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1. Rationale

The ever-growing importance of scientific issues in our daily lives demands a populace who have sufficient knowledge and understanding to follow science and scientific debates with interest, and to engage with the issues science and technology pose — both for them individually and for our society as a whole.¹

Scientific knowledge at the beginning of the third millennium is the result of centuries of human endeavour. The process of scientific inquiry has been developed over time and contributes profoundly to our culture. It relies on evidence and careful reasoning. It is an open process, where new ideas are shared and are subject to critical appraisal and testing. These are behaviours and values considered important, not only in science but in our society.

We are increasingly exposed to environments and situations that require knowledge of science and scientific ways of thinking. Scientifically and technologically advanced tools are commonplace in our everyday lives. In this century citizens must not only be literate, they must also be scientifically literate.

Science²¹ deals with themes in real-world contexts that are of intrinsic interest and importance to students — the way the human body works, the ways we communicate, our place in the universe, our environment, our enjoyment of both synthesised and natural things. A course in Science²¹ develops:

- knowledge and understanding of science
- skills in scientific investigative processes
- appreciation of scientific issues and the impacts of science
- the capacity to communicate about science.

The approach to learning in Science²¹ is consistent with and builds upon the teaching and learning that underpins the Years 1–9 Science Essential Learnings and Standards and the Year 10 Guidelines: Science learning area.

Science²¹ is an interdisciplinary science course that aims to develop in students a broad understanding of the relevant science in today’s scientific and technological age. The interdisciplinary nature of Science²¹ enables students to become knowledgeable and active participants in a scientifically rich society. A course of study in Science²¹ is academically rigorous and complements student learning in the established science disciplines of Physics, Chemistry, Biology and Earth Science.

1.1 Indigenous perspectives

This syllabus recognises Aboriginal and Torres Strait Islander peoples, their traditions, histories and experiences from before colonisation through to the present time. To strengthen students’ appreciation and understanding of the first peoples of the land, relevant sections of the syllabus identify content and skills that can be drawn upon to encourage engagement with:

- Indigenous frameworks of knowledge and ways of learning
- Indigenous contexts in which Aboriginal and Torres Strait Islander peoples live
- Indigenous contributions to Australian society and cultures.

In Science21 there is opportunity to explore indigenous knowledge of natural phenomena, native flora and fauna, land, water and waste management, food production and other technologies. Using an inquiry approach, Science21 should provide opportunities to learn science in contexts that are valued by indigenous students, their peers and communities, acknowledging their values and approaches to learning.
2. General objectives

The general objectives for this subject are those that the school is required to teach and students have the opportunity to learn. Schools must assess how well students have achieved the general objectives.

The general objectives are grouped in dimensions, i.e. the salient properties or characteristics of distinctive learning. The first three dimensions are the assessable general objectives. The fourth group of general objectives, Attitudes and values, is not directly assessed. It is achieved through teaching and learning approaches offered to students.

Progress in aspects of any dimension at times may be dependent on the characteristics and skills foregrounded and developed in another. The process of learning through each of the dimensions must be developed in increasing complexity and sophistication over a four-semester course.

Schools must assess how well students have achieved the general objectives using the standards. The standards have a direct relationship with the general objectives and are described in the same dimensions.

The general objectives for a course in Science21 are grouped in the dimensions:

- Knowledge and conceptual understanding
- Investigative processes
- Issues and impacts
- Attitudes and values.

2.1 Knowledge and conceptual understanding

Knowledge and conceptual understanding refers to recalling and explaining factual material, understanding concepts, and applying these in new situations. It encompasses a range of simple-to-complex subject matter that develops an understanding of underlying scientific knowledge. This knowledge is required to engage with processes and phenomena across diverse contexts and situations.

By the conclusion of the course, students should:

- state, describe and explain scientific information including facts, definitions, formulas, terminology, concepts, theories, procedures, sequences, diagrams, symbols, figures, systems and patterns
- compare and explain interrelationships between scientific concepts, theories, processes and phenomena
- use scientific knowledge and information to generate explanations of real-world phenomena.

2.2 Investigative processes

Investigative processes refers to devising and implementing investigations using appropriate methods and techniques. This dimension involves the generation, recording and evaluation of qualitative and quantitative data; and the communication and sharing of data and ideas with others.
By the conclusion of the course, students should:

- conduct scientific investigations — this includes formulating questions, hypothesising, planning, experimenting, evaluating, refining and justifying decisions
- use scientific and technological equipment to gather data and information — this includes assessing and managing risk; safely selecting, applying and operating equipment in the laboratory and the field
- use qualitative and quantitative data — this includes processing, analysing, evaluating and interpreting data using appropriate mathematical techniques where necessary
- communicate information and ideas in a variety of ways using scientific convention and terminology — this includes selecting and presenting data and ideas to convey meaning to selected audiences in written, oral and multimedia formats.

2.3 Issues and impacts

An issue is a topic that has no apparent clearly-defined single outcome or answer. It is concerned with various points of view that should be informed by scientific understanding and evidence. The impacts of science can be positive or negative and may apply at a variety of levels of society — global, local and personal.

Coming to an informed position on the issues and impacts of science involves determining the relevance and admissibility of data and information, and is based on an understanding of the relevant science.

By the conclusion of the course, students should:

- identify and explain issues and evaluate scientific impacts
- draw conclusions and express positions that are scientifically and technologically informed
- analyse a range of factors that influence the development of scientific knowledge.

2.4 Attitudes and values

This dimension refers to the appreciation of science and a scientific view of the world. Attitudes and values incorporate the envisioning of possible, probable and preferred futures and taking responsibility for one’s own actions and decisions to promote ethical practices.

By the conclusion of the course, students should:

- retain an openness to new ideas, a thirst for knowledge and an appreciation of the need for lifelong learning
- value intellectual honesty, integrity, collegiality, cooperation and respect for evidence and ethical conduct
- develop a level of sensitivity to the implications of science for individuals and society and an understanding that science is a human endeavour with consequent limitations.
3. Course organisation

3.1 Introduction

A course of study developed from this syllabus will:

- underscore science as a way of understanding the world through inquiry
- explore issues that integrate science disciplines and link with technology
- be flexible in accommodating the various backgrounds, abilities, interests and maturity levels of students, and be relevant to the aspirations of students within and beyond school
- require the use of information communication technologies (ICTs) to acquire, manipulate and communicate scientific information.

3.2 Organising principles

Courses of study in Science21 are constructed on the following organising principles:

- coherent sequencing and development of key concepts
- contextual units of work
- range of complexity
- accommodation for individual and group differences.

3.2.1 Coherent sequencing and development of key concepts

To ensure effective sequencing, the key concepts should be mapped across the four semester course of study. The sequencing of the key concepts in the course of study should develop in complexity, scope and depth, over the four semesters. Key concepts need to be explored in at least two different units of work, preferably one in Year 11 and one in Year 12. Some key concepts may be included on more occasions than this, however, when a key concept is not a significant aspect of a unit of work it should not be the focus of assessment.

3.2.2 Contextual units of work

A context that is purposeful and significant for learning is a framework that links concepts and learning experiences in real-world situations. Units of work developed through contexts enable students to identify science in their world and understand the importance of science in their lives. By learning science in a range of contexts students have the opportunity to develop deep and transferable understandings of scientific concepts and inquiry skills.

3.2.3 Providing a range of complexity

It is expected that an increasing scope and depth of complexity will be developed over the course of study in Science21. The increasing complexity will be reflected in the teaching and learning experiences and the assessment program developed by the school.

Depth refers to the development of knowledge and understandings from simple through to complex, within and across the key concepts.
Scope refers to the development of the key concepts across at least two purposeful contexts for learning. Where possible the development of key concepts should also range from specific to general. This may occur within a unit of work or across units of work.

3.2.4 Accommodating individual and group differences

The development of courses should take into consideration the needs of individuals and class groups as well as the prior experiences of students. This principle is applied in terms of the school context, selection of resources, learning experiences, assessment instrument design and educational equity. The resources available within the school, including the teacher’s special areas of expertise and interest, will be especially significant in this. Teachers are encouraged to explore the local community for resources related to science that would enrich the contexts chosen for the course.

3.3 Course structure

A course of study in Science21 is built on:
- scientific priorities
- focus areas and key concepts.

3.3.1 Scientific priorities

Science21 specifies four scientific priorities, described in Table 1, from which contexts must be drawn over the course of study. These are:
- Technology
- Health and wellbeing
- Catalysts for discovery
- Environment

Table 1 Scientific priorities

<table>
<thead>
<tr>
<th>Technology (Tech)</th>
<th>Indicative topics</th>
<th>Health and wellbeing (H&amp;W)</th>
<th>Indicative topics</th>
</tr>
</thead>
</table>
| Technology is the application of science to produce a product. Scientific development is critically dependent on the development of scientific technologies. Some technologies are developed specifically for furthering science itself. | • Communication  
• Medicine  
• Science  
• Transport  
• Environment  
• Energy | Science impacts on human health, particularly in areas relating to the cause, spread and control of infectious disease. In terms of wellbeing, science directs attention to preventative measures and provides solutions to health and lifestyle challenges. The impacts of science on health and wellbeing have accelerated in the last | • Infectious disease and prevention  
• Genetics  
• Nutrition  
• Longevity |
They have great prospects for the future and affect not only humans, but also other animals and plants.

- Reproduction
- Lifestyle
- Mental health

### Catalysts for discovery (CfD)

Unique circumstances often precipitate rapid progress in science. These unique circumstances include: crises, global change, the work of exceptional individuals, new frontiers for exploration and economic opportunities.

These unique circumstances often result in an explosion of knowledge and technology at a sophisticated level that filters down to consumers in a short period of time and at economical rates. It also leads to the development of new industry and employment opportunities.

<table>
<thead>
<tr>
<th>Indicative topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crises:</td>
</tr>
<tr>
<td>natural disasters</td>
</tr>
<tr>
<td>wars</td>
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<tr>
<td>epidemics</td>
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<tr>
<td>Global change:</td>
</tr>
<tr>
<td>global warming</td>
</tr>
<tr>
<td>ozone layer depletion</td>
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<tr>
<td>overpopulation</td>
</tr>
<tr>
<td>Economic opportunities:</td>
</tr>
<tr>
<td>energy</td>
</tr>
<tr>
<td>biotechnology</td>
</tr>
<tr>
<td>consumer electronics</td>
</tr>
<tr>
<td>the internet</td>
</tr>
</tbody>
</table>

The work of exceptional individuals, e.g.:
- Newton
- Einstein
- Darwin
- Pasteur
- Pauling
- New frontiers for exploration:
  - space
  - deep oceans
  - rainforests

### Environment (Env)

Human interactions with the Earth have a profound effect on future generations. Science informs complex global problems. The advances in all areas of science, together with enormous increases in computing power and communication technologies, are making it possible to address these problems.

These advances hinge on the collaboration of experts in many fields working in interdisciplinary teams. On a personal level, it is socially responsible to develop an understanding of the issues and to contribute to informed community debate.

<table>
<thead>
<tr>
<th>Indicative topics</th>
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</thead>
<tbody>
<tr>
<td>Sustainability</td>
</tr>
<tr>
<td>Climate change</td>
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<tr>
<td>Biodiversity</td>
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<tr>
<td>Alternative energies</td>
</tr>
</tbody>
</table>

...
3.3.2 Focus areas and key concepts

The focus areas in Table 2 reflect the integrated nature of science and incorporate key concepts that are considered fundamental to science in the 21st century. In a course of study it is expected that:

- all focus areas are equally significant and mandatory
- a context will incorporate key concepts from more than one focus area
- the key concepts listed in Table 2 will be included in at least two contexts
- the complexity in scope and depth of key concepts will be suitable to the context selected.

The specified list of key concepts is not exhaustive and schools are encouraged to include any additional concepts that will be explored within a context. Where possible, schools should include reference to these additional concepts in their work program.

Table 2 Focus areas, key concepts and elaborations

<table>
<thead>
<tr>
<th>Focus area</th>
<th>Key concepts</th>
<th>Elaborations</th>
<th>Possibilities for linking key concepts to scientific priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure and properties of matter</strong></td>
<td>SP1 The molecular nature of matter</td>
<td>- Matter is usually comprised of molecules.</td>
<td>Understanding the structures and reactions of molecules is the basis for many technologies. (Tech)</td>
</tr>
<tr>
<td>From nutrition to electronics, from rockets to medicines, an ability to think at the molecular level is a powerful way to view the world. While centred in the established disciplines of physics and chemistry, it is the way of thinking that is driving revolutions in biology and technology.</td>
<td>- Two or more atoms bound together by sharing electrons (a covalent bond) form a molecule.</td>
<td>Biological molecules are built primarily on carbon. (CfD)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Ions are atoms or molecules which carry a charge (caused by gaining or losing one or more electrons).</td>
<td>By understanding the structures and reactions of biological molecules we can understand biological processes. (H&amp;W, CfD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The arrangement of atoms in molecules (the molecular structure) determines the properties of a molecule.</td>
<td>This information can be applied to improve human health and the environment. (H&amp;W, Env)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Molecules undergo chemical reactions which obey the laws of thermodynamics.</td>
<td>Molecules bond and react to form new materials with useful properties that depend on molecular structures. (Tech, CfD)</td>
</tr>
<tr>
<td><strong>Gases, liquids, solutions, solids</strong></td>
<td>SP2</td>
<td>- Different states of matter — solids, liquids and gases have distinctive and useful properties.</td>
<td>New technologies make use of unusual states of matter — liquid crystals, plasmas and supercritical fluids. (Tech, CfD)</td>
</tr>
<tr>
<td>From nutrition to electronics, from rockets to medicines, an ability to think at the molecular level is a powerful way to view the world. While centred in the established disciplines of physics and chemistry, it is the way of thinking that is driving revolutions in biology and technology.</td>
<td>- A solution is a liquid that is a homogenous mixture of two or more substances.</td>
<td>Water (liquid) and oxygen (gas) are fundamental to life on earth. (H&amp;W, Env)</td>
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<td></td>
<td>All biological reactions occur in water. (Tech, H&amp;W)</td>
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<td></td>
<td></td>
<td>The ability of water to dissolve compounds is important in biology and in earth processes. (H&amp;W, Env)</td>
</tr>
<tr>
<td><strong>Radioactivity</strong></td>
<td>SP3</td>
<td>- Some atoms undergo radioactive decay (nuclear fission) to emit subatomic particles and energy.</td>
<td>Radioactivity is used in medicine and to make some home devices. (Tech, H&amp;W)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Some atoms can fuse to form new elements and emit energy as particles or waves.</td>
<td>Radioactive processes have been harnessed to provide useful energy and for warfare. (Tech, CfD, Env)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Fusion reactions in the sun create(d) the other elements from hydrogen. (CfD)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Fission and fusion reactions are used in nuclear weapons. (Tech, CfD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Radioactive decay is used for historical dating. (CfD, Env)</td>
</tr>
<tr>
<td>Focus area</td>
<td>Key concepts</td>
<td>Elaborations</td>
<td>Possibilities for linking key concepts to scientific priorities</td>
</tr>
<tr>
<td>-------------------------------------</td>
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<td>---------------------------------------------------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td><strong>Living systems</strong></td>
<td>LS1 The cell as the basis for life</td>
<td>• The cell is the simplest form of organisation that can perform all activities required for life.</td>
<td>• Understanding how bacterial cells grow and reproduce is the foundation for new biotechnology industries and for disease prevention. (Tech, H&amp;W)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• More complex organisation of cells includes tissues, organs and organ systems.</td>
<td>• Understanding how animal cells communicate is the basis for understanding homeostasis. (H&amp;W, CfD)</td>
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<td></td>
<td></td>
<td></td>
<td>• Understanding how viruses infect cells is important for disease control. (H&amp;W, CfD)</td>
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<tr>
<td></td>
<td>LS2 Genes, genetics and evolution</td>
<td>• All living organisms have evolved from a common ancestor through processes that include natural selection.</td>
<td>• Inherited diseases can be understood in terms of mutation of DNA. (H&amp;W, CfD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• DNA encodes the information needed for cells and organisms to replicate.</td>
<td>• Manipulation of the DNA in organisms allows therapeutic proteins to be produced, genetically modified crops to be developed and industrial processes to be accomplished more efficiently. (Tech, H&amp;W, CfD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mutation in DNA can lead to evolutionary changes in species.</td>
<td>• Manipulation of human DNA in stem cells has medical and ethical implications. (Tech, H&amp;W, CfD)</td>
</tr>
<tr>
<td></td>
<td>LS3 Ecosystems</td>
<td></td>
<td>• A reduction of biodiversity has consequences. (CfD, Env)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Biodiversity can be affected by changes in selection pressures in the environment.</td>
<td>• Human activities threaten the sustainability of ecosystems. (CfD, Env)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Interactions in ecosystems exist between living and non-living components.</td>
<td>• Matter and energy cycle through ecosystems. (Tech, CfD, Env)</td>
</tr>
<tr>
<td><strong>Earth and space</strong></td>
<td>ES1 Structure and properties of the Earth</td>
<td>• Plate tectonics is the theory which explains large scale motions within the Earth’s crust.</td>
<td>• Movements in the Earth’s crust lead to:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Geological changes occur through physical and chemical processes.</td>
<td>– earthquakes, tsunamis and volcanic activity (CfD, Env)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>– the existence of different flora and fauna, which have evolved from common ancestors, on different continents. (CfD, Env)</td>
</tr>
<tr>
<td></td>
<td>ES2 Global cycles and the atmosphere</td>
<td>• Life on Earth depends on the continuous recycling of essential chemical elements.</td>
<td>• Human activities and natural processes impact on landscapes over human and geological timescales. (Tech, Env)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The atmosphere is comprised of layers with different gaseous compositions.</td>
<td>• The Earth’s crust is exploited for non-renewable resources. (Tech, Env)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The atmosphere interacts dynamically in global cycles involving living and non-living components.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ES3 Solar systems and the universe</td>
<td>• The movement of astronomical objects is governed by gravitational forces.</td>
<td>• The understanding of Global cycles is essential for forecasts of environmental changes and for the development of a responsible relationship between humanity and nature. (Env, Tech)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Stars are sources of energy for solar systems.</td>
<td>• Anthropogenic climate change is the result of an increasing release of carbon dioxide to the atmosphere. (CfD, Env)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The “Big Bang” provides an accurate model for the initial formation and subsequent evolution of the universe.</td>
<td>• Depletion of ozone in the atmosphere has possible implications for human health and the health of ecosystems. (H&amp;W, Env)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Increased levels of nitrogen in aquatic systems damage the health of ecosystems. (Tech, Env)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The atmosphere and the impact of the Sun’s radiation determine climatic events. (CfD, Env)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>**Motion of components of the solar system accounts for diurnal cycles, seasons, tides. (CfD, Env)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>**Science is tackling the difficulties of space travel and the possibilities for life beyond Earth. (Tech, CfD)</td>
</tr>
</tbody>
</table>
### Energy

**Focus area**
Energy is the ability to cause a change in an object. When objects interact with each other energy is transferred and/or transformed. Energy is intimately related to the concept of matter; it manifests itself in various forms, and powers life and change at the molecular, everyday and astronomical levels.

<table>
<thead>
<tr>
<th>Key concepts</th>
<th>Elaborations</th>
<th>Possibilities for linking key concepts to scientific priorities</th>
</tr>
</thead>
</table>
| EN1 Forms of energy | • Energy is needed to do work — to apply a force through a distance, to move something.  
• Energy transfers and transformations obey the laws of thermodynamics.  
• Different forms of energy include:  
  - kinetic energy — possessed by objects and molecules in motion  
  - potential energy — derived from the position or configuration of objects and molecules rather than their motion  
  - chemical  
  - electromagnetic  
  - gravitational  
  - nuclear. | • Energy transfers and transformations occur in all contexts, some of which could include:  
  - power generation (Tech)  
  - heating and cooling (Env)  
  - transport and communication (Tech, CfD)  
  - maintenance of life processes (H&W)  
  - planetary motion (CfD)  
  - electronics in technology. (Tech, CfD) |
| EN2 Forces and motion | • Objects in motion (except very small or very fast) obey Newton's Laws.  
• Fundamental forces underpin the interactions of the simplest particles and are the basis of all forces. They are the:  
  - strong and weak nuclear forces (which act on subatomic particles)  
  - gravitational force (which acts between masses)  
  - electromagnetic force (which acts between electric charges). | • The above contexts (Forms of energy) also involve forces and motion. |

### Information and communication

Communication, the sharing of information, is fundamental to the development of human societies. Developing methods for storing, retrieving and communicating information through digital technologies are at the forefront of social change. In the living world, communication of information occurs at molecular, microscopic and macroscopic scales. A two-way link is emerging between artificial and living information systems.

<table>
<thead>
<tr>
<th>Key concepts</th>
<th>Elaborations</th>
<th>Possibilities for linking key concepts to scientific priorities</th>
</tr>
</thead>
</table>
| IC1 Storage, transfer and interpretation | • Information is needed to understand or comprehend any artefact, phenomenon, event or change.  
• Information must be encoded, transmitted, received and decoded.  
• Information can be stored, transmitted and processed in analogue or digital form.  
• Communication requires information to be interpreted as meaning. | • Information can be stored in and transmitted via different media — such as solid state and hard disk drives, optical discs, magnetic tapes, microwave transmitters and fibre optic cables. (Tech, CfD)  
• Storage, transfer and processing of information is essential for all aspects of life — within and between cells (replication, cell to cell signalling) and organisms (brain and behaviour). (H&W, CfD)  
• Biological systems use particles and energy to store, transfer and process information. (CfD, Env)  
• Technology for storing, transmitting and processing information is critical to modern civilisation. (Tech, CfD) |
3.4 **Time allocation**

The minimum number of hours of timetabled school time, including assessment, for a course of study developed from this syllabus, is 55 hours per semester. A course of study will usually be completed over four semesters (220 hours).

3.5 **Planning a course of study**

When planning a course of study, teachers should refer to the scientific priorities, focus areas and key concepts, the general objectives, and should incorporate and apply the organising principles.

The planned sequence of units of work provides the means for students to explore systematically the key concepts of Science21 in at least two purposeful contexts for learning. A unit of work may be between four weeks and a semester in length, and should allow students the opportunity to develop depth of understanding through the exploration of the key concepts and associated elaborations. When key concepts are substantially revisited, the depth and sophistication of understanding and/or the complexity should be increased.

3.5.1 **Course organisation summary**

- 6–12 units of work over the four semester course of study
- Each unit of work developed using a purposeful context for learning across at least two focus areas
- Each key concept incorporated in at least two different units of work
- The sequencing of contexts and associated units of work ensure that the course of study develops in complexity, scope and depth over the four semesters
- The course of study should be written to suit the resources, both physical and human, of the school

3.6 **Developing a unit of work**

3.6.1 **Developing contexts as units of work**

Learning occurs best when the learner considers it to be real and relevant. In Science21, this is done through contextual units of work. Sources or stimuli for contexts are the four scientific priorities of: technology, health and wellbeing, catalysts for discovery, and environment (see Section 3.3). Therefore, a context for Science21 must allow the exploration of:

- big scientific ideas and explanatory frameworks
- important local and/or global societal issues
- how scientific knowledge is established.

A context can be developed using:

- a key question or series of questions
- investigation(s)
- hypotheses to be tested
- a problem or problems to be solved
• design challenges
• issues.

Selecting purposeful contexts for learning

When developing contexts, schools should consider student population, school resources (including technology), local community, environments and social factors. Each purposeful context for learning should complement other contexts through the development of key concepts.

Some questions to be considered in selecting contexts include:

• What classroom resources are available (texts, equipment, computer facilities, etc.)?
• What community resources are available (factories, industries, government utilities such as power stations, museums, hospitals, government departments, CSIRO, universities, training providers, expert speakers, indigenous community groups)?
• What local natural resources are available (rivers, lakes, mines, dams, etc.)?
• What is the teacher’s level of expertise, familiarity or confidence with the topic?
• Have cultural, social and gender differences been catered for?
• Have indigenous perspectives been incorporated?
• Is the context inclusive of all students?
• Will the context cater for the future needs of students? Will a majority go on to TAFE, university or employment?
• Will the context complement other contexts being selected and not be just a variation of a context?

3.6.2 Planning a unit of work

A unit of work provides a structure to facilitate the delivery of contextual learning. It is a detailed teaching plan that identifies the context(s) and key concepts which are being developed and provides opportunities for students to apply and reinforce the processes of scientific investigation, scientific techniques and their knowledge and conceptual understandings through the selected learning experiences. It relates the learning experiences selected to earlier and later learning experiences, builds on students’ prior learning and conceptualisation, and provides the basis for further development.

The structure and delivery of the unit of work reflects the integrated nature of the learning experiences with the assessment techniques. The assessment technique should be appropriate to the context(s) and fit structurally with the organisation of the unit of work.

For example, the extended techniques could be considered as learning experiences within themselves, providing students the opportunity to develop deeper understanding of the key concepts.

In planning and developing a unit of work, teachers should include the following in their consideration of the unit:

• the scientific priorities and focus areas that underpin a suitable context
• the general objectives being developed
• the key concepts to be developed
• the time available
• the sequencing of the contexts
- the development of concepts within and across contexts
- the selection of learning experiences best suited to the development of concepts within the unit
- the learning environment, for example, individual, small group and whole class activities, workshops, tutorial sessions, guest speakers, real-life situations, access to available resource centres
- the specific resources to be used
- suitable assessment instruments
- the level of support provided to students
- the relationships between the general objectives, assessment and teaching and learning.
3.7 Composite classes

This syllabus enables teachers to develop a course that caters for a variety of circumstances, such as combined Year 11 and 12 classes, combined campuses, or modes of delivery involving periods of student-managed study.

The flexibility of the syllabus can support teaching and learning for composite classes by enabling teachers to:

- structure learning experiences and assessment that allow students to access the key concepts and ideas suited to their needs in each year level
- provide opportunities for multilevel group work, peer teaching and independent work on appropriate occasions.

The following guidelines may prove helpful in designing a course of study for a composite class:

- The course of study could be written in a Year A/Year B format, if the school intends to teach the same topics to both cohorts.
- A topic that will allow Year 11 students ease of entry into the course should be placed at the beginning of each year.
- Learning experiences and assessment instruments need to cater for both year levels throughout the course. Even though tasks may be similar for both year levels, it is recommended that more extended and/or complex tasks be used with Year 12 students.

Bridging study

A bridging study could cater for students who enter a course later than the rest of the class. This may include students entering the first year of a composite class, or students entering a course significantly after its commencement. There may be other contexts in which a bridging study is used.

The bridging study:

- might introduce key terms and concepts or supplement topics already covered in the course
- is not intended to be considered as a substitute for key terms and concepts or a topic — the study is intended to supplement any subsequent key terms and concepts or topics
- is not expected to be included in a work program for approval.

3.8 Work program requirements

A work program is the school’s plan of how the course will be delivered and assessed, based on the school’s interpretation of the syllabus. It allows for the special characteristics of the individual school and its students.

The requirements for on-line work program approval (WP Online), work program requirements, checklists and samples can be accessed on the Queensland Studies Authority’s website <www.qsa.qld.edu.au>.
4. Learning experiences

Learning experiences are activities and/or tasks, conducted within appropriate contexts, that contribute to student learning as outlined in the general objectives. In Science21, learning experiences are embedded in the processes of scientific inquiry.

4.1 General guidelines for learning experiences

Learning experiences draw on a range of pedagogical approaches, for example guided inquiry, cooperative learning, individualised instruction and direct instruction. In Science21, learning experiences are framed in inquiry terms to involve students in actively developing their understanding of science (see 4.2.1). Inquiry-based learning is particularly appropriate for courses such as Science21 that emphasise real-world contexts.

Learning experiences should be presented in a supportive environment where:

- students are encouraged to learn and their opinions and views are respected and listened to
- academic risk-taking is supported through scaffolding of thinking skills
- open communication is encouraged
- students are encouraged to learn by defining their own directions and setting goals for themselves
- students are encouraged to learn through intrinsic and extrinsic motivation.

Learning experiences should not focus on a single dimension or general objective but, where possible, should encompass elements of all dimensions, extending understandings through an increasing depth of study. As soon as learning experiences require students to use Investigative processes or to assess Issues and impacts they must call on their understandings gained in Knowledge and conceptual understanding.

Learning experiences should progress developmentally from simple to more complex and sophisticated as the course of study progresses. They can be modified by altering the:

- quantity of information that students must use
- complexity of such information
- information-gathering requirements
- cognition required, especially the complexity or depth of the analysis, application, synthesis and evaluation of the information
- time available for decision making.

The cognitive skills that support the dimensions and general objectives of this syllabus should be specifically taught and embedded in the learning experiences throughout the course so that students may demonstrate what they know and can do.

Learning experiences should include experimental investigations as well as research based on secondary data. They should extend beyond the classroom and where possible beyond the school.

The process of assessment is itself a learning experience and can occur at the end of, or periodically during, a series of learning experiences. Complex assessment tasks, such as extended experimental investigations, will require scaffolding as part of the early learning experiences. These experiences should prepare students for the corresponding assessment techniques used later in the course.
Ideas for generic learning experiences that may be useful include:

- researching from primary and secondary sources
- conducting practical experiments or field research
- accessing and using computers, including internet research
- undertaking national science initiatives
- developing decision-making skills
- interpreting data from a wide range of sources, including media
- analysing current strategies or policies of the issue being investigated
- analysing strategies and evaluating effectiveness or improvements
- applying the principles of research ethics
- formulating hypotheses and testing them through field work, experiments, interviews and research
- synthesising ideas in a variety of forms, for example, oral, written, practical
- practising assessment instrument requirements, such as genre writing
- predicting impact of recommendations
- proposing and/or implementing strategies for improvement
- solving problems
- engaging in active research projects, independently and with groups and teams
- participating in forum discussions and debates
- sharing information mutually beneficial to the group
- advocating for change.

4.2 Teaching Science

4.2.1 Inquiry-based learning

Science21 requires the teacher to teach the mandatory aspects of the course through a range of strategies including investigations, inquiry using both individual and cooperative learning and direct instruction related to the scientific priorities and the focus areas and key concepts (see Section 3.3). In this inquiry-based framework students play a major role in answering questions asked by themselves or their teacher.

Inquiry-based learning is a process, a way of thinking and problem solving. It is an effective strategy for:

- the development of higher-order thinking skills
- increasing student involvement and ownership of the curriculum
- encompassing effective teaching and learning principles
- recognising and catering for individual difference.
4.2.2 An inquiry approach

New learning

**DEFINE**
Establishing, refining, framing:
- Investigation
- Hypothesis
- Design brief
- Problem or challenge
- Research
- Management and resource strategy

**ANALYSE**
Dissecting to ascertain and examine constituent parts and/or their relationships.

**SYNTHESISE**
Assembling constituent parts into a coherent, unique and/or complex entity.

**PRODUCE**
Undertaking and completing the inquiry, producing a response.

**EVALUATE/JUSTIFY**
Assigning merit according to criteria/providing sound reasons or evidence to support a statement.

**REFLECT**
Re-examining the question, the research method and the outcomes.
- Has a solution been found?
- Do new questions arise?
- Where to from here?
  - The answer may be to begin inquiry again.
- What have I learnt that can inform future learning?

Critical thinking/reflecting throughout the process
The guiding principles for teaching inquiry are:

- Effective inquiry is a skill. The inquiry approach requires explicit teaching.
- The inquiry approach to research is not a linear process as the model attempts to illustrate.
- Inquiry is recursive and iterative in nature and involves reflection and critical thinking at all stages.
- The student-teacher relationship during the inquiry process is typified by the teacher yielding control. There are different levels of inquiry, ranging from verification (where the problem and answer are given) to open inquiry, where all of the steps are open or negotiated. The level of openness of an activity can be categorised as shown in Table 3.

Table 3 Levels of openness of inquiry

<table>
<thead>
<tr>
<th>Level</th>
<th>Problem</th>
<th>Equipment</th>
<th>Procedure</th>
<th>Answer</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Given</td>
<td>Given</td>
<td>Given</td>
<td>Given</td>
<td>Verification</td>
</tr>
<tr>
<td>1</td>
<td>Given</td>
<td>Given</td>
<td>Given</td>
<td>Open</td>
<td>Guided inquiry</td>
</tr>
<tr>
<td>2a</td>
<td>Given</td>
<td>Given</td>
<td>Open/Negotiated</td>
<td>Open</td>
<td>Open guided inquiry</td>
</tr>
<tr>
<td>2b</td>
<td>Given</td>
<td>Open/Negotiated</td>
<td>Open/Negotiated</td>
<td>Open</td>
<td>Open guided inquiry</td>
</tr>
<tr>
<td>3</td>
<td>Open/Negotiated</td>
<td>Open/Negotiated</td>
<td>Open/Negotiated</td>
<td>Open</td>
<td>Open inquiry</td>
</tr>
</tbody>
</table>

The level of openness is largely determined by the nature of the task and the context in which it is being undertaken. Students require opportunities to learn and exercise self-control, however, open investigations should not be equated with minimal guidance, where learners are expected to discover or construct essential information for themselves. Teachers should ensure that when inquiry-based investigations are a component of summative assessment, the possibility for student success is likely.

Where an inquiry approach is used it should support the dimensions (salient properties or characteristics of distinctive learning) of the general objectives.

4.2.3 Inquiries in context

Context-based learning provides students with opportunities to learn in circumstances that are relevant and interesting to them. The scientific knowledge and understanding of the students is developed, consolidated and refined in, about and through the context. It supports the teacher using pedagogical approaches suitable to the situation, with multiple approaches often appropriate. In Science21, contexts are drawn from the scientific priorities and include elements of at least two focus areas (see Section 3.3). This ensures the interdisciplinary nature of the subject.

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4.3 Animal welfare and ethics

The *Animal Care and Protection Act 2001* (the Act) and the accompanying Animal Care and Protection Regulation 2002 govern the treatment and use of all animals in Queensland. The Department of Employment, Economic Development and Innovation (DEEDI), through Biosecurity Queensland, is responsible for enforcement of the legislation. The purpose of the Act is to promote the responsible care and use of animals, provide standards for the care and use of animals, protect animals from unjustifiable, unnecessary or unreasonable pain, and ensure that the use of animals for scientific purposes is accountable, open and responsible. “Scientific purposes” is defined as any activity performed to acquire, demonstrate or develop knowledge or a technique in a scientific discipline including teaching. Under the Act an animal is any live vertebrate or cephalopod. This includes amphibians, birds, fish, mammals (other than humans), reptiles and cephalopods (octopus, squid, cuttlefish and nautilus). This also includes live prenatal or prehatched creatures in the last half of gestation, including mammalian or reptilian foetus, prehatched avian, mammalian or reptilian young (eggs), and live marsupial young. It does not include invertebrates other than cephalopods; the eggs, spat or spawn of fish; and immature amphibians and fish prior to final metamorphosis. Further details of the categories covered by the Act can be obtained from the DEEDI website <www.dpi.qld.gov.au/27_9907.htm> under “Animal ethics and using animals for scientific purposes”.

The Act also requires mandatory compliance with the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes (the Code). The current 2004 version is the 7th edition and can be downloaded from National Health and Medical Research Council’s publications website <www.nhmrc.gov.au/publications/subjects/animal.htm>

The code provides guidance for institutions, researchers, teachers and animal ethics committees on the ethical framework necessary to ensure that the welfare of animals used for research and teaching is given an appropriate level of consideration. National codes of practice are available for most livestock industries, and outline acceptable standards of husbandry and management. There are also Model Codes of Practice covering areas such as transporting livestock, saleyards and abattoirs. In Queensland, the national livestock codes are used as the minimum standard. Codes of Practice are available from the CSIRO publishing website <www.publish.csiro.au/nid/22/sid/11.htm>

If you intend to use animals for scientific purposes, which include teaching, in order to comply with the Act:

- you (or your employing institution) must register with the DEEDI and nominate the Animal Ethics Committee (AEC) that will assess your animal use activity; and
- you must ensure the animal use activity is approved by the AEC prior to the commencement of the activity; and
- you must comply with the annual reporting requirements of your AEC and DEEDI for all approved activities where animals were used.

Animals must not be used for scientific purposes in any Queensland school without prior written approval from the Queensland Schools Animal Ethics Committee (QSAEC).

The QSAEC is a cross-sector committee linking Education Queensland, Queensland Catholic Education Commission and Independent Schools Queensland, and includes members drawn from the scientific and wider community to bring a diversity of knowledge, values and beliefs to the committee. The QSAEC meets once a term — usually during the third week of each term. There are at least four meetings of the QSAEC each year.

The main task of the members of the Queensland Schools Animal Ethics Committee is to assess and monitor using animals in schools to safeguard the welfare of the animals involved. The QSAEC members decide whether proposed activities using animals are
justified, that the 3Rs (replacement, refinement and reduction) have been considered and that the welfare needs of the animals have been adequately addressed.

More information on the QSAEC and its activities can be found at <http://education.qld.gov.au/curriculum/area/science/qsaec.html>

Further information and resources on animal ethics can be found at <http://education.qld.gov.au/curriculum/area/science/animal-ethics.html>

### 4.4 Workplace health and safety

Science21 is designed to give students exposure to the practical components of science. A significant portion of the course should be devoted to practical experiences in the laboratory. These practical experiences expose students to a variety of hazards, from corrosive and poisonous substances to injury from glass and hot objects. Besides a teacher’s duty of care that derives from the Education (General Provisions) Act 1989, there are other legislative and regulatory requirements, for example the Workplace, Health and Safety Act 1995, that will influence the nature and extent of practical work.

All practical work must be organised with student safety in mind. In Science21, there are many activities associated with handling biological materials including live animal and plant specimens, microorganisms, and materials for dissection, that expose teachers and students to health hazards.

The current science safety requirements are clearly explained at the Queensland Government Department of Education and Training website in Education policy and procedures register > Health and safety > HLS-PR-012: Curriculum Activity Risk Management:


It is the responsibility of the school to ensure that their practices meet current guidelines.
5. **Assessment**

Assessment is an integral part of the teaching and learning process. For Years 11 and 12 it is the purposeful, systematic and ongoing collection of information about student learning outlined in the senior syllabuses.

In Queensland, assessment is standards-based. The standards for each subject are described in dimensions, which identify the valued features of the subject about which evidence of student learning is collected and assessed. The standards describe the characteristics of student work.

The major purposes of assessment in senior Authority subjects are to:

- promote, assist and improve learning
- inform programs of teaching and learning
  - advise students about their own progress to help them achieve as well as they are able
  - give information to parents and teachers about the progress and achievements of individual students to help them achieve as well as they are able
- provide comparable levels of achievement in each Authority subject to be recorded in student learning accounts. The comparable levels of achievement may contribute to the award of a Queensland Certificate of Education
- serve as the base data for tertiary entrance purposes
- provide information about how well groups of students are achieving for school authorities and the State Education and Training Minister.

5.1 **Principles of exit assessment**

All the principles of exit assessment must be used when planning an assessment program and must be applied when making decisions about exit levels of achievement.

A standards-based assessment program for the four-semester course of study requires application of the following interdependent principles.

- Information is gathered through a process of continuous assessment.
- Balance of assessment is a balance over the course of study and not necessarily a balance over a semester or between semesters.
- Exit achievement levels are devised from student achievement in all areas identified in the syllabus as being mandatory.
- Assessment of a student’s achievement is in the significant aspects of the course of study identified in the syllabus and the school’s work program.
- Selective updating of a student’s profile of achievement is undertaken over the course of study.
- Exit assessment is devised to provide the fullest and latest information on a student’s achievement in the course of study.

While most students will exit a course of study after four semesters, some will exit after one, two or three semesters.
Continuous assessment

Judgments about student achievement made at exit from a course of study must be based on an assessment program of continuous assessment.

Continuous assessment involves gathering information on student achievement using assessment instruments administered at suitable intervals over the developmental four-semester course of study.

In continuous assessment, all assessment instruments have a formative purpose. The major purpose of formative assessment is to improve teaching and student learning and achievement.

When students exit the course of study, teachers make a summative judgment about their levels of achievement in accordance with the standards matrix.

The process of continuous assessment provides the framework in which the other five principles of exit assessment operate: balance, mandatory aspects of the syllabus, significant aspects of the course, selective updating, and fullest and latest information.

Balance

Judgments about student achievement made at exit from a course of study must be based on a balance of assessments over the course of study.

Balance of assessments is a balance over the course of study and not a balance within a semester or between semesters.

Balance of assessment means judgments about student achievements of all the assessable general objectives are made a number of times using a variety of assessment techniques and a range of assessment conditions over the developmental four-semester course.

See also Section 5.6 Requirements for verification folio.

Mandatory aspects of the syllabus

Judgments about student achievement made at exit from a course of study must be based on mandatory aspects of the syllabus.

The mandatory aspects are:

- the general objectives of Knowledge and conceptual understanding, Investigative processes and Issues and impacts
- the focus areas and key concepts.

To ensure that the judgment of student achievement at exit from a four-semester course of study is based on the mandatory aspects, the exit standards for the dimensions stated in the standards matrix (refer to Section 5.8.1) must be used.

Significant aspects of the course of study

Judgments about student achievement made at exit from a course of study must be based on significant aspects of the course of study.

Significant aspects are those areas described in the school’s work program that have been selected from the choices permitted by the syllabus to meet local needs.

The significant aspects must be consistent with the general objectives of the syllabus and complement the developmental nature of learning in the course over four semesters.
Selective updating

Judgments about student achievement made at exit from a course of study must be selectively updated throughout the course.

Selective updating is related to the developmental nature of the course of study and works in conjunction with the principle of fullest and latest information.

As subject matter is treated at increasing levels of complexity, assessment information gathered at earlier stages of the course may no longer be representative of student achievement. Therefore, the information should be selectively and continually updated (not averaged) to accurately represent student achievement.

Schools may apply the principle of selective updating to the whole subject group or to individual students.

Whole subject group

A school develops an assessment program so that, in accordance with the developmental nature of the course, later assessment information based on the same groups of objectives replaces earlier assessment information.

Individual students

A school determines the assessment folio for verification or exit (post-verification). The student’s assessment folio must be representative of the student’s achievements over the course of study. The assessment folio does not have to be the same for all students, however the folio must conform to the syllabus requirements and the school’s approved work program.

Selective updating must not involve students reworking and resubmitting previously graded responses to assessment instruments.

Fullest and latest information

Judgments about student achievement made at exit from a course of study must be based on the fullest and latest information available.

- “Fullest” refers to information about student achievement gathered across the range of general objectives.
- “Latest” refers to information about student achievement gathered from the most recent period in which achievement of the general objectives is assessed.

As the assessment program is developmental, fullest and latest information will most likely come from Year 12 for those students who complete four semesters of the course.

The fullest and latest assessment data on mandatory and significant aspects of the course of study is recorded on a student profile.

5.2 Planning an assessment program

To achieve the purposes of assessment listed at the beginning of this section, schools must consider the following when planning a standards-based assessment program:

- general objectives (see Section 2)
- learning experiences (see Section 4)
- principles of exit assessment (see Section 5.1)
- variety in assessment techniques over the four-semester course (see Section 5.5)
• conditions in which assessment instruments are undertaken (see Section 5.5)
• verification folio requirements, that is, the range and mix of assessment instruments necessary to reach valid judgments of students’ standards of achievement (see Section 5.6)
• post-verification assessment (see Section 5.6)
• exit standards (see Section 5.7).

In keeping with the principle of continuous assessment, students should have opportunities to become familiar with the assessment techniques that will be used to make summative judgments.

Further information can be found at <www.qsa.qld.edu.au> under the relevant subject areas.

5.3 Special provisions

Guidance about the nature and appropriateness of special provisions for particular students may be found in the Authority’s Policy on Special Provisions for School-based Assessments in Authority and Authority-registered subjects (2009), available from <www.qsa.qld.edu.au> by searching for “Special provisions”.

This statement provides guidance on responsibilities, principles and strategies that schools may need to consider in their school settings.

To enable special provisions to be effective for students, it is important that schools plan and implement strategies in the early stages of an assessment program and not at the point of deciding levels of achievement. The special provisions might involve alternative teaching approaches, assessment plans and learning experiences.

5.4 Authentication of student work

It is essential that judgments of student achievement are made on accurate and genuine student assessment responses. Teachers should ensure that students’ work is their own, particularly where students have access to electronic resources or when they are preparing collaborative tasks.

The QSA information statement Strategies for authenticating student work for learning and assessment is available from <www.qsa.qld.edu.au> by searching for “authenticating”. This statement provides information about various methods teachers can use to monitor that students’ work is their own. Particular methods outlined include:

• students’ planning production of drafts and final responses
• teachers seeing plans and drafts of student work
• maintaining documentation of the development of responses
• students acknowledging resources used.

Teachers must ensure students use consistent accepted conventions of in-text citation and referencing, where appropriate.

5.4.1 Advice on drafting of student assessment responses

Several assessment techniques require students to draft responses both as part of the process of developing the response and as a strategy to improve the quality of the response.
Teachers and other participants in the teaching and learning process play a significant role in the drafting of student assessment responses. It is important to make the distinction between feedback given as part of the teaching and learning process and structured feedback given as part of developing an assessment response.

The purpose of viewing student drafts is to provide them with feedback so that improvements can be made to the response. Drafting is a consultation process, not a marking process. Teachers should not award a notional result or level of achievement for a work in draft form.

Drafting feedback should ask the student to reflect on strategies they might use to refine their work. The instrument-specific standards should be used to help the students identify the areas they need to review. Schools should consider increasing independence of student learning when constructing drafting policies.

**What is a draft in Science21?**

A draft is a body of evidence that is provided by students in response to assessment instruments. In Science21 this could be a response that is nearly good enough to submit for assessment. Prior to submitting a draft, students may be required to:

- submit a written outline about their approach
- discuss their approach with their teacher.

**What sort of feedback will be provided?**

In providing feedback, teachers will indicate aspects of the response which need to be improved or developed in order to meet the criteria. Students may be advised to:

- work on their role as writer/speaker and show more awareness of the audience
- give priority to the most important points by rearranging the sequence and structure of ideas
- conduct further research or substantiate points made with references.

Teachers may:

- indicate some textual errors and indicate that the draft requires more careful editing — they may not correct or edit all the textual errors in a draft
- provide some written feedback on drafts submitted by the due date
- provide a summary of their feedback and advice to the whole class.
Suggested drafting strategy demonstrating increasing independence of student learning

<table>
<thead>
<tr>
<th>Instruments</th>
<th>Year 11</th>
<th>Year 12</th>
</tr>
</thead>
</table>
| Written     | • teacher consultation allowed  
              • outline submitted  
              • maximum of two drafts submitted | • teacher consultation allowed  
              • one draft or outline submitted |
| Spoken      | • teacher consultation allowed  
              • maximum of two drafts submitted  
              • feedback provided during rehearsal | • teacher consultation allowed  
              • one draft or outline submitted  
              • feedback provided during rehearsal |

5.5 Assessment techniques

The techniques and associated conditions of assessment most suited to the judgment of student achievement in this subject are described below. The general objectives and dimensions to which each technique is best suited are also indicated.

For each dimension, standards are described. These standards descriptors are used to determine the properties or characteristics to be assessed by individual assessment instruments. The properties or characteristics for each instrument determined by a school are termed criteria. Therefore, the criteria for an assessment instrument are drawn from the syllabus standards descriptors for relevant dimensions (see Section 5.8.1 Standards matrix).

Schools decide the instruments to be used for assessment. For each assessment instrument, schools develop a criteria sheet: a tool for making judgments about the quality of students’ responses to an assessment instrument. It lists the properties or characteristics used to assess students’ achievements. Students must be given a criteria sheet for each assessment instrument.

Where students undertake assessment in a group or team, instruments must be designed so that teachers can validly assess the work of individual students and not apply a judgment of the group product and processes to all individuals.

The following assessment techniques may be considered:

- Supervised written assessment
- Extended experimental investigation
- Extended response task
- Collection of work
## 5.5.1 Supervised written

<table>
<thead>
<tr>
<th>Supervised written assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose:</strong> This technique is used to assess student responses that are produced independently, under supervision and in a set timeframe. There is no question of student authorship in this technique.</td>
</tr>
<tr>
<td><strong>A brief description:</strong> This technique is written (by hand or on a computer) and conducted under supervised conditions. It may have a single or multiple items.</td>
</tr>
<tr>
<td><strong>What dimensions will be assessed through this technique?</strong> Aspects of at least two of the dimensions Knowledge and conceptual understanding, Investigative processes and Issues and impacts, should be evident in a Supervised written assessment.</td>
</tr>
<tr>
<td><strong>Specific guidance for a supervised written assessment:</strong> A supervised written assessment could be constructed using one or more items. The items might be in response to stimulus materials, which may be seen or unseen, or questions which should be unseen prior to the administration of the assessment. When using seen materials, schools must ensure the purpose of this technique is maintained. These conditions must be explained on the assessment instrument. Unseen means that the students have not previously seen the material or question. Unseen materials or questions should not be copied from information or texts that students have previously been exposed to or have directly used in class. When stimulus materials are used they should be succinct enough to allow students sufficient time to engage with them. If the stimulus materials are lengthy, complex or large in number they may need to be shared with students prior to the administration of the assessment.</td>
</tr>
</tbody>
</table>

### Types of items that could be included in a supervised written assessment:
- **Multiple choice, single word, true/false, or sentence answers**
  - useful for diagnostic and formative purposes
  - often used for testing content knowledge
  - difficult to construct questions that will elicit meaningful high order cognition responses.
- **Short responses - prose**
  - allows for further explanation when more than a sentence is required
  - ideas are maintained, developed, justified
  - students write in full sentences, constructing a piece of prose that may have one or several paragraphs
  - 50–250 words.
- **Short responses – other (includes practical exercises and calculations)**
  - where students are required to construct, use, interpret or analyse primary or secondary data, graphs, tables or diagrams; and/or to apply algorithms or demonstrate mathematical calculations and problem solving
  - may include paragraph responses
  - 50–250 words (applies to the prose, diagrams and workings not included in word count).
- **Extended written response – essays**
  - require sustained analysis, synthesis and evaluation to fully answer a problem, question or hypothesis
  - generally follows analytical exposition format/genre
  - in response to an seen or unseen question or statement and seen or unseen supplied sources/stimuli
  - 500–800 words
  - if an extended piece of writing is chosen, it is best if it is the only item, as this will better allow students to demonstrate the full range of standards.
Recommended time: 1–1½ hours
Perusal time may be required
Schools must ensure that where computers/word processing are used the purpose of this technique is maintained. Teachers should consider which general objectives are most appropriate
May be open book or notes allowed, these conditions must be clearly outlined on the assessment
Short responses:
- Stimuli/questions unseen
- 50–250 words (applies to the prose, diagrams and workings not included in word count)
Extended written response:
- seen or unseen question
- 500–700 words.

Recommended time: 1½–2 hours
Perusal time may be required
Schools must ensure that where computers/word processing are used the purpose of this technique is maintained. Teachers should consider which general objectives are most appropriate
May be open book or notes allowed, these conditions must be clearly outlined on the assessment
Short responses:
- Stimuli/questions unseen
- 50–250 words (applies to the prose, diagrams and workings not included in word count)
Extended written response:
- seen or unseen question
- 600–800 words.

What must teachers do when planning for a supervised written assessment? What information must be provided to students about supervised written assessments?

Teachers should:
- construct questions that are unambiguous
- format the assessment to allow for ease of reading and responding
- consider the language needs of the students
- ensure the questions allow the full range of standards to be demonstrated
- consider the instrument conditions in relation to the requirements of the question/stimulus
- determine appropriate use of stimulus materials and students notes
- provide students with learning experiences that support the types of items included in the assessment
- teach the appropriate language and communication skills and strategies
- inform the students and indicate on the assessment what dimensions will be assessed.

5.5.2 Extended experimental investigation

Extended experimental investigation

Purpose:
This technique is used to assess the abilities of students to experiment and conduct primary research.

A brief description:
Within this technique, instruments are developed to investigate a hypothesis or answer practical research questions. The focus is on planning the extended experimental investigation and problem solving using primary data generated by student. Experiments may be laboratory- or field-based. An extended experimental investigation may last from four weeks to the entirety of the unit of work, and use in-class and often students’ own time.

Extended experimental investigations are based on research practices. These practices include locating and using information that goes beyond the data that students have been given and the knowledge they currently have. The research process is iterative. It is based on the exploration of a research question, issue or hypothesis.

Extended experimental investigations will follow an inquiry approach and include the:
- establishment of a research question/hypothesis
- generation and/or collection of primary (and/or secondary) data/information
- analysis of data/information
- synthesis of data/information
- examining and evaluating validity and value of data information
- development of research outcomes (conclusions, recommendations, actions, solutions) with justifications.

Specific guidance to the extended experimental investigations:
The outcome of an extended experimental investigation is a written scientific report.

In the report, the student will draw some form of conclusion regarding the question, hypothesis or issue under investigation and support the conclusion with logical argument. A report will normally be presented with section headings. It will often include tables, graphs or diagrams and the analysis of data. Research conventions (e.g. referencing) must be adhered to.

What dimensions will be assessed through this technique?
Aspects of each of the dimensions Knowledge and conceptual understanding, Investigative processes and Issues and impacts, should be evident in the extended experimental investigation.

<table>
<thead>
<tr>
<th>Year 11</th>
<th>Year 12</th>
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</thead>
</table>

What must teachers do when planning for an extended experimental investigation? What information must be provided to students about extended experimental investigations?

Teachers should:
- provide a focus for the research (suggest topics/issues) or work in conjunction with students to develop one, and provide some stimulus to trigger student interest
- negotiate with students to ensure safety and the possibility of success
- allow class time for students to be able to effectively undertake each component of the extended experimental investigation. However, independent student time will be required to complete the task
- implement strategies to ensure authentication of student work. Some strategies are annotated notes in response to issues that emerged during research (e.g. journals, experimental logs), drafting, teacher observation sheets, research checklists, referencing, and reference lists
- consult, negotiate and provide feedback before and during the time the students are working on the extended experimental investigation to provide ethical guidance and to monitor student work. Feedback and assistance should be provided judiciously, gradually being reduced with the development of student experience and confidence
- provide scaffolding. When an extended experimental investigation is undertaken for the first time, the scaffolding should help students complete the assessment by modelling the process and skills required. However, the scaffolding provided should not specify the science or lead the student through a series of steps dictating a solution. Scaffolding should be reduced from Year 11 to Year 12 to allow the student to better demonstrate independence in the research process. When an extended experimental investigation technique is revisited, the scaffolding should be reduced and could be a series of generic questions
- provide students with learning experiences in the use of appropriate communication strategies, including the generic requirements for presenting research (e.g. research report structures, referencing conventions)
- inform the students and indicate on the assessment what dimensions will be assessed and debrief the instrument specific standards.
5.5.3 Extended response

Extended response task

Purpose:
This technique is used to assess the abilities of students to conduct secondary research into a scientific question or issue and examine its impacts.

A brief description:
Within this technique, instruments are developed to investigate a scientific question or issue, with the focus on using secondary data gathered by student (however, primary data could be used where appropriate). An extended response task may last from two weeks to the entirety of the unit of work, and use in class and often students’ own time.

Extended response tasks are based on research practices. These practices include locating and using information that goes beyond the data that students have been given and the knowledge they currently have. The research process is iterative. It is based on the exploration of a scientific question or issue.

Extended response tasks will follow an inquiry approach and include the:
- establishment of a scientific question or issue
- generation and/or collection of secondary (and/or primary) information
- analysis of information
- synthesis of information
- examining and evaluating validity and value of information
- development of research outcomes (conclusions, recommendations, actions, solutions) with justifications.

It may also include the creation of a product and/or the completion of an action or strategy.

What dimensions will be assessed through this technique?
Aspects of each of the dimensions Knowledge and conceptual understanding, Investigative processes and Issues and impacts, should be evident in the extended response task.

Possible types of extended response tasks:
- Analytical exposition, essay: Students provide a response to a specific question or issue. The response may be supported by references or where appropriate tables of data, diagrams and flowcharts. The response could be a persuasive argument or informative text, in the form of a magazine article, paper or research assignment.
- Report: In the report, the student would make some form of decision regarding the question, hypothesis or issue under investigation and support the decision with logical argument. The report may be in response to observations made and conclusions drawn from various sources including case study or studies or experimental outcomes. A report will normally be presented with section headings. It will often include tables, graphs or diagrams and the analysis of statistical data.
- Product: Students design and/or make an artefact. Supporting documentation would be required for the production of a product. This should outline the research processes explaining the choices made in the product creation.

<table>
<thead>
<tr>
<th>Year 11</th>
<th>Year 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytical exposition, essay: 800–1000 words or 3–5 minutes for spoken/multimodal presentation.</td>
<td>Analytical exposition, essay: 1000–1500 words or 5–8 minutes for spoken/multimodal presentation.</td>
</tr>
<tr>
<td>Report: 800–1000 words (analysis, discussion, recommendations and conclusions) or 3–5 minutes for spoken/multimodal presentation.</td>
<td>Report: 1000–1500 words (analysis, discussion, recommendations and conclusions) or 5–8 minutes for spoken/multimodal presentation.</td>
</tr>
<tr>
<td>Product: 800–1000 words (analysis, discussion, recommendations and conclusions).</td>
<td>Product: 1000–1500 words (analysis, discussion, recommendations and conclusions).</td>
</tr>
</tbody>
</table>
What must teachers do when planning for an extended response task? What information must be provided to students about extended response tasks?

Teachers should:
- provide a focus for the research (suggest topics/issues) or work in conjunction with students to develop one, and provides some stimulus to trigger student interest.
- negotiate with students to ensure the possibility of success.
- allow class time for students to be able to effectively undertake each component of the extended response task. However, independent student time will be required to complete the task.
- implement strategies to ensure authentication of student work. Some strategies are annotated notes in response to issues that emerged during research (e.g. journals), drafting, teacher observation sheets, research checklists, referencing, and reference lists.
- consult, negotiate and provide feedback before and during the time the students are working on the extended response task to provide ethical guidance and to monitor student work. Feedback and assistance should be provided judiciously, gradually being reduced with the development of student experience and confidence.
- provide scaffolding. When an extended response task is undertaken for the first time, the scaffolding should help students complete the assessment by modelling the process and skills required. However, the scaffolding provided should not specify the science or lead the student through a series of steps dictating a solution. Scaffolding should be reduced from Year 11 to Year 12 to allow the student to better demonstrate independence in the research process. When an extended response task technique is revisited, the scaffolding should be reduced and could be a series of generic questions.
- provide students with learning experiences in the use of appropriate communication strategies, including the generic requirements for presenting research (e.g. research report structures, referencing conventions).
- inform the students and indicate on the assessment what dimensions will be assessed and debrief the instrument specific standards.

5.5.4 Collection of work

**Collection of work**

**Purpose:**
This technique is used to assess student responses to a series of tasks relating to a single cohesive investigative context.

**A brief description:**
The assessable outcome of a collection of work is a folio containing student responses to a variety of assessment situations. This should comprise one written and a minimum of two other written and/or nonwritten components.

**Written:**
- summary and analysis of a newspaper or magazine article from a scientific perspective
- scientific analysis of a real-world scenario
- report on a short practical activity
- processing of research data or of data gathered on a field trip or industry site visit
- annotated bibliography.

**Nonwritten:**
Oral, electronic or multimodal presentation.

**What dimensions will be assessed through this technique?**
Aspects of each of the dimensions Knowledge and conceptual understanding, Investigative processes and Issues and impacts, should be evident in the collection of work.
What must teachers do when planning for a collection of work? What information must be provided to students about collections of work?

Teachers should:
- define the purpose of the collection of work. Components of the collection must relate to each other so that they form a single cohesive investigative context
- provide a focus for the research (suggests topics/issues) or work in conjunction with students to develop one, and provide some stimulus to trigger student interest
- negotiate with students to ensure the possibility of success
- allow some continuous class time for the students to be able to effectively undertake each component of the collection of work. Teachers may allow activities to be conducted in small groups or pairs. However, independent student time will probably be required to complete the collection of work
- implement strategies to ensure authentication of student work. Some strategies are annotated notes in response to issues that emerged during research (e.g. journals), drafting, teacher observation sheets, research checklists, referencing, and reference lists
- consult, negotiate and provide feedback before and during the time students are working on the collection of work to provide ethical guidance and to monitor student work. Feedback and assistance should be provided judiciously, gradually being reduced with the development of student experience and confidence
- provide scaffolding. When a collection of work is undertaken for the first time, the scaffolding should help students complete the assessment by modelling the process and skills required for each component of the collection of work. However, the scaffolding provided should not specify the science or lead the student through a series of steps dictating a solution. Scaffolding should be reduced from Year 11 to Year 12 to allow students to better demonstrate independence in the research process. When a collection of work is revisited, the scaffolding should be reduced and could be a series of generic questions
- provide students with learning experiences in the use of appropriate communication strategies, including the generic requirements for presenting research (e.g. research report structures, referencing conventions)
- inform the students and indicate on the assessment what dimensions will be assessed and debrief the instrument specific standards.

5.6 Requirements for verification folio

A verification folio is a collection of a student’s responses to assessment instruments on which the level of achievement is based. For students who are to exit with four semesters of credit, each folio must contain the range and mix of assessment techniques for making summative judgments stated below.

Students’ verification folios for Science21 must contain:
- a minimum of four and a maximum of six assessment instruments
- a range of assessment instruments that include both of the following assessment techniques:
  - Supervised written assessment
  - Extended experimental investigation.
- no more than two of any one assessment technique
- evidence of assessment in all five focus areas
• a criteria sheet for each assessment instrument which provides evidence of how students meet standards associated with each dimension being assessed

• a student profile that records achievement in the assessment instruments across all assessment dimensions used to substantiate the proposed interim level of achievement.

For information about preparing monitoring and verification submissions schools should refer to the moderation handbook, available at <www.qsa.qld.edu.au>.

5.6.1 Post-verification assessment

Schools must use assessment information gathered after verification in making judgments about exit levels of achievement for those students who are completing the fourth semester of the course of study. For this syllabus students are to complete at least one subsequent summative assessment instrument. It is desirable for the instrument to assess across all three dimensions.

5.6.2 Student profile

The purpose of the student profile is to record student achievement over the four-semester course of study. Key elements on the profile include:

• semester units/contexts/topics
• assessment instruments in each semester
• standard achieved in each dimension for each instrument
• instruments used for summative judgments
• interim level of achievement at monitoring and verification.

5.7 Exit standards

The purpose of standards is to make judgments about students’ levels of achievement at exit from a course of study. The standards are described in the same dimensions as the assessable general objectives of the syllabus. The standards describe how well students have achieved the general objectives and are stated in the standards matrix.

The following dimensions must be used:

• Dimension 1: Knowledge and conceptual understanding
• Dimension 2: Investigative processes
• Dimension 3: Issues and impacts

Each dimension must be assessed in each semester, and each dimension is to make an equal contribution to the determination of exit levels of achievement.
5.8 Determining exit levels of achievement

When students exit the course of study, the school is required to award each student an exit level of achievement from one of the five levels:

- Very High Achievement (VHA)
- High Achievement (HA)
- Sound Achievement (SA)
- Limited Achievement (LA)
- Very Limited Achievement (VLA).

Exit levels of achievement are summative judgments made when students exit the course of study. For most students this will be after four semesters. For these students, judgments are based on exit folios providing evidence of achievement in relation to all general objectives of the syllabus and the standards.

All the principles of exit assessment must be applied when making decisions about exit levels of achievement.

5.8.1 Determining a standard

The standard awarded is an on-balance judgment about how the qualities of the student’s work match the standards descriptors overall in each dimension. This means that it is not necessary for the student to have met every descriptor for a particular standard in each dimension.

When standards have been determined in each of the dimensions for this subject, the following table is used to award exit levels of achievement, where A represents the highest standard and E the lowest. The table indicates the minimum combination of standards across the dimensions for each level.

<table>
<thead>
<tr>
<th>Awarding exit levels of achievement</th>
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<tbody>
<tr>
<td><strong>VHA</strong></td>
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<tr>
<td><strong>HA</strong></td>
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<tr>
<td><strong>SA</strong></td>
</tr>
<tr>
<td><strong>LA</strong></td>
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<tr>
<td><strong>VLA</strong></td>
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</tbody>
</table>

Some students will exit after one, two or three semesters. For these students, judgments are based on folios providing evidence of achievement in relation to the general objectives of the syllabus covered to that point in time. The particular standards descriptors related to those objectives are used to make the judgment.

Further information can be found at <www.qsa.qld.edu.au> by searching for “discontinued”.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
</table>
| Knowledge and conceptual understanding | The student work has the following characteristics:  
- description and explanation of complex scientific information  
- comparison and explanation of complex interrelationships between scientific ideas, concepts, theories, processes and phenomena  
- interpretation and application of scientific knowledge and information to generate reasoned explanations of real-world phenomena. | The student work has the following characteristics:  
- description and explanation of scientific information  
- comparison and explanation of interrelationships between scientific ideas, concepts, theories, processes and phenomena  
- application of scientific knowledge and information to generate informed explanations of real-world phenomena. | The student work has the following characteristics:  
- description of scientific information  
- description of interrelationships between scientific ideas, concepts, theories, processes and phenomena  
- generation of scientific explanations of real-world phenomena. | The student work has the following characteristics:  
- statements of scientific information  
- statements of simple interrelationships between scientific ideas and concepts  
- identification of scientific information about real-world phenomena. | The student work has the following characteristics:  
- statements of isolated scientific facts  
- statements of simple scientific ideas  
- superficial statements about real-world phenomena. |
| Investigative processes | The student work has the following characteristics:  
- questions and/or hypotheses formulated by identifying problems and/or issues that inform justified and refined plans for investigation  
- assessment and management of risk; safe selection and use of equipment and purposeful use of technology to gather and enhance the reliability of data and information | The student work has the following characteristics:  
- questions and/or hypotheses formulated by identifying problems and/or issues that inform justified plans for investigation  
- assessment and management of risk; safe selection and use of equipment and appropriate use of technology to gather reliable data | The student work has the following characteristics:  
- questions and/or hypotheses formulated using given problems and/or issues to select and implement a given scientific investigation  
- assessment and management of risk; safe selection and use of equipment and technology to gather data | The student work has the following characteristics:  
- implementation of given structured scientific investigation  
- management of risk; safe use of equipment /technology to gather data | The student work has the following characteristics:  
- identification of scientific problems or issues  
- safe, directed operation of equipment /technology |
<table>
<thead>
<tr>
<th>Dimension</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issues and impacts</td>
<td>• systematic analysis and interpretation of data and information using appropriate quantitative and qualitative techniques to identify trends, relationships and anomalies&lt;br&gt;• discriminating selection and presentation of scientific data/ideas, using scientific convention and terminology, to clearly convey meaning to a variety of intended audiences using appropriate formats.</td>
<td>• analysis and interpretation of data and information using appropriate quantitative and qualitative techniques to identify trends and anomalies&lt;br&gt;• selection and presentation of scientific data/ideas, using scientific convention and terminology, to convey meaning to a variety of intended audiences using appropriate formats.</td>
<td>• analysis of data and information using appropriate quantitative and qualitative techniques&lt;br&gt;• selection and presentation of scientific data/ideas to make meaning accessible in a variety of formats.</td>
<td>• partial analysis of data and information&lt;br&gt;• presentation of scientific data/ideas in a variety of formats.</td>
<td>• rudimentary analysis of data or information</td>
</tr>
</tbody>
</table>
6. Language education

Teachers of Senior English have a special responsibility for language education. However, it is the responsibility of all teachers to develop and monitor students’ abilities to use the forms of language appropriate to their own subject areas. Their responsibility entails developing the following skills:

- ability in the selection and sequencing of information required in the various forms (such as reports, essays, interviews and seminar presentations)
- the use of technical terms and their definitions
- the use of correct grammar, spelling, punctuation and layout.

Assessment in all subjects needs to take into consideration appropriate use of language. Students should understand and use appropriate scientific terms and phrases wherever the need arises. In order to achieve understanding of appropriate scientific terms, it may be necessary for students to develop their own glossaries as they progress through a course in Science21.

Students should be engaged in learning experiences which involve them in:

<table>
<thead>
<tr>
<th>Drawing upon sources of information, such as:</th>
<th>Using language for the purposes of:</th>
<th>Presenting information in forms such as:</th>
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<tbody>
<tr>
<td>observations</td>
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<tr>
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<td>predicting the results of an</td>
<td>models</td>
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<tr>
<td>lectures</td>
<td>experiment</td>
<td>photographs</td>
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<tr>
<td>interviews</td>
<td>evaluating scientific arguments</td>
<td>electronic media</td>
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<tr>
<td>discussions</td>
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</tbody>
</table>
7. Quantitative concepts and skills

Success in dealing with issues and situations in life and work depends on the development and integration of a range of abilities, such as being able to:

- comprehend basic concepts and terms underpinning the areas of number, space, probability and statistics, measurement and algebra
- extract, convert or translate information given in numerical or algebraic forms, diagrams, maps, graphs or tables
- calculate, apply algebraic procedures, implement algorithms
- use calculators and computers
- use skills or apply concepts from one problem or one subject domain to another.

Some subjects focus on the development and application of numerical and other mathematical concepts and skills. These subjects may provide a basis for the general development of such quantitative skills or have a distinct aim, such as to prepare students to cope with the quantitative demands of their personal lives or to participate in a specific workplace environment.

Nevertheless, in all subjects, students are to be encouraged to develop their understanding and to learn through the incorporation — to varying degrees — of mathematical strategies and approaches to tasks. Similarly, students should be presented with experiences that stimulate their mathematical interest and hone those quantitative skills that contribute to operating successfully within each of their subject domains.

The distinctive nature of a subject may require that new mathematical concepts be introduced and new skills be developed. In many cases, however, it will be a matter of teachers, in the context of their own subjects, encouraging the use of quantitative skills and understandings that were developed previously by their students. Within appropriate learning contexts and experiences in the subject, opportunities are to be provided for the revision, maintenance, and extension of such skills and understandings.

In Science21, students are encouraged to develop their understanding and to learn through the incorporation — to varying degrees — of mathematical strategies and approaches to tackling problems. They should be presented with experiences that stimulate their mathematical interest and hone those quantitative skills that contribute to operating effectively within scientific contexts and participating successfully in society.
8. Educational equity

Equity means fair treatment of all. In developing work programs from this syllabus, schools should incorporate the following concepts of equity.

All young people in Queensland have a right to gain an education that meets their needs and prepares them for active participation in creating a socially just, equitable and democratic global society. Schools need to provide opportunities for all students to demonstrate what they know and can do. All students, therefore, should have equitable access to educational programs and human and physical resources. Teachers should ensure that particular needs of the following groups of students are met: female students; male students; Aboriginal students; Torres Strait Islander students; students from non–English-speaking backgrounds; students with disabilities; students with gifts and talents; geographically isolated students; and students from low socioeconomic backgrounds.

Subject matter chosen should include, whenever possible, the contributions and experiences of all groups of people. Learning contexts and community needs and aspirations should also be considered. In choosing appropriate learning experiences teachers can introduce and reinforce non-racist, non-sexist, culturally sensitive and unprejudiced attitudes and behaviour. Learning experiences should encourage the participation of students with disabilities and accommodate different learning styles.

Resource materials used should recognise and value the contributions of both females and males to society and include social experiences of both genders. Resource materials should also reflect cultural diversity within the community and draw from the experiences of the range of cultural groups in the community.

To allow students to demonstrate achievement, barriers to equal opportunity need to be identified, investigated and removed. This may involve being proactive in finding the best ways to meet the diverse range of learning and assessment needs of students. The variety of assessment techniques in the work program should allow students of all backgrounds to demonstrate their knowledge and skills related to the dimensions and standards stated in this syllabus. Syllabus dimensions and standards should be applied in the same way to all students.

Teachers should consider equity policies of individual schools and schooling authorities, and may find the following resources useful for devising an inclusive work program:


9. Resources

Text and reference books

A wide variety of textbooks and resource materials that could be used as sources of information about Science21 are available. Book suppliers provide information regarding current publications.

World wide web

Many interactive and static websites can be used to enhance a course in Science21 and often include useful resources. Some particularly useful sites include:

- Commonwealth Scientific and Industrial Research Organisation (CSIRO) (resources, activities and awards for school science education programs) <www.csiro.au>
- EdNa Queensland Science Teachers Group (discussion group for teachers of Science in Queensland) <www.groups.edna.edu.au>
- The Khan Academy — a not-for-profit organisation that provides online video tutorials on a variety of science topics <www.khanacademy.org>
- How Stuff Works (easy-to-read articles, and links to a huge number of subjects, including introductory science topics) <http://science.howstuffworks.com>
- Nova: Science in the news (published by the Australian Academy of Science) <www.science.org.au/nova>
- School Science <www.schoolscience.co.uk>
- TeachNET — a professional development network for contextual teaching and learning <www.cew.wisc.edu/teachnet>
- Web Elements <www.webelements.com>

Newspaper reports

Many newspapers carry regular pages, columns and features about science. Local newspapers can also be a source of useful data. The compilation of news files on particular topics can broaden the knowledge base of students and provide a valuable source of material for developing assessment instruments.

Periodicals

Journals and periodicals provide current, relevant information. Journals and periodicals relevant to Science21 may include:

- Australasian Science <www.australasianscience.com.au>
- Cosmos <www.cosmosmagazine.com>
- New Scientist <www.newscientist.com>
- Popular Science <www.popsci.com.au>
- Scientific American <www.scientificamerican.com>
School librarians should be able to provide assistance with identifying and locating other useful periodicals. The National Library of Australia and The State Library of Queensland also provided access to electronic databases.

- The National Library of Australia — eResources. Provides access to indexes, databases, full-text journals, subject guides and websites <www.nla.gov.au/app/eresources>
- The State Library of Queensland — e-service. Provides access to the State Library of Queensland’s collections and services, including access to electronic databases containing full text journal, magazine and newspaper articles <www.slq.qld.gov.au/services/ecard>

**Electronic media and learning technology**

A wide range of videos, DVDs and television recordings are available on a variety of topics related to Science21. A variety of computer software programs and CD-ROMs may be useful for a course in Science21, both as learning tools, to gain access to information presented in a variety of forms and to assist students in gaining ICT skills. Educational program distributors are able to supply updated resource lists.

iTunes <www.apple.com/itunes> provides access to a wide range of science podcasts and iTunes U content. Some of these include:

- All in the Mind
- Astronomy Cast
- Brain Science Podcast
- CSIROpod
- Dr Karl on triple j
- The Naked Scientists
- The Science Show
- Science Weekly
- Scientific American Podcast
- The Skeptics’ Guide to the Universe

**Organisations and community resources**

A variety of government and community organisations provide personnel, advice, resources and information to assist in constructing and implementing a course in Science21.

Schools should be aware that protocols must be observed when working with Aboriginal and Torres Strait Islander organisations and community groups, for example, meeting with the elders before any activity is conducted. One such set of protocols may be found in the senior syllabus in Aboriginal and Torres Strait Islander Studies.
10. Glossary

For terms related to assessment and moderation see the QSA assessment glossary, available from <www.qsa.qld.edu.au> by searching for “Assessment Glossary”.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algorithm</td>
<td>Process or set of rules to be used; systematic procedure to solve a problem in a finite number of steps; step-by-step approach.</td>
</tr>
<tr>
<td>Analyse</td>
<td>To break up a whole into its parts, to examine in detail to determine the nature of, to look more deeply and to detect the relationships between parts.</td>
</tr>
<tr>
<td>Communicate</td>
<td>Convey information about; make known; impart; reveal clearly; manifest.</td>
</tr>
<tr>
<td>Compare</td>
<td>Displaying recognition of similarities and differences and recognising the significance of these similarities and differences.</td>
</tr>
<tr>
<td>Complexity</td>
<td>Relating to the number of elements or components in a relationship or interaction; many elements or components may be viewed as having greater complexity than that which has fewer.</td>
</tr>
<tr>
<td>Concept</td>
<td>An abstract idea or a mental symbol, typically associated with a corresponding representation in language or symbology, that denotes all of the objects in a given category or class of entities, interactions, phenomena, or relationships between them. Concepts are abstract in that they omit the differences of the things in their extension, treating them as if they were identical. They are universal in that they apply equally to everything in their extension. Concepts are also the basic elements of propositions. Concepts are discursive and result from reason. Concepts help to integrate apparently unrelated observations and phenomena into viable hypotheses and theories.</td>
</tr>
<tr>
<td>Conclusion</td>
<td>Final result or summing up; inference deduced from previous information; reasoned judgment.</td>
</tr>
<tr>
<td>Contextualised</td>
<td>A context is a framework for linking concepts and learning experiences that enables students to identify and understand the application of science to their world. A context is a group of related situations, phenomena, technical applications and social issues likely to be encountered by students. A context provides a meaningful application of concepts in real-world situations.</td>
</tr>
<tr>
<td>Contrast</td>
<td>Displaying recognition of differences by deliberate juxtaposition of contrary elements.</td>
</tr>
<tr>
<td>Data</td>
<td>In the context of the Science21 syllabus, data are thought of as documented information or evidence of any kind that lends itself to scientific interpretation. Data may be quantitative or qualitative.</td>
</tr>
<tr>
<td>Decision</td>
<td>The process of coming to a conclusion or determination about something; resolve, form conclusions, provide judgment for an answer; choice formed after considering various alternatives.</td>
</tr>
<tr>
<td>Deduce</td>
<td>Reach a conclusion which is necessarily true provided a set of assumptions is true.</td>
</tr>
<tr>
<td>Demonstrate</td>
<td>Explain process; prove or show to be true; provide evidence.</td>
</tr>
<tr>
<td>Depth</td>
<td>The development of knowledge and understandings from simple through to complex.</td>
</tr>
<tr>
<td>Describe</td>
<td>Give an account of in speech or writing; convey an idea or impression of; characterise; represent pictorially; depict; trace the form or outline of.</td>
</tr>
<tr>
<td>Discuss</td>
<td>Consider a particular topic in speaking or writing; talk or write about a topic to reach a decision.</td>
</tr>
<tr>
<td>Elaborations</td>
<td>Statements that illustrate the key concepts.</td>
</tr>
<tr>
<td>Estimate</td>
<td>Calculate an approximate amount or quantity.</td>
</tr>
<tr>
<td><strong>Evaluate</strong></td>
<td>Establishes the value, quality, importance, merit, relevance or appropriateness of information, data or arguments based in logic as opposed to subjective preference.</td>
</tr>
<tr>
<td><strong>Explain</strong></td>
<td>Make clear or understandable; show knowledge in detail.</td>
</tr>
<tr>
<td><strong>Genre</strong></td>
<td>Genres are conventionalised, staged, purposeful language interactions that occur among and are recognised by those who participate within a certain culture.</td>
</tr>
<tr>
<td><strong>Hypothesis</strong></td>
<td>A tentative explanation for a phenomenon, in the form of a testable statement, used as a basis for further investigation.</td>
</tr>
<tr>
<td><strong>Identify</strong></td>
<td>Recognise, name or select.</td>
</tr>
<tr>
<td><strong>Interpret</strong></td>
<td>Give meaning to information presented in various forms — words, symbols, pictures, graphs, etc.</td>
</tr>
</tbody>
</table>
| **Journal** | Journals may be used to record a range of information, including ideas and working processes. They are useful sources when monitoring the progress of learners. They may be used by students to record the progress of, and their reflection on, the process of research. When used for summative assessments, journals must be accompanied by a description of specific criteria drawn from the exit criteria, and by a clear statement of assessment conditions. Sections of journals may be used as drafts for final reports. The draft material should be included in the verification folio. Journals should be linked to other assessment instruments. Journals may include:  
  - personal writings, points of view  
  - interpretations of relevant research findings, articles, references, news clippings  
  - charting of personal ideas and responses to an issue as an aid to reflection  
  - media files  
  - critiques of scientific journals  
  - drawings, photographs, videos, audiotapes  
  - records of and reflections on conversations, interviews, discussions with individuals and in groups  
  - teacher annotations, feedback on drafts, confirmation of checkpoints. |
| **Justify** | Provide sound reasons based on logic or theory to support response; prove or show statements are just or reasonable; convince. |
| **Key concepts** | The key concepts are accepted broad scientific understandings. |
| **Primary data** | Information that does not already exist, collected under research guidelines. |
| **Qualitative** | Concerned with quality; verbal analysis. |
| **Quantitative** | Concerned with measurement; mathematical analysis. |
| **Reliability** | Able to be trusted to be accurate or correct or to provide a correct result. |
| **Secondary data** | The result of research that involves the summary, collation and/or synthesis of existing research rather than primary research (where data is collected from, for example, research subjects or experiments). |
| **Solution** | Answers to problems, investigations, research or questions. |
| **State** | Students are required to state scientific information. Under examination conditions, students must necessarily recall information in order to then state it. |
| **Synthesise** | Assemble constituent parts into a coherent, unique and/or complex entity. The term entity includes a system, theory, communication, plan, set of operations. |
| **Theory** | A set of facts, propositions, or principles analysed in their relation to one another and used, especially in science, to explain phenomena. |
| **Validity** | Sound, reasonable, relevant, defensible, well grounded, able to be supported with logic or theory. |