock cycle, water cycle • weather cycles, seasonal changes • weathering, corrosion, erosion, soil formation • volcanoes, earthquakes **Interactions within systems beyond Earth:** • interactions in the solar system — orbits; day and night; moon phases; meteors, comets, satellites, telescopes • interactions within star systems — galaxies, constellations	**Some interactions between systems of the Earth:** • between atmosphere, water and land — weather, water cycle • between land and water — weathering, erosion, mountain building, changing course of rivers, formation of rocks (sedimentary, metamorphic, igneous) **Some interactions between systems beyond Earth:** • between Earth, moon and sun — moon phases, tides, eclipses, day, night, seasons • interactions in the solar system — orbits, rotations • asteroids, meteors, comets • space exploration

Events on Earth, in the solar system and in the universe occur on different scales of time and space.

3.2 *Students discuss regular and irregular events in time and space that occur on the Earth and in the sky.*	***4.2*** *Students collect information which illustrates that changes on Earth and in the solar system occur on different scales of time and space.*
Regular events on Earth and in the sky: • daily, seasonal and yearly cycles of change • weathering and erosion cycles • effect of sun's radiation on all its planets • cycles of levels of moonlight and effect on nocturnal vision • hourly and yearly changes in position of sun, constellations • meteor showers, comets **Irregular events on Earth and in the sky:** • earthquake — compare site of epicentre to total area affected • volcanic eruption — compare location of volcano to area affected, distant sky coloration • rainfall or cyclone — compare local area to total area affected • sunset coloration caused by distant fires • asteroid movements in the vicinity of planets and moons • supernovas, exploding stars	**Changes occurring on different scales of time and space:** • sites and rates of erosion compared to the sites and rates of rock formation • timelines involved in various erosion and deposition processes — the rock cycle • catastrophic events (volcanic eruptions, earthquakes, flooding, tsunamis) and size of affected areas • movement of pollutants • magnitude of atmospheric events — storms compared to cyclones • climatic changes, rainfall and temperature patterns, El Niño and La Niña • continental drift • time space probes take to pass various bodies • times for revolutions and rotations

Living things use the resources of the Earth, solar system and universe to meet their needs.

3.3 *Students collect information which describes ways in which living things use the Earth and the sun as resources.*	***4.3*** *Students summarise information to compare ways in which different communities use resources from the Earth and beyond.*
Human use of the Earth's resources: • building and art materials, ores for minerals and jewellery • fossil fuels, soil • water for irrigation, households, industry, transport and recreation **Use of the sun by all living things:** • light, warmth, energy • telling time and direction • navigation, photosynthesis, signal to begin particular activities, drives water cycle	**Community use of Earth's resources:** • making bricks, dyes, petrochemical products, pottery • extracting products from ores, fossil fuels • using waterways — transport, irrigation, washing, bathing, town water supplies, recreation • farming, recreation, forestry • use of land and water **Community use of resources from beyond:** • sun's radiation • navigation using sun and stars • yearly calendar, time of day, omens • to determine crop plantings and harvesting • festivals and religious events • information from the universe

Sequence of core learning outcomes with elaborations

Earth and Beyond

The Earth, solar system and universe are dynamic systems.

5.1 *Students explain how present-day features and events can be used to make inferences about past events and changes in Earth and beyond.*	***6.1*** *Students use scientific ideas and theories about interactions within and between systems of the Earth and beyond to explain past and present features and events.*
Present-day features and events: • Earth's crust, mantle and core; conduction and convection currents • earthquake and volcanic activity, ocean trenches • fossils, sedimentary layers • rock types and their location • location of ore bodies, coal seams • distribution of plant and animal species • climatic similarities and differences **Inferences about past events:** • folding and faulting • birth and death of stars • meteorite collisions with Earth and moon • continental drift • earthquake and volcanic activity	**Ideas and theories to explain:** • rock types, ores, land and water features in a particular place • eclipses • composition, weather and climatic features of planets and their moons • location of fossils • origin of the universe • nebulae • magnetic alignment of crystals within rocks of various ages • angles of axis and directions of rotation of the planets and the moon **Scientific ideas and theories:** • plate tectonics • 'big bang' theory • 'steady state' theory

Events on Earth, in the solar system and in the universe occur on different scales of time and space.

5.2 *Students infer from data that the events that occur on Earth and in the solar system can have effects at other times and in other places.*	***6.2*** *Students use scientific ideas about the Earth and components of the universe to explain how events over time and in space can lead to catastrophic changes.*
Earth data: • build-ups in Earth's crust • plate tectonics • land slippages • volcanic build-ups • weather fronts • El Niño and La Niña • climatic changes • erosion and deposition • pollution — place and time of origin compared to area affected and time of effect **Solar system data:** • solar flares and communication interference	**Earth:** • earthquakes • droughts • floods • El Niño, La Niña • meteorite collisions • changes to Earth's crust • ice ages • rises and falls of oceans • continental drift • global warming **Other systems:** • birth and death of stars • meteorite collisions with other planets • collision of galaxies • collision between Earth and moon

Living things use the resources of the Earth, solar system and universe to meet their needs.

5.3 *Students prepare scenarios about the use of renewable and non-renewable resources of the Earth and beyond.*	***6.3*** *Students argue a position regarding stewardship of the Earth and beyond, and consider the implications of using renewable and non-renewable resources.*
Significance of using renewable resources: • should not run out — water, air • quality can deteriorate • inequitable distribution on Earth and amongst people • needed by other living things **Significance of using non-renewable resources:** • will run out — fossil fuels, ores • impact of collecting and transporting • alternative uses • inequitable distribution on Earth and amongst people **Using information about the universe:** • to determine present and past events • to predict events, to prepare for further exploration	**Implications of using renewable resources:** • emission of particles and CO_2, pollution • overharvesting, for recreation • effects on interactions occurring in land, water, air systems **Implications of using non-renewable resources:** • accidents during mining and transport • dwindling supplies • competing interests of miners, industry, farmers, recreational users and indigenous peoples • extracting and refining — pollution, environmental damage **Visiting or colonising other planets:** • life supplies, timelines, protection • feasibility of colonisation, potential benefits

Sequence of core learning outcomes with elaborations

Energy and Change

The forces acting on objects influence their motion, shape, behaviour and energy.

1.1 *Students collect information about the ways that objects of different shapes and sizes move.*	***2.1*** *Students demonstrate different ways that forces (including push and pull) change the shape and motion of objects.*
Ways that different objects move: • slip, slide • grip, stick • roll, tumble, fall • flow, float, fly, sink • spin, bounce, shake **What affects the ways things move:** • size, shape • texture • mass — heavy, light • different surfaces	**Different ways forces can be used to change shape and motion of objects:** • dropping, throwing • pushing, pulling • squeezing, stretching, twisting • colliding • propelling **Factors which can affect motion and shape of objects:** • size, shape • texture • mass — heavy, light • different surfaces • size of force

In interactions and changes, energy is transferred and transformed but is not created or destroyed.

1.2 *Students identify the effects of energy in their daily lives.*	***2.2*** *Students identify and describe forms of energy in their community (including heat and energy of movement).*
Experiences and observations to raise awareness of the presence of energy: • rubbing hands together warms them • hair moves when near a fan • feeling hot when running around • plucking guitar strings makes musical sounds • putting an egg in boiling water cooks it	**Exploration of students' own concepts of different energy forms — electricity, light, heat, movement, sound:** • different ways of making a golf ball or balloon move • produce and describe different types of sound and different coloured light • sources of heat in the home • ways to control heating and cooling in the home • sources of heat — fuels, friction • items in the classroom that use electrical energy • sources of sound — doorbells, musical instruments, various objects in the school • animals use light to see

There are different ways of obtaining and utilising energy and these have different consequences.

1.3 *Students make links between the way they use energy and the immediate source of that energy.*	***2.3*** *Students illustrate the ways that energy is used in their community.*
Links between immediate source and the way energy is used: • a light works when you turn on the switch • a car works when you put petrol in it • energy needed to walk to school or play sport • battery in a torch • spring in a toy • electricity needed to make the toaster work • heat needed to cook food	**Uses of energy in the community:** • cars, trucks, boats, planes require fuel to move • electricity in shops, factories, dentists' surgeries and for street lighting • sounds • heating in the home — oven, kettle • different ways people use solar energy — drying clothes, heating water in the home, growing plants

Sequence of core learning outcomes with elaborations

Energy and Change

The forces acting on objects influence their motion, shape, behaviour and energy.

3.1 *Students collect data and make and test inferences to describe the effects of forces (including magnetic and electrostatic forces) on the motion and shape of objects.*	***4.1*** *Students design and perform investigations into relationships between forces, motion and energy.*
Effects of forces: • attraction and repulsion caused by magnetic forces • electrostatic forces created by rubbing some non-metals with different fabrics • influence of magnetic forces on electric current • motion and shape of objects affected by gravitational forces — falling raindrops, planes • forces operating in liquids — floating, sinking • forces operating in simple machines • friction • cohesive and adhesive forces	**Relationships between forces, motion and energy:** • seesaws • machines • floating, sinking • flight, space travel • gravity • electromagnetism • friction • static situations — holding a bag of groceries, building dams, preventing a bus from toppling

In interactions and changes, energy is transferred and transformed but is not created or destroyed.

3.2 *Students identify forms of energy (including electrical and sound energy) and describe the effects and characteristics of those different forms.*	***4.2*** *Students collect and present information about the transfer and transformation of energy (including potential and kinetic energy).*
Characteristics and effects of different forms of energy: • pushing a bike causes movement • water can be heated • musical instruments • wind-up toys, electrical appliances • circuits, batteries • insulation affects the rate at which ice melts • bouncing balls, elastic bands, springs • sound — vibration, volume, pitch, frequency, echo • food as a form of chemical energy • effects of applying heat to different substances — wax, plastic, plant or animal tissue	**Types of energy:** • potential energy • kinetic energy **Transformation of types of energy:** • kinetic, chemical, heat to electrical • electrical to kinetic, sound and heat **Energy transfer from one substance to another:** • light transfer through different media — rainbows • reflection and refraction of light • absorption and transmission • conduction and convection of heat • conduction of electricity **Energy converters:** • in the home — appliances • in industry • in the biological world — plants, animals

There are different ways of obtaining and utilising energy and these have different consequences.

3.3 *Students identify different ways of obtaining energy.*	***4.3*** *Students present alternative ways of obtaining and using energy (including energy from the sun and from fossil fuels) for particular purposes.*
Types and sources of energy: • water, wind, fossil fuels, the sun • geothermal, electrostatic, nuclear generators • power stations • batteries (and associated circuits), generators **Energy storage:** • hydro-electric dams, batteries, food	**Alternative ways of obtaining or harnessing energy:** • fossil fuels • hydro-electric • wind, geothermal • solar, nuclear **Alternative ways of using energy:** • generating electrical energy, transport • heating, cooling • communications **Reasons for use of particular energy forms in particular ways:** • cost, convenience • environmental effects • renewability, energy conservation

Sequence of core learning outcomes with elaborations

Energy and Change

The forces acting on objects influence their motion, shape, behaviour and energy.

5.1 *Students analyse situations where various forces (including balanced and unbalanced forces) act on objects.*	***6.1*** *Students use scientific ideas of motion (including action and reaction) to explain everyday experiences.*
Forces acting on objects: • balanced and unbalanced forces • action and reaction **Identifying forces and energy transfers:** • pushes, pulls, collisions • machines • floating, sinking • flight, space travel • electromagnetism, electric circuits • static situations — holding a bag of groceries, preventing a bus from toppling • road cambers and vehicles going around corners	**Scientific ideas of motion:** • Newton's laws — balanced and unbalanced forces, action and reaction • inertia, momentum • speed, velocity, acceleration • mathematical expressions of relationships between force and motion and energy and work **Using scientific ideas of motion to explain everyday experiences:** • use of machines, flight, floating and sinking • space travel, electric circuits, skate boards **Efficiency:** • achieving changes in motion — setting up reaction forces, depending on friction • using machines to obtain greater forces • perpetual motion machines and why they don't work

In interactions and changes, energy is transferred and transformed but is not created or destroyed.

5.2 *Students explain how energy is transferred and transformed (including energy transfer by convection and conduction).*	***6.2*** *Students model and analyse applications of energy transfer and transformation.*
Explanations of ways energy is transferred and transformed: • why copper is a better conductor of electricity than is plastic • why birds fluff their feathers to keep warm • how colour and texture affect insulation from, and absorption of, heat, sound and light • the series of changes that occur as food is converted to energy for use by muscles which produce movement • use of mirrors and lenses in industry, medicine and space exploration • kinetic energy transferred through pushes, pulls and collisions • transfer of sound — string telephones, vibrations • energy transfers in an electric circuit	**Energy transfer used to achieve desired outcomes:** • use of electricity to create a permanent magnet • use of wind generators to convert kinetic energy into electricity • energy transfers in distribution of electricity —power station to end use • calculation of V, I, R, P in simple circuits • use of digital and analog electrical signals in telecommunications and home entertainment • use of X-rays, lasers and ultrasound in industry and medicine **Using concepts related to energy transfer:** • relationship between energy and work • efficiency of machines • how factors affecting friction influence design of machines • conservation of energy — pendulums, roller coasters

There are different ways of obtaining and utilising energy and these have different consequences.

5.3 *Students discuss the consequences of different ways of obtaining and using energy (including nuclear energy).*	***6.3*** *Students evaluate the immediate and long-term consequences of different ways of obtaining and using energy.*
Consequences of different ways of obtaining and using energy: • cost, convenience • environmental impact • community priorities — employment • sustainability • energy conservation **Analysis of energy use in the home:** • which appliances use the most energy over time • how use of energy changes from winter to summer	**Efficiency:** • cost of obtaining and using different energy forms • long-term economics of alternative energy sources • short- and long-term environmental impact of alternative energy • feasibility and convenience of alternative energy sources • sustainability of obtaining energy from particular sources • energy conservation, energy storage

Sequence of core learning outcomes with elaborations

Life and Living

The characteristics of an organism and its functioning are interrelated.

1.1 *Students discuss their thinking about needs of living things.*	***2.1*** *Students look for patterns and relationships between the features of different living things and how those living things meet their needs.*
Needs of living things: • animals — food, water, air (oxygen), shelter, suitable temperature • plants — air (oxygen, carbon dioxide), water, nutrients, sunlight, suitable temperature	**Relationships between features and needs being met:** • limbs — food collection, movement, protection • beaks, teeth — feeding, protection • skeleton — support, protection • body covering — protection, temperature control, camouflage • sense organs — finding food, water; avoiding harm; communicating • behaviour — nocturnal or diurnal, hibernation, care of young; deciduous or evergreen • roots — taking in water, nutrients • leaves — taking in sunlight, gases • flowers, cones, seeds — reproduction

Evolutionary processes have given rise to a diversity of living things which can be grouped according to their characteristics.

1.2 *Students group living things in different ways based on observable features.*	***2.2*** *Students illustrate changes which take place in the course of the life span of living things (including the growth of a plant and an animal).*
Grouping of living versus non-living based on: • growth, movement, respiration, sensitivity, reproduction, excretion, nutrition **Grouping of animals versus plants based on:** • method of obtaining food; method of obtaining air (oxygen) **Grouping of plants and animals based on:** • body covering, type and number of limbs, method of feeding, type of skeleton • flowers, cones, leaves, woody, herbaceous, height	**Changes in living things during their life span:** • growth, change in size and shape • change in colour • loss of leaves, hair • fruiting, flowering • germination of seeds • failing eyesight, loss of hearing • ageing, wrinkling of skin • wilting, withering • producing young, offspring • death

Environments are dynamic and have living and non-living components which interact.

1.3 *Students observe and describe components of familiar environments.*	***2.3*** *Students make links between different features of the environment and the specific needs of living things.*
Components of the environment: • living parts — plants and animals • physical parts — water, air, light, temperature • features — soil types, rocks, rivers, lakes, forests, deserts, mountains, scrub, fields **Different types of environment:** • aquatic and terrestrial • rainforest — many different animals and plants; humid; low light • arid — dry; high light; little water • city — buildings; numerous people • agricultural — single type of plant in a crop	**Components of the environment and supplying needs:** • food — from other living things • air — for both plants and animals • shelter — in trees, in bark, under rocks; nests, burrows • water — from the ground, bodies of water • sunlight — for plants • temperature — ways of keeping warm or cool

Sequence of core learning outcomes with elaborations

Life and Living

The characteristics of an organism and its functioning are interrelated.

3.1 *Students draw conclusions about the relationship between features of living things and the environments in which they live.*	***4.1*** *Students examine the internal and external structure of living things (including animal respiratory systems and plant systems) and account for observed similarities and differences in terms of adaptation.*
Relationship between features and environments: • body covering — long thick hair conserves body warmth in cold climates • beak shapes and type of food eaten • tongue size and shape — long sticky tongue of a frog helps it catch insects • teeth — help animals to eat particular foods • foot shape — wide, spreading toes of wading birds help them to walk in mud • limbs — fins help animals swim • eye and ear shape and size — help animals see and hear in ways which are most useful in their own environment • root types and leaf orientation and shape — big leaves help rainforest trees to get enough light	**Internal and external structures:** • systems, organs, tissues • structures working together — sense organs, nerves, muscles and bones sense and respond (movement) – leaves and roots collect light and water needed for photosynthesis **Similar and different structural adaptations:** • respiratory systems — gills, lungs, skin • digestive systems — long or short intestines • circulatory system — open or closed system • shoot systems — reduced leaves and stems reduce water loss • root systems — food storage (carrots); support; tap or fibrous systems • reproductive mechanisms — plants and animals **Adaptation:** • structural, functional, behavioural features help living things meet needs in their own environment

Evolutionary processes have given rise to a diversity of living things which can be grouped according to their characteristics.

3.2 *Students present information which illustrates stages in different types of life cycles (including metamorphosis) of familiar living things.*	***4.2*** *Students identify and analyse similarities and differences in the ways that different living things reproduce.*
Different types of life cycles: • vegetative reproduction — cuttings, suckers, tubers, bulbs • egg to adult, seed to mature plant • different forms of the same plant or animal — caterpillar and butterfly; tadpole and frog; seed, fruit and adult plant • metamorphosis — insect (caterpillar), frog (tadpole) • baby to adult **Stages in different life cycles:** • egg laying, hatching • larva–pupa–nymph stages • reproductive stages, puberty • germination, pollination	**Similarities and differences in the ways that living things reproduce:** • sexual reproductive systems in different animals and plants • reproductive processes — internal and external fertilisation and development; parental care, courtship; eggs • sex cells and fertilisation in animals and plants • pollen transfer and seed dispersal in plants by wind, water, other organisms • alternation of generations in different plant groups • asexual — vegetative reproduction (cuttings, suckers, tubers, bulbs, runners); budding, binary fission

Environments are dynamic and have living and non-living components which interact.

3.3 *Students describe some interactions (including feeding relationships) between living things and between living and non-living parts of the environment.*	***4.3*** *Students make generalisations about the types of interactions which take place between the living and non-living parts of the environment.*
Interactions between living things: • feeding relationships • living together — communities, mates, families • harmful or helpful **Interactions between living and non-living parts:** • different living things in different climates • living things affected by changes in temperature, availability of water, light, shelter • the environment affected by living things — growth of tall plants may reduce light available to lower-growing plants **Natural changes:** • weathering, erosion • changes in temperature, water availability • volcanic eruptions, fire, drought, earthquake	**Types of interactions between living things:** • food chains and webs — producer, consumer, decomposer • herbivore, carnivore, omnivore • predator–prey; competition • symbiosis — parasitism, mutualism, commensalism • ecosystems — populations, communities **Types of interactions between living and non-living parts:** • adaptations — structural, functional, behavioural • survival after bushfires, volcanoes • nutrient cycles • living things — tolerance limits for external factors **Interactions between non-living parts:** • cycling of water, nutrients • temperature changes and water availability due to weather conditions, seasonal changes, daily changes

Sequence of core learning outcomes with elaborations

Life and Living

The characteristics of an organism and its functioning are interrelated.

5.1 *Students collect information about the structure (including cell structure) and function of living things and relate structure and function to survival.*

Structure and function of animal systems related to survival:
- digestive — changes food into useable form
- circulatory — carries nutrients and oxygen to cells, wastes away from cells; moves heat around body
- excretory — removes harmful wastes
- nervous and endocrine — control functioning

Structure and function of plant systems related to survival:
- shoot systems — photosynthesis; gas exchange for respiration and waste removal
- transport systems — carry water, organic matter, hormones; remove wastes

Cells and survival:
- comparison of animal and plant cell structure
- chemical processes — photosynthesis and respiration

6.1 *Students seek reasons for and can explain why functioning and behaviour change in response to variations in internal and external conditions (including disease, temperature, water and light).*

Changes in functioning and behaviour (homeostasis):
- temperature control in plants and animals
- water and salt balance in plants and animals
- plant response to light intensity and direction
- immune response in animals
- hormonal responses in plants and animals

Internal and external conditions which may affect functioning and behaviour:
- disease-causing pathogens, parasites in plants and animals
- vaccination, prior exposure to pathogens, auto-immunity
- temperature changes in plants and animals
- water and salts in external and internal environment in plants and animals
- lifestyle and diet, heredity

Evolutionary processes have given rise to a diversity of living things which can be grouped according to their characteristics.

5.2 *Students evaluate different processes and strategies of reproduction (including asexual reproduction and care of young) in terms of their relative efficiency in ensuring survival of offspring.*

Evaluation of contribution of asexual vs. sexual reproduction to survival of offspring:
- cell division to produce identical daughter cells vs. producing gametes with different genetic makeup
- fertilisation producing increased genetic variety vs. production of identical offspring
- greater chances of survival if environment changes vs. few or many offspring

Evaluation of contribution of different reproductive strategies to survival of offspring:
- separate sexes vs. hermaphroditism
- courtship behaviours and sex differences — birds, flowers
- internal vs. external fertilisation, eggs, development of young
- degree of development of young and need for nurture and protection
- numbers of offspring — parental care, nurture, protection, chances of survival

6.2 *Students use scientific ideas (including concepts of genetics and natural selection) to explain how variation in living things leads to change in species over time.*

Ideas about genetic variation:
- cell division to produce gametes
- fertilisation — mixing of genetic information produces variety in offspring
- role of chromosomes
- Mendelian genetics — dominant and recessive characteristics, incomplete dominance, sex-linkage
- mutation

Ideas about how genetic variation can lead to change in species over time:
- natural selection leads to change in species characteristics which leads to adaptation — ideas of Darwin and Lamarck
- evidence of evolution and alternative ideas

Environments are dynamic and have living and non-living components which interact.

5.3 *Students evaluate the consequences of interactions between the living and non-living parts of environments.*

Consequences of interactions:
- energy flow — photosynthesis, respiration
- cycling of matter — oxygen, carbon, nitrogen, water
- role of bacteria, decomposition
- variations in temperature, rainfall, soil type, topography, water availability, salt and mineral content of soil and water, food availability
- tolerance limits to variations in physical conditions
- changes in habitat, population numbers, feeding relationships
- weathering and erosion
- pollution, succession

6.3 *Students prepare scenarios to describe the potential long-term effects of changes in biodiversity caused by human action on ecosystems.*

Human actions affecting ecosystems:
- agricultural practices, pest control, plant and animal breeding, introduction of plants and animals, biological control measures
- industry, urbanisation, forestry, tourism
- revegetation, conservation, preservation

Potential effects:
- habitat — modification or destruction
- increased food supply leading to further population growth
- increased awareness of need to protect and maintain genetic variation and biodiversity

Sequence of core learning outcomes with elaborations

Natural and Processed Materials

The properties and structure of materials are interrelated.

1.1 *Students describe observable properties of familiar materials, including solids and liquids.*	***2.1*** *Students group materials on the basis of properties (including solubility, texture and hardness).*
Observable properties: • visual — shape, colour; transparent, translucent, opaque • tactile — flexibility, rigidity, texture, shape, softness, hardness; liquid, solid, heavy, light • olfactory • taste • auditory — tone, volume **Familiar materials:** • water, playdough, paper • food, plastics, wood • fabrics, metals, sand	**Group according to properties such as:** • solubility in water • lustre, colour, texture • transparent, translucent, opaque • flexibility, rigidity, elasticity, strength • softness, hardness • heavy, light; floats, sinks • solid, liquid, gas • magnetic, non-magnetic • odour, taste **Materials:** • water, playdough, paper, food, plastic • wood, fabrics, metal, sand

Patterns of interaction between materials can be identified and used to predict and control further interactions.

1.2 *Students describe observable changes (including change of state) that occur in materials.*	***2.2*** *Students recognise ways in which changes in properties of familiar materials occur (including temperature change and magnetism).*
Familiar materials: • eggs, pikelets • ice, water, steam • sugar, salt • playdough **Observable changes:** • coagulates, cooks • melts, solidifies • evaporates, condenses, freezes, melts • dissolves • change of shape • change of sound • change of colour • change of texture	**Familiar materials:** • glass, wood, playdough • eggs, pikelets, sugar, salt • ice, water, steam **Nature of change:** • breaks, melts, solidifies • evaporates, condenses, freezes, melts • decomposes, combines, dissolves • change of shape, change of sound • change of colour, change of texture **Possible causes of change:** • mixing, shaking • heating, cooling, cooking, burning • wetting, washing • combining, squeezing, manipulating • magnetism

The uses of materials are determined by their properties, some of which can be changed.

1.3 *Students look for alternative ways that familiar materials can be used.*	***2.3*** *Students explain why common materials are used in particular situations.*
Familiar materials: • water, fabrics, glass • plastics, wood, paper, air • soap **Uses:** • drinking, building, clothing • drawing on, cleaning • listening through or with • seeing through or with	**Common materials:** • water • fabrics, glass, plastics, wood, metals • paper, soap • food — sugar, salt • sunscreen **Uses:** • drinking, keeping cool, recreation • clothing, seeing through or with, building • drawing on, cleaning • food, tools • medicine

Sequence of core learning outcomes with elaborations

Natural and Processed Materials

The properties and structure of materials are interrelated.

3.1 *Students examine and describe the smaller visible parts of common materials and relate these to the properties of the materials.*	***4.1*** *Students collect information and propose ideas to explain the properties of materials in terms of each material's underlying structure.*
Examination and description of smaller visible parts of common materials: • rocks, crystals, fibrous materials • building materials — chipboard, ply, plasterboard • food — bread, fruit, salt, sugar, flour **Properties:** • solubility in water • lustre, colour, texture, shape; magnetic, non-magnetic • transparent, translucent, opaque • flexibility, rigidity, elasticity, strength • softness, hardness; heavy, light; floats, sinks • solid, liquid, gas • odour, taste	**Properties:** • solubility • porous, non-porous • conductor or insulator of heat or electricity • ability to conduct sound • filters, blocks, transmits, reflects or refracts light • odour • viscosity, density • absorbent, waterproof **Underlying structure of materials:** • food — sugar, salt, bread, flour • soil, sand, rocks, fibrous materials • manufactured materials

Patterns of interaction between materials can be identified and used to predict and control further interactions.

3.2 *Students compare properties of materials before and after physical and chemical changes.*	***4.2*** *Students identify patterns in the types of change that take place in materials.*
Physical changes: • evaporating, condensing, solidifying, melting • dissolving • thickening • wetting, drying • mixing • crystallising • separating **Chemical changes:** • cooking, burning, decomposing, combining **Properties before and after change:** • shape, texture, colour • flexibility, elasticity, hardness, strength, viscosity • odour, taste, ability to conduct sound • solid, liquid, gas • crystallinity	**Patterns in types of changes caused by:** • heating, cooling • burning, rusting • dissolving • crystallising • magnetising, demagnetising • freezing, melting • evaporating, condensing • mixing • combining • decomposing • filtering • decanting • distilling

The uses of materials are determined by their properties, some of which can be changed.

3.3 *Students collect information to illustrate how combining different materials influences their usefulness.*	***4.3*** *Students examine and assess ways that materials can be changed to make them more useful.*
How combining materials influences their usefulness: • solubility in water • lustre, colour, texture, shape; magnetic, non-magnetic • transparent, translucent, opaque • flexibility, rigidity, elasticity, strength • durability, malleability, wettability • softness, hardness; heavy, light; floats, sinks • solid, liquid, gas • odour, taste • conducting or insulating properties, adhesive properties • filters, blocks, transmits, reflects or refracts light **For materials such as:** • fibrous materials, building materials — brick, cement • packaging materials, glue, food, soil, rocks, alloys	**Changing materials for greater usefulness:** • fibres — wool, cotton, hemp, synthetic • leather • paper, glass, sponge • detergent, soap • foods — sugar, flour • particle board, wood • ores, minerals, metals **Changed by:** • heating, cooling, dissolving • dehydrating, adding water • crystallising • colouring, painting • rubbing, manipulating, moulding • cleaning, shining • recycling process

Sequence of core learning outcomes with elaborations

Natural and Processed Materials

The properties and structure of materials are interrelated.

5.1 *Students present information in a variety of ways to explain the structure and behaviour of matter in terms of particles of which it is made.*	***6.1*** *Students explain the structure and properties of matter using models of atoms and molecules.*
Structure of matter: • particle theory • atoms, elements • molecules, compounds • crystalline or non-crystalline **Behaviour of matter:** • solid, liquid, gas, plasma • density, viscosity • conductor or insulator of heat or electricity • solubility • mixture, pure substance, suspension, solution • acidic or basic	**Structure of matter:** • Periodic Table • atomic structure — nucleus, protons, electrons, neutrons • molecular structure — elements, compounds, ionic and non-ionic molecules, polymers, acids and bases, organic and inorganic molecules, metals **Physical properties of matter:** • solid, liquid, gas, plasma • conductor or insulator of heat or electricity • density, solubility, viscosity **Chemical properties of matter:** • reactivity, stability

Patterns of interaction between materials can be identified and used to predict and control further interactions.

5.2 *Students make inferences about the effect of various factors (including temperature of the reaction and surface area of the reactants) on the nature and rate of reactions.*	***6.2*** *Students use identified patterns of change to predict interactions between materials.*
Nature of reaction: • requires or releases heat • changes state • reversible, irreversible • combustion • acid–base, acid–metal, acid–carbonate • displacement • precipitation • electrochemical • crystallisation • fast or slow **Effect of factors such as:** • catalysis • surface area, temperature, concentration of reactants	**Identifying patterns of change:** • requires or releases heat • reversible or irreversible • changes colour • precipitates • crystallises • combines • separates • dissolves • neutralises • changes state • produces a gas • fast or slow **Word equations**

The uses of materials are determined by their properties, some of which can be changed.

5.3 *Students devise tests and interpret data to show that the properties and interactions of materials influence their use.*	***6.3*** *Students collect and present information about the relationship between the commercial production of industrial, agricultural and fuel products and their properties.*
Properties that influence use: • solubility in water • lustre, colour, texture, shape; magnetic, non-magnetic • transparent, translucent, opaque • flexibility, rigidity, elasticity, strength • durability, malleability, wettability • softness, hardness; heavy, light; floats, sinks • solid, liquid, gas • odour, taste • conducting or insulating properties, adhesive properties • filters, blocks, transmits, reflects or refracts light **Interactions that influence use:** • combining materials	**Chemical properties and commercial production:** • salts suitable for plant uptake (sulfates, phosphates, ammonium salts) — fertiliser production • nature of mineral ore (sulfide, oxide, carbonate) — froth flotation, smelting **Physical properties and commercial production:** • mixture of liquids with different boiling points (crude oil) — fractional distillation • mixture of solids with different magnetic or electrostatic properties (mineral sands) — magnetic or electrostatic separation • mixture of gases with different liquefaction temperatures (air) — production of oxygen, carbon dioxide, nitrogen