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1 Rationale

To have an informed voice in charting the future of society and to effectively participate in society and everyday life, where science and technology play significant and increasing roles, students need to be scientifically literate.

Science in Practice contributes to developing scientifically literate individuals who are interested in and understand the world around them by talking about science issues. They are able to identify questions, investigate and draw evidence-based conclusions. By questioning claims made by others about scientific matters, students will be able to make informed decisions about the environment and their own health and well-being.

Through the processes of practical and investigative approaches, Science in Practice develops students who will:

- think critically about the scientific basis of significant contemporary issues
- apply their knowledge in a broad range of relevant practical situations, including field work
- foresee consequences for their own and society’s activities on the living and physical world
- participate as informed and responsible citizens in decision-making processes
- use community and industry resources
- use technology
- collaborate and work effectively in teams.

The scientific skills developed are relevant to employment in many fields and may form the basis of further training and education, e.g. animal welfare, biotechnology, food technology, forensics, health and medicine, pharmaceutical industry, recreation and tourism, research and the resources sector.
2 Dimensions and objectives

The dimensions are the salient properties or characteristics of distinctive learning for this subject. The dimensions are described through their objectives and it is these that schools are required to teach and that students should have the opportunity to learn. The objectives describe what students should be able to do by the end of the course of study.

Progress in a particular dimension may depend on the qualities and skills developed in other dimensions. Learning through each of the dimensions must be developed in increasing complexity and sophistication over a four-semester course of study.

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

The dimensions for a course of study in this subject are:
- Dimension 1: Knowing
- Dimension 2: Investigating
- Dimension 3: Connecting

2.1 Dimension 1: Knowing

The dimension, Knowing, incorporates the recall, description, explanation and application of relevant scientific understandings in particular contexts, such as workplace health and safety circumstances. This knowledge and understanding forms the basis for scientific literacy.

2.1.1 Objectives

By the conclusion of the course of study, students should:
- recall, describe and explain scientific facts, concepts and principles
- identify and explain scientific procedures and processes, risks and hazards
- apply ethical and scientific understandings in a range of situations.

2.2 Dimension 2: Investigating

The dimension, Investigating, incorporates components of scientific inquiry, including planning investigations, developing and refining research questions or hypotheses, collecting and recording quantitative and qualitative data, and applying research and practical scientific skills.

2.2.1 Objectives

By the conclusion of the course of study, students should:
- plan investigations using questions or hypotheses
- collect, select and record data and information
- use practical scientific skills, research processes and methods, including the safe usage of materials, equipment and technology.
2.3 Dimension 3: Connecting

The dimension, *Connecting*, incorporates components of scientific inquiry including analysing research findings, synthesising data, and developing solutions to scientific questions and issues in contemporary and authentic science contexts. This data and information is communicated and presented to meet particular purposes and audience needs.

2.3.1 Objectives

By the conclusion of the course of study, students should:

- analyse and synthesise data and information, and scientific understandings
- make inferences, propose solutions, predict outcomes and draw conclusions
- communicate and present scientific data and information for particular purposes and audiences.
3 Course organisation

3.1 Course overview
When designing the four semester course of study schools must include within each year of the course:

- at least three of the following Course organisers (see 3.1.1):
  - Science for the workplace
  - Resources, energy and sustainability
  - Health and lifestyles
  - Environments
  - Discovery and change
- the Study area core (see 3.1.2):
  - Scientific literacy and working scientifically
  - Workplace health and safety
  - Communication and self-management skills
- at least 10 hours of practical field work (see 3.1.4)
- technology (see 3.1.5)
- at least two units of work.

Each unit of work must:

- use a contextualised approach (see 3.1.3) that facilitates the inclusion of learning experiences from aspects of at least two science disciplines (Biology, Chemistry, Earth Science, Physics)
- integrate aspects from each of the Study area core topics (see Table 2, page 7)
- have a practical nature
- be a minimum of twenty hours.

3.1.1 Course organisers
A course of study is based on the Course organisers outlined in Table 1.

Table 1: Course organisers

<table>
<thead>
<tr>
<th>Science for the workplace</th>
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<tbody>
<tr>
<td>The nature of work and work skills required change rapidly. New skills in the workplace are in demand all the time; at the same time some skills are becoming obsolete. Many employers argue that communication, teamwork, problem solving, initiative and enterprise, planning and organising, self-management, and learning and technology skills are as important as professional, paraprofessional and technical skills. Students should explore and develop an awareness of science as it operates in common or local workplaces. A unit of work may be designed, which provides opportunities to apply scientific knowledge and skills to specific work roles and/or environments. This will depend on ease of access to community resources, local trades and industry, and the needs and interests of the students. Employment opportunities that exist within this area include:</td>
</tr>
<tr>
<td>Laboratory manager</td>
</tr>
<tr>
<td>Horticulturalist</td>
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<tr>
<td>Hairdresser</td>
</tr>
</tbody>
</table>
Science for the workplace

- Apprenticeships, traineeships and trades.

Resources, energy and sustainability

The solutions to the resources and energy challenges facing humanity are likely to come from the wise application of science and technology. Students should develop an awareness of the consequences of using resources by considering short and long term impacts and sustainability.

“Fossil fuels will continue to play a major role in our regional and global energy needs … joint research, development, deployment and transfer of low and zero emission technologies for their cleaner use, particularly coal, will be essential. It is also important to enhance energy efficiency and diversify energy sources and supplies, including renewable energy. For those economies which choose to do so, the use of nuclear energy, in a manner ensuring nuclear safety, security and non-proliferation in particular its safeguards, can also contribute.” (APEC Sydney Declaration, 2008)

Employment opportunities that exist within this area include:

- Environmental health officer
- Fisheries inspector
- Conservation worker
- Mine industry worker.

Health and lifestyles

Individuals and industry have a responsibility, both to themselves and to society, to promote health. Increasing numbers of individuals are being diagnosed with diseases such as asthma, arthritis, cancer, obesity, allergies, diabetes and cardiovascular disease.

Students should understand the potential impact of science on human health. Science directs attention to preventative measures and provides solutions to health and lifestyle challenges. The impacts of science on health and safety have accelerated in the last century. These impacts have great implications for the future and affect not only humans, but also plants and animals.

“A … challenge for the future is to engage the methods of science in addressing the entire gamut of factors affecting health; these include behavioural and environmental influences … Thus we must consider all levels of biological organisation — from cellular and molecular to functional systems, organisms and populations.” (Hamburg & Nightingale, 1984)

Employment opportunities that exist within this area include:

- Enrolled nurse
- Dispensing assistant
- Fitness Instructor
- Dental assistant/Dental technician/Dental hygienist
- Allied health therapist.
Environments

Environments can be geological and ecological, large or small, natural or man-made. Students should understand the management of environments is reliant upon an understanding of the individual components and their inherent interrelationships and the impact of the human species on them.

We are both part of, and determining factors in, the “environment”. Human interactions with the Earth have a profound effect on present and future generations. Science informs complex global problems.

“When human numbers were small, our technology simple and our consumption mainly for survival, nature was generally able to absorb our impact … Consider this: … in a mere 100 years, the population of the planet has quadrupled. Almost all the modern technology we take for granted has been developed and expanded since the late 1800s … these factors have amplified humanity’s ecological footprint … consequently we are now altering the chemical, physical and biological makeup of the planet on a geological scale.” (David Suzuki, 2008)

Employment opportunities that exist within this area include:
- Aquaculture technician
- Gardener/Pest and weed controller/Greenkeeper
- Park ranger
- Farmer
- Ecotourism guide.

Discovery and change

Changing circumstances and paradigms often precipitate rapid progress in science. These circumstances could include: crises, global change, the work of individuals, changes in technology and new frontiers for exploration. Cutting-edge technology has forged new frontiers with the use of lasers, fibre optics, microchips, genomics, computer-based drug design, digital imaging, and computer-generated models.

Students should examine new discoveries in science or where scientific understandings have recently been challenged and modified; for example, cycads are no longer considered plants of the dinosaur era.

“A strong science and innovation system — focused on developing and retaining skills, generating new ideas through research and turning them into commercial success — can contribute to Australia’s future prosperity. Science and innovation can also provide the tools to solve complex problems and adapt to social and environmental challenges such as population ageing, land degradation and climate change. Within that system, research plays a critical role.” (Australian Government, 2008)

Students should understand that changes may be driven by recognition of threats to health, safety, or the national or personal interest. They 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. They can also lead to the development of new industry and employment opportunities.

Employment opportunities that exist within this area include:
- Ultrasound technician
- Telecommunications technician
- Computer service technician
- Journalist
- Research assistant.

3.1.2 Study area core

The Study area core underpins the study area specification and is essential to realising the objectives of the course of study. It is delivered through the specific unit choices of the school.

The Study area core must be integrated and progressively developed throughout the course of study chosen by the school.
The core topics are designed to encourage students to develop an understanding of the principles and practices of:

- Scientific literacy and working scientifically
- Workplace health and safety
- Communication and self-management skills.

**Table 2: Study area core topics**

<table>
<thead>
<tr>
<th>Scientific literacy and working scientifically</th>
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<tbody>
<tr>
<td>This core topic is designed to encourage students to become scientifically informed individuals. Scientific literacy is a way of thinking and a way of viewing and interacting with the world; it is encouraged and developed through working scientifically. Working scientifically encompasses the practical and analytical approaches of scientific inquiry and investigation. When working scientifically students make sense of the phenomena they experience as they investigate, understand and communicate. Students should develop regard for the wellbeing of the living and non-living components of the environment and the consequences of decisions by:</td>
</tr>
<tr>
<td>- engaging in conversations in and about science</td>
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<tr>
<td>- being sceptical and questioning</td>
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<tr>
<td>- identifying questions and drawing evidence-based conclusions</td>
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<tr>
<td>- making and communicating informed decisions</td>
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<tr>
<td>- valuing ideas and seeking explanations</td>
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<tr>
<td>- respecting evidence and reasoning</td>
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<tr>
<td>- thinking creatively and laterally</td>
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<tr>
<td>- demonstrating ethical behaviour.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Workplace health and safety</th>
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<tbody>
<tr>
<td>This core topic is designed to introduce students to the principles and practices of Workplace health and safety when operating in a scientific context, e.g. when protecting the safety and health of people using a laboratory and associated equipment. Workplace health and safety legislation usually requires that a risk assessment be carried out prior to performing laboratory procedures. This risk assessment should:</td>
</tr>
<tr>
<td>- identify the hazards</td>
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<tr>
<td>- identify who may be affected by the hazard and how</td>
</tr>
<tr>
<td>- evaluate the risk</td>
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<tr>
<td>- identify any required actions. Students should:</td>
</tr>
<tr>
<td>- be familiar with Workplace health and safety documents such as material safety data sheets (MSDS), standard operating procedures, and relevant Australian standards</td>
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<tr>
<td>- identify, assess and report hazards in the laboratory and in the field in relation to various tasks</td>
</tr>
<tr>
<td>- identify hazardous substances from labels and MSDS and consequently:</td>
</tr>
<tr>
<td>- use appropriate personal protection equipment (PPE) when conducting practical work in the laboratory and in the field</td>
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<tr>
<td>- adapt their surroundings to meet safety requirements</td>
</tr>
<tr>
<td>- take appropriate precautions to prevent injury, e.g. when handling glass and/or hot objects</td>
</tr>
<tr>
<td>- recognise and demonstrate the correct procedures when:</td>
</tr>
<tr>
<td>- using hazardous substances</td>
</tr>
<tr>
<td>- handling and using a range of tools, technologies and equipment</td>
</tr>
<tr>
<td>- handling biological materials such as live animal and plant specimens, micro-organisms and materials for dissection</td>
</tr>
<tr>
<td>- working in the laboratory and in the field</td>
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<tr>
<td>- carry out emergency procedures established for a particular hazard, e.g. chemical spill, fire evacuation.</td>
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</tbody>
</table>
Communication and self-management skills

This core topic is designed to increase awareness of the balance between discipline-specific skills and those necessary for the workplace. It is important for students to develop communication and self-management skills, including initiative, teamwork, problem-solving, planning and organisation and technological competence. These, along with the General capabilities are also beneficial for successful participation in Australian society. In a world where knowledge rapidly becomes obsolete the ability to identify, access, network and communicate new information is vital for career success. Students should:

- acquire and convey information in suitable forms specific to a context of study
- develop interpersonal and self-organisation skills and persistence
- follow written and oral instructions and procedures in order to operate in a safe and efficient manner, whether in a classroom, a laboratory, the field or a place of work
- use appropriate formats to record written information in a complete, accurate and legible fashion
- use technology suitable for conveying information in a clear manner
- communicate oral and written information using appropriate everyday and scientific language in a range of modes
- identify, organise and prepare materials and/or equipment for tasks stated in verbal or written instructions
- manage time and complete tasks within agreed time frames
- access information from a variety of relevant and valid sources.

3.1.3 Developing contexts as units of work

Learning occurs best when the learner considers it to be real and relevant. Units of work developed through contexts enable students to identify science in their world and understand the importance of science in their lives. By engaging with scientific concepts in a range of contexts students have the opportunity to develop informed and transferable understandings.

A context that is purposeful and significant for learning is a framework that links concepts and learning experiences in real-world situations. 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.

3.1.4 Practical and field work

Practical and field work form an integral part of this study area. It is important that schools recognise the need to provide adequate time for learning experiences of a practical nature.

At least 10 hours per year is recommended for student field work. Field work may range from local, short-duration activities to an extended excursion, e.g. visiting local industries, places of work, laboratories and museums; accessing mobile laboratories, displays and resources; and researching local natural environments such as bushland, creeks and dams.
3.1.5 Technology
Courses of study for Science in Practice should be rich in learning experiences involving the use of scientific instrumentation and technology. The use of computers and data-logging equipment will significantly enhance learning outcomes. Schools should consider the use of:

- computers (spreadsheetsing, accessing the internet, creating websites)
- data-loggers and interactive whiteboards
- presentations using various software
- podcasts and vodcasts
- wikis
- electronic databases
- telecommunication technologies.

3.1.6 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).

3.2 Advice, guidelines and resources
The following advice, guidelines and resources support the implementation of the syllabus, and unless otherwise stated, are available from the Science in Practice subject page of the QSA website <www.qsa.qld.edu.au/17310.html>.

Aboriginal and Torres Strait Islander perspectives
The Queensland Studies Authority (QSA) recognises Aboriginal and Torres Strait Islander peoples, their traditions, histories and experiences from before European settlement and colonisation through to the present time. To strengthen students’ appreciation and understanding of the first peoples of the land, opportunities exist in the syllabus to encourage engagement with Aboriginal and Torres Strait Islander:

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

Subject-specific resources are available on the Science in Practice subject page. In addition, guidelines about Aboriginal and Torres Strait Islander perspectives and resources for teaching can be accessed on the QSA website at <www.qsa.qld.edu.au/577.html>.

Composite classes
This syllabus enables teachers to develop a course of study that caters for a variety of ways to organise learning, such as combined Years 11 and 12 classes, combined campuses, or modes of delivery involving periods of student-managed study. This resource provides guidelines about composite classes.

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1 The Queensland Government has a vision that Aboriginal and Torres Strait Islander Queenslanders have their cultures affirmed, heritage sustained and the same prospects for health, prosperity and quality of life as other Queenslanders. The QSA is committed to helping achieve this vision and encourages teachers to include Aboriginal and Torres Strait Islander perspectives in the curriculum.
**Educational equity**

Equity means fair treatment of all. In developing work programs from this syllabus, schools need to provide opportunities for all students to demonstrate what they know and what they can do. All students, therefore, should have equitable access to educational programs and human and material resources.

In addition to the subject-specific resources available on the Science in Practice subject page, guidelines about educational equity and resources for devising an inclusive work program can be accessed on the QSA website at [www.qsa.qld.edu.au/10188.html](http://www.qsa.qld.edu.au/10188.html).

**General capabilities**

Students require a number of skills and dispositions in preparation for life and work. These include "planning and organising, the ability to think flexibly, to communicate well and to work in teams … the capacity to think creatively, innovate, solve problems and engage with new disciplines", according to the *Melbourne Declaration on Educational Goals for Young Australians*[^2]. The Australian Curriculum identified seven general capabilities for their entitlement curriculum. These are:

- Literacy
- Numeracy
- Information and communication technology (ICT) competence
- Critical and creative thinking
- Personal and social competence
- Ethical behaviour
- Intercultural understanding.

It is the responsibility of teachers to continue to develop the general capabilities established in the Prep to Year 10 Learning areas that are appropriate to Science in Practice.

**Learning experiences and sample resources**

This resource provides guidelines for learning experiences and sample resources, which may include unit/s of work.

**Reference materials**

This resource provides links to reference materials, text and reference books, websites, newspaper reports, periodicals, electronic media and learning technology, and organisations and community resources for the subject.

**Study plan**

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

The requirements for study plan approval are available on the QSA’s website [www.qsa.qld.edu.au](http://www.qsa.qld.edu.au). Consult this information before completing a study plan. Updates of the requirements for study plan approval may occur periodically.

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4 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 which may contribute credit towards a Queensland Certificate of Education
- provide 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.

4.1 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, i.e. continuous assessment.
- Balance of assessment is a balance over the course of study and not necessarily a balance over a semester or between semesters, i.e. balance.
- Exit achievement levels are devised from student achievement in all areas identified in the syllabus as being mandatory, i.e. mandatory aspects of the syllabus.
- 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, i.e. significant aspects of the course of study.
- Selective updating of a student’s profile of achievement is undertaken over the course of study, i.e. selective updating.
- Exit assessment is devised to provide the fullest and latest information on a student’s achievement in the course of study, i.e. fullest and latest.

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 — 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 of study, 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 assessments means judgments about students’ achievements of all the dimensions are made a number of times using a variety of assessment techniques and a range of assessment conditions over the developmental four-semester course of study.

See also Section 4.6 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 objectives of the dimensions *Knowing, Investigating* and *Connecting*.
- the Study area core.

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 4.7.2) 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 objectives of the syllabus and complement the developmental nature of learning in the course of study over four semesters.
Selective updating

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

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 of study 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 of study, 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 objectives.
- “Latest” refers to information about student achievement gathered from the most recent period in which achievement of the 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 of study.

The fullest and latest assessment data on mandatory and significant aspects of the course of study is recorded on a student profile.
4.2 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:

- dimensions and objectives (see Section 2)
- course organisation (see Section 3)
- principles of exit assessment (see Section 4.1)
- variety in assessment techniques over the four-semester course of study (see Section 4.5)
- conditions in which assessment instruments are undertaken (see Section 4.5)
- exit folio requirements, i.e. the range and mix of assessment instruments necessary to reach valid judgments of students’ standards of achievement (see Section 4.6)
- exit standards (see Section 4.7).

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 on the Science in Practice subject page of the QSA website <www.qsa.qld.edu.au/17310.html>.

4.3 Special provisions

Guidance about the nature and appropriateness of special provisions for particular students may be found in the QSA’s Policy on Special Provisions for School-based Assessments in Authority and Authority-registered Subjects (2009), available from <www.qsa.qld.edu.au/2132.html>.

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.

4.4 Authentication of student work

It is essential that judgments of student achievement be 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 A–Z of Senior Moderation contains a section on authenticating student work <www.qsa.qld.edu.au/1426.html>. This provides information about various methods teachers can use to monitor that students’ work is their own. Particular methods outlined include:

- teachers seeing plans and drafts of student work
- student production and maintenance of documentation for the development of responses
- student acknowledgment of resources used.

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

4.5 Assessment techniques

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

For each dimension, standards are described. Schools decide the instruments to be used for assessment. For each assessment instrument, schools develop instrument-specific standards from the syllabus standards descriptors for relevant dimensions (see Section 4.7.2 Standards matrix). These instrument-specific standards are used for making judgments about the quality of students’ responses. Students must be given instrument-specific standards 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.

4.5.1 Supervised written

Purpose

This technique assesses a range of cognition through written responses produced independently, under supervision and in a set timeframe to ensure authenticity.

Description

- A supervised assessment may include one or more items.
- Conditions must be explained on the assessment instrument.
- Items will be in response to questions or statements. Questions or statements are typically unseen. If seen, teachers must ensure the purpose of this technique is not compromised.
- Stimulus materials may also be used. Stimulus materials may be seen or unseen.
- Unseen questions, statements or stimulus materials should not be copied from information or texts that students have previously been exposed to or have directly used in class.

Dimensions to be assessed

Supervised written assessments are best used to determine student achievement in objectives from:

- Knowing
- Connecting.

Types of items that could be included

Short responses

- Short items requiring multiple-choice, single-word, sentence or short paragraph responses (up to 50 words)
- Labelling or interpretation activities that use visuals of laboratory equipment, graphs, tables, diagrams, data and information
- Calculations that use the application of simple algorithms
- Paragraph responses when explanations are required (50–150 words)
- Responses to seen or unseen stimulus materials, which may take the form of a series of short items, practical exercises and paragraph responses.
Conditions clearly stated on the assessment

<table>
<thead>
<tr>
<th>Year 11</th>
<th>Year 12</th>
</tr>
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</table>
| • Recommended time: **45 minutes–1 hour**.  
  • Perusal times may be added as required.  
  • Use of support materials or technologies, e.g. notes, other reference materials, calculators or computers, may be appropriate.  
  • Questions may be seen or unseen.  
  • Word lengths:  
    – short responses: **50–150 words** (diagrams and workings not included in word count)  
  • If students use computers to respond to these assessments, schools must ensure that the purpose of this technique is maintained. | • Recommended time: **1–1.5 hours**.  
  • Perusal times may be added as required.  
  • Use of support materials or technologies, e.g. notes, other reference materials, calculators or computers, may be appropriate.  
  • Questions may be seen or unseen.  
  • Word lengths:  
    – short responses: **50–150 words** (diagrams and workings not included in word count)  
  • If students use computers to respond to these assessments, schools must ensure that the purpose of this technique is maintained. |

Advice for teachers

• Format the assessment to allow for ease of reading and responding.
• Consider the language needs of the students and avoid ambiguity.
• 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.
• Outline any permitted material in the instrument conditions, e.g. one page of handwritten notes.
• Determine appropriate use of stimulus materials and student notes. Ensure stimulus materials are succinct enough to allow students to engage with them in the time provided; if they are lengthy, consider giving students access to them before the assessment.
• Provide students with learning experiences that support the types of items, including opportunities to respond to unseen tasks using appropriate communication strategies.
• Indicate on the assessment the dimensions and objectives that will be assessed and explain the instrument-specific standards.

4.5.2 Research

Purpose
This technique assesses research practices and the outcomes of the application of that research.

Description
• Research practices include locating and using information that goes beyond the data students have been given and the knowledge they currently have.
• A research assessment may be presented in a variety of modes. Research conventions (e.g. referencing) must be followed regardless of the mode of presentation.
• Most research responses will follow an inquiry approach and include:  
  – the establishment of a research question or hypothesis  
  – the generation and/or collection of primary and/or secondary data/information
- students’ independent collection of data/information from a variety of sources
- the sorting and analysis of data/information — examining and evaluating validity and value
- synthesis of data/information
- development of inferences, solutions, predictions and conclusions with justifications.

- This assessment occurs over a period of time, in class and often in students’ own time.

Dimensions to be assessed

Research assessments are best used to determine student achievement in objectives from:

- Knowing
- Investigating
- Connecting.

Types of items that could be included

A research response may be presented in a variety of modes including written, spoken and/or multimodal.

Written research responses

Assignment

- Examples include: essay, brochure, magazine article and letter to the editor.
- Students provide a response to a specific question or hypothesis through collection, analysis and synthesis of secondary data obtained through research.
- The response may be supported by references or, where appropriate, data, diagrams, flow charts, tables and graphics.
- The response could be a persuasive argument or informative text.

Report

- Examples may include write-ups of scientific investigations or experiments.
- Students provide a response to a specific question or hypothesis through collection, analysis and synthesis of secondary data obtained by research.
- A report will normally be presented with section headings. It will often include tables, graphs and/or diagrams and the analysis of data supported by references.

Portfolio

- Examples include a collection from the following ideas: summary and analysis of a newspaper, magazine article or documentary from a science perspective; report on a short practical activity; processing of data gathered on field-trip or industry-site visit, using flowcharts and diagrams.
- Students provide a collection of shorter responses to a variety of assessment situations. These situations are a series of tasks relating to a single context.
- The portfolio should contain collection, analysis and synthesis of secondary data obtained by research.
- The portfolio will present evidence of research, including the collection and selection of data, which must be supported by references.
**Spoken research response**

- Examples may include orals, debates, webcasts, podcasts, and slide, seminar or video presentations.

**Multimodal research response**

- Examples may include digital presentations.

**Further guidance**

- A multimodal presentation is one that uses a combination of modes, such as visual, electronic, physical, audio and/or spoken modes. It must combine a minimum of two modes, with both significantly contributing to the presentation and assessment decisions.
- Teachers must ensure that the full range of standards is possible when using spoken or multimodal techniques. If the student’s spoken or multimodal response is the focus for assessment decisions, supporting documentation will be required to substantiate decisions for moderation purposes.

**Conditions clearly stated on the assessment**

<table>
<thead>
<tr>
<th>Year 11</th>
<th>Year 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written: 400–500 words (word count includes data analysis, discussion and research outcomes/recommendations)</td>
<td>Written: 500–600 words (word count includes data analysis, discussion and research outcomes/recommendations)</td>
</tr>
<tr>
<td>Spoken: 3–4 minutes</td>
<td>Spoken: 4–5 minutes</td>
</tr>
<tr>
<td>Multimodal: 3–5 minutes</td>
<td>Multimodal: 5–7 minutes</td>
</tr>
</tbody>
</table>

**Advice for teachers**

- Establish a focus for the research, or work with the student to develop a focus.
- Allow class time for the student to effectively undertake each component of the research assessment. Independent student time will be required to complete the task.
- The required length of student responses should be considered in the context of the tasks – longer is not necessarily better. Word lengths and time limits are given as guides.
- Implement strategies to promote the authenticity of student work. Some strategies include annotated notes such as journals or experimental logs, drafting, teacher observation sheets, research checklists, referencing, and reference lists.
- Scaffolding must be provided. When a research assessment technique is undertaken for the first time, the scaffolding should help students complete the assessment by modelling the process and skills required. The scaffolding should not specify 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 a research assessment technique is revisited (most likely in Year 12), the scaffolding should be reduced, e.g. as 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).
- Indicate on the assessment the dimensions and objectives that will be assessed, and explain the instrument-specific standards.
4.5.3 Performance

Purpose
This technique assesses physical demonstrations as outcomes of applying a range of cognitive, technical, physical, creative and/or expressive skills in response to a scientific question or issue (practical project work).

Description
- The focus of this assessment is performance through the psychomotor domain to an audience (e.g. teacher, peers, web audience).
- Performance assessment is based on the application of:
  - knowledge, understanding and skills
  - analysis, synthesis and evaluation of data and/or information.
- Performance assessment involves the creative input of students and the application of identified skill/s in solving a problem or providing a solution.
- The development of a performance includes documentation of the process.
- This assessment occurs over a period of time, in class, and often students’ own time.

Dimensions to be assessed
Performance assessments are best used to determine student achievement in objectives from:
- Knowing
- Investigating
- Connecting.

Types of items that could be included
Possible types of performances:
- Delivery of demonstrations, i.e. given procedures or student-designed experimental procedures
- Setting up, monitoring and maintaining systems, e.g. aquariums, ecosystems and habitats
- Organising and delivering presentation tasks, e.g. segments at events such as a science competition, forum or Science Week events.

Further guidance
- Practical projects can be completed in teams or individually.
- Students should develop a planned course of action and maintain a journal. The journal documents the investigation including planning and detail, and decisions and modifications made over the course.

Conditions clearly stated on the assessment

<table>
<thead>
<tr>
<th>Year 11</th>
<th>Year 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance in contexts that have some complex circumstances.</td>
<td>Performance in contexts that have a diversity of complex circumstances, including organisational and presentation challenges.</td>
</tr>
</tbody>
</table>
4.5.4 Product

Purpose
This technique assesses the development and making of an artefact and is the outcome of applying a range of cognitive, technical, physical, creative and/or expressive skills.

Description
- The focus of a product assessment is the application of skills to make, create or construct an artefact.
- Product assessment is based on the application of:
  - knowledge, understanding and skills
  - analysis, synthesis and evaluation of data and/or information.
- Product assessment involves the creative input of students and the application of identified skill/s in solving a problem.
- The development of a product may also include documentation of the process.
- This assessment occurs over a period of time, in class, and often students’ own time.

Dimensions to be assessed
Product assessments are best used to determine student achievement in objectives from:
- Knowing
- Investigating
- Connecting.

Types of items that could be included
It requires the student to make something using skills learnt in the course of study. Possible types of products:
- Model building, e.g. computer simulations, energy efficient models, DNA models
- Prototypes
- Films.

Conditions clearly stated on the assessment

<table>
<thead>
<tr>
<th>Year 11</th>
<th>Year 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Products will have at least one aspect that is complex.</td>
<td>Products will have a number of complex aspects.</td>
</tr>
</tbody>
</table>

Advice for teachers
The development of the product is observed throughout the unit of work.

4.6 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 objectives of the syllabus. The standards describe how well students have achieved the objectives and are stated in the standards matrix.
The following dimensions must be used:

- Dimension 1: Knowing
- Dimension 2: Investigating
- Dimension 3: Connecting.

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.

### 4.7 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 objectives of the syllabus and standards.

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

#### 4.7.1 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>Level</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHA</td>
<td>Standard A in any two dimensions and no less than a B in the remaining dimension</td>
</tr>
<tr>
<td>HA</td>
<td>Standard B in any two dimensions and no less than a C in the remaining dimension</td>
</tr>
<tr>
<td>SA</td>
<td>Standard C in any two dimensions and no less than a D in the remaining dimension</td>
</tr>
<tr>
<td>LA</td>
<td>At least Standard D in any two dimensions</td>
</tr>
<tr>
<td>VLA</td>
<td>Standard E in the three dimensions</td>
</tr>
</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 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/1426.html>.
### 4.7.2 Standards matrix

<table>
<thead>
<tr>
<th>Knowing</th>
<th>Investigating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard A</strong></td>
<td>The student work has the following characteristics:</td>
</tr>
<tr>
<td></td>
<td>- detailed description and explanations of scientific facts, complex concepts and principles</td>
</tr>
<tr>
<td></td>
<td>- detailed and accurate identification and explanation of scientific procedures and processes, risks and hazards</td>
</tr>
<tr>
<td></td>
<td>- application of ethical and scientific understandings in unfamiliar and abstract situations.</td>
</tr>
<tr>
<td><strong>Standard B</strong></td>
<td>The student work has the following characteristics:</td>
</tr>
<tr>
<td></td>
<td>- considered planning for investigations using researchable questions or hypotheses</td>
</tr>
<tr>
<td></td>
<td>- diverse collection, effective selection and accurate recording of data and information</td>
</tr>
<tr>
<td></td>
<td>- systematic use of practical scientific skills, research processes and methods, purposefully using materials, equipment and technology efficiently and safely.</td>
</tr>
<tr>
<td><strong>Standard C</strong></td>
<td>The student work has the following characteristics:</td>
</tr>
<tr>
<td></td>
<td>- effective planning for investigations using questions or hypotheses</td>
</tr>
<tr>
<td></td>
<td>- relevant collection and selection, and mostly accurate recording of data and information</td>
</tr>
<tr>
<td></td>
<td>- effective use of practical scientific skills, research processes and methods, efficiently using materials, equipment and technology safely.</td>
</tr>
<tr>
<td><strong>Standard D</strong></td>
<td>The student work has the following characteristics:</td>
</tr>
<tr>
<td></td>
<td>- appropriate planning for investigations</td>
</tr>
<tr>
<td></td>
<td>- appropriate collection, selection and recording of data and information</td>
</tr>
<tr>
<td></td>
<td>- appropriate use of practical scientific skills, research processes and methods, including using materials, equipment and technology safely.</td>
</tr>
<tr>
<td><strong>Standard E</strong></td>
<td>The student work has the following characteristics:</td>
</tr>
<tr>
<td></td>
<td>- basic description of simple scientific facts</td>
</tr>
<tr>
<td></td>
<td>- identification of obvious scientific procedures and processes, risks and hazards</td>
</tr>
<tr>
<td></td>
<td>- application of ethical and scientific understandings in aspects of some familiar situations.</td>
</tr>
<tr>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td></td>
<td>The student work has the following characteristics:</td>
</tr>
<tr>
<td></td>
<td>• thorough analysis and informed synthesis of information and scientific understandings</td>
</tr>
<tr>
<td></td>
<td>• reasoned and informed inferences, solutions, predictions and conclusions</td>
</tr>
<tr>
<td></td>
<td>• convincing communication and presentation of scientific information for particular purposes and audiences.</td>
</tr>
</tbody>
</table>
Glossary

accurate         precise; to the point; consistent with a standard
appropriate      fitting; suitable to the context
basic            underdeveloped; simple and straightforward
complex          a number of elements, components or steps interacting or related to each other
considered       careful; measured; well thought out
convincing       persuasive because of a clear, definite and strong argument, data and presentation; leaving no doubt
design challenge a task that requires students to problem-solve through investigation and research. The solutions suggested must fulfil certain requirements or constraints and/or meet particular needs. It may require the production of a model or prototype
detailed         meticulous; specific; precise
diverse          a number of different sources or places
effective        meeting the assigned purpose
familiar          materials (including texts) or circumstances that have been the focus of learning experiences
hypothesis        an idea or assumption that requires investigation, proving or disproving
informed          well-versed; demonstrating a depth of understanding
investigation     an examination or enquiry into something
issue             something for discussion; a general concern, conundrum or dilemma
limited           of narrow scope or number
obvious           predictable; immediately apparent
plausible         credible and possible; capable of being believed
reasoned          logical and sound; presented with justification
relevant         specific and important to the context
simple            easy to understand and deal with; may involve a single or basic aspect, few steps, obvious data/outcomes or limited/no relationships
superficial       apparent; sometimes trivial; lacking depth
systematic  methodical

thorough  including all that is required; meticulous and detailed; including the important and discarding the superfluous

unfamiliar  new; not previously explored or experienced

varied  wide-ranging