Study Area Specification

Science (Open trial)

To be used in approved schools
commencing with Year 11 students only in 2009

2008 (updated 2010)

Queensland Government

Queensland Studies Authority
Partnership and innovation

Science (Open trial) Study Area Specification 2008 (updated 2010)

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Contents

Rationale **1**

Approach A: VET certificate **3**

1. Overview of VET certificates in Science 3
2. Certificates offered in this approach 4
   - 2.1 MSL20104 Certificate II in Sampling and Measurement 4
   - 2.2 PML20104 Certificate II in Sampling and Measurement 4
3. Work placement 4
4. Higher qualifications 5

Approach B: Science in Practice **6**

1. Aims 6
2. General objectives 6
   - 2.1 Knowing and understanding 7
   - 2.2 Investigating 7
   - 2.3 Connecting and concluding 7
   - 2.4 Attitudes and values 7
3. Course organisation 8
   - 3.1 Time allocation 8
   - 3.2 Designing a course of study 8
   - 3.3 Developing contexts as units of work 9
   - 3.4 Practical and field work 9
   - 3.5 Technology 9
   - 3.6 Study area core 10
   - 3.7 Course organisers 13
   - 3.8 Study plan requirements 15
4. Sample units of work 16
5. Learning experiences 21
   - 5.1 Guidelines for learning experiences 21
   - 5.2 Planning learning experiences 21
6. Legislation relevant to Science in Practice 23
   - 6.1 Guidelines for workplace, health and safety 23
   - 6.2 Animal welfare 23
7. Assessment 25
   - 7.1 Principles of exit assessment 25
   - 7.2 Planning an assessment program 27
   - 7.3 Assessment techniques 28
   - 7.4 What do teachers do when planning and implementing the assessment categories? 32
   - 7.5 Exit criteria and standards 32
   - 7.6 Determining exit levels of achievement 33
8. Language education 37
9. Quantitative concepts and skills 38
10. Educational equity 39
11. Resources 40
    - 11.1 Text and reference books 40
    - 11.2 World Wide Web 40
    - 11.3 Newspaper reports 40
    - 11.4 Periodicals 40
    - 11.5 Electronic media and learning technology 41
    - 11.6 Organisations and community resources 41

Glossary **42**

Rationale

In its *Education and Skills for the Smart State* report (2006), Queensland's Smart State Council states:

> Knowledge-based industries cannot exist without the technically and commercially qualified individuals that drive them and will not thrive in the absence of a scientifically literate society. In the future, "*virtually all quality jobs in the knowledge economy will require certain scientific and mathematical skills*."[1]

Not all senior students will enter science- or technology-based careers, but they will *all* share in the responsibility for charting the future of a society in which science and technology play a significant and increasing role.

The Science study area specification (SAS) can contribute to the development of scientifically literate individuals who:

- are interested in and understand the world around them
- engage in discourses of and about science
- are able to identify questions, investigate and draw evidence-based conclusions
- are sceptical and questioning of claims made by others about scientific matters
- make informed decisions about the environment and their own health and wellbeing[2].

The Science SAS balances the suite of senior science subjects by offering students opportunities to engage meaningfully in vocational applications of science. As such, this skills-based course gives rise to dual outcomes in employability and scientific literacy.

A course developed using the Science SAS embraces the intrinsic, hands-on nature of the subject and provides students with opportunities to develop the key competencies in contexts that arise naturally from the subject matter and from the practical and investigative approach to learning.

All seven key competencies (KCs) are relevant to studies in the Science SAS:

- KC1: collecting, analysing and organising information
- KC2: communicating ideas and information
- KC3: planning and organising activities
- KC4: working with others and in teams
- KC5: using mathematical ideas and techniques
- KC6: solving problems
- KC7: using technology.

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[1] Smart State Council, *Education and Skills for the Smart State*, 2006, p. 6, <www.smartstate.qld.gov.au/resources/publications/ss_council/EducationSkillsreport.pdf>, and citing *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, National Academy of Sciences, National Academy of Engineering, Institute of Medicine, 2005.

[2] L Rennie, "The community's contribution to science learning: Making it count", *Proceedings of the Australian Council for Educational Research Conference*, Melbourne, 2006, p. 6.

By studying the Science SAS, students will develop *science and scientific literacy skills* while learning to:

- engage in the processes of science
- think critically about the scientific basis of significant contemporary issues
- apply their knowledge in a broad range of relevant practical situations
- foresee the consequences of their own and society's activities on the living and physical world
- participate as informed and responsible citizens in decision-making processes
- safely carry out scientific inquiries, investigations, experiments and procedures
- use community and industry resources
- identify science in the context of the workplace
- collaborate and work effectively in teams
- communicate effectively in a range of modes.

The scientific skills and key competencies developed by a course in the Science SAS are relevant to employment in a range of fields such as the resources sector, health and medicine, animal welfare, pharmaceutical industry, research, recreation and tourism, food technology, biotechnology and forensics; and may form the basis of further training and education.

The Science SAS has been developed for a broad range of students in their senior phase of learning. It enables two approaches:

Approach A: Vocational Education and Training (VET) certificate

Schools may choose to pursue MSL20109 Certificate II in Sampling and Measurement. Certificate II is usually completed over four semesters. The units of competency studied could allow students to gain credit towards MSL30109 Certificate III in Laboratory Skills.

Approach B: Vocational learning strand

Schools may devise a course of study over four semesters, based on units designed to promote vocational education as well as general knowledge and skills due to the increased reliance on scientific knowledge and understanding across various levels of society and industry. This will enable students to complete the Authority-registered subject, Science in Practice.

Approach A: VET certificate

1. Overview of VET certificates in Science

This approach offers certificates from nationally endorsed training packages at the Certificate II level.

Table 1: Certificates available in this approach

Training package	Certificate II
MSL09 Laboratory Operations (Version 1 released Jan 2010)	MSL20109 Certificate II in Sampling and Measurement (all new enrolments from 2011, as per transitions arrangements
PML04 Laboratory Operations (superseded by MSL09)	PML20104 Certificate II in Sampling and Measurement (No new enrolments in this qualification after 2010, as per transition arrangements)

The Queensland Studies Authority (QSA) can provide support for this certificate in terms of:

- advice in accordance with Australian Quality Training Framework (AQTF) standards and guidelines
- advice on the relevant units of competency within this certificate
- access to the units of competency via a link to the National Training Information Service (NTIS) website <www.ntis.gov.au>
- advice on competency-based assessment
- sample delivery and assessment strategies
- facilitating access to resources
- information on registration requirements.

This support may be accessed on the QSA website, <www.qsa.qld.edu.au>, under Years 10-12 > VET - Vocational education and training.

To offer this certificate, schools must either:

- register with the QSA and meet particular human and physical resource requirements for each qualification. Relevant information is on the QSA website, <www.qsa.qld.edu.au>, under Years 10-12 > VET - Vocational education and training

  or

- work with a registered training organisation (RTO) that has this qualification in its scope of registration. This provider could be another school, a TAFE institute, or a private provider.

Schools may also design their own course from the training package.

The delivery of a Certificate II is the QSA's preferred approach. A certificate may be delivered over four semesters.

2. Certificates offered in this approach

2.1 MSL20104 Certificate II in Sampling and Measurement

MSL20104 Certificate II in Sampling and Measurement qualification is based on units of competency selected from pathways described in the MSL09 Laboratory Operations training package (Version 1 released in January 2010, replacing PML20104).

To achieve the qualification, students must achieve competence in units that meet the qualification packaging rules.

Training packages are amended periodically to reflect the latest industry practices. For information on certificate structure for this approach, download the latest version by going to the National Training Information Service <www.ntis.gov.au> and locating information about the training package.

2.2 PML20104 Certificate II in Sampling and Measurement

PML20104 Certificate II in Sampling and Measurement qualification is based on units of competency selected from pathways described in the PML04 Laboratory Operations training package (superseded by MSL09 in January 2010).

To achieve the qualification, students must achieve competence in units that meet the qualification packaging rules.

Training packages are amended periodically to reflect the latest industry practices. For information on certificate structure for this approach, download the latest version by going to the National Training Information Service <www.ntis.gov.au> and locating information about the training package.

3. Work placement

VET programs when delivered in an institutional setting (e.g. a school) should include quality work placement for these reasons:

- it is necessary for industry recognition of training delivered in this manner
- it provides opportunities for school students to become confident and capable in applying off-the-job knowledge and skills to workplace standards according to the relevant training package in actual workplace settings
- it provides opportunities for school students to acquire generic workplace competencies (employability or generic skills) that are highly valued by employers; these skills are not necessarily acquired in institutional settings.

Therefore, it is strongly recommended that students undertaking these certificates be given the opportunity for work placement. The following period is recommended: 20 days (or equivalent) for Certificate II. This could include part-time, paid, or unpaid work.

4. Higher qualifications

Students who complete a Certificate II qualification should be given the opportunity to commence a VET qualification at a higher level through either a TAFE institute or a private provider.

Schools should form partnerships to identify suitable programs for the senior phase of learning that meet the diverse vocational needs of young people, by working with:

- other registered training organisations (RTOs) for delivery of content and conduct of assessment
- business/community groups for work placement, employment opportunities and support for professional development.

Approach B: Science in Practice

1. Aims

A course of study devised from Science in Practice aims to assist students to develop knowledge, skills, attitudes and values that are transferable to a range of work options and life plans. Students will develop:

- scientific literacy and numeracy skills
- a curiosity and interest for the world they live in, and consequently a sense of responsibility for the stewardship of their local and global environments
- an appreciation of the issues and impacts of science
- knowledge, practical skills and work-related practices which are essential for effective participation in the workforce
- the ability to communicate effectively
- the skills to use and apply a range of technologies
- the knowledge, abilities and ethical commitment to participate as active citizens in a rapidly changing world.

2. General objectives

The general objectives are a summary of what students should be able to achieve as a result of completing a course in Science in Practice. They are derived from the interaction of the course rationale (see Rationale on page 1) and the aims (see Section 1 above).

The general objectives for the course are:

- *Knowing and understanding*
- *Investigating*
- *Connecting and concluding*
- *Attitudes and values*.

The general objectives within the dimension *Attitudes and values* relate to the affective elements that the course aims to encourage — they are not directly assessed. The general objectives under the remaining three dimensions are the criteria on which student achievement is assessed.

By the conclusion of the course of study, students should be able to demonstrate achievement in the following objectives.

2.1 Knowing and understanding

This objective provides opportunities for students to demonstrate a knowledge and understanding of the science relevant to the chosen contexts. The scientifically literate citizen requires an understanding of scientific knowledge so that they can make decisions based on informed reasoning.

By the end of this course, students should be able to:

- describe and explain scientific facts, processes, concepts and principles
- apply scientific knowledge and understanding in a range of situations.

2.2 Investigating

This objective provides opportunities for students to collect and interpret quantitative and qualitative data. Before they can evaluate scientific claims, scientifically literate citizens need to recognise and critically engage with scientific methodologies.

By the end of this course, students should be able to:

- formulate questions and hypotheses
- plan and conduct investigations
- collect, record, present and manipulate data
- identify and manage potential risks and hazards and use materials, equipment and technology safely.

2.3 Connecting and concluding

This objective provides opportunities for students to make links as they reflect on their research and that of others. This process will require them to explore contemporary applications of science and communicate informed decisions. The scientifically literate citizen has an integrated approach to problem solving and decision making.

By the end of this course, students should be able to:

- analyse and synthesise information in order to make inferences, propose solutions, predict outcomes and draw conclusions
- determine the reliability and relevance of sources, data and procedures
- communicate scientific information in a variety of modes.

2.4 Attitudes and values

This objective provides opportunities for students to develop heightened attitudes and values about the implications of science for individuals and groups in society. The scientifically literate citizen incorporates science into their view of the world. They think about questions and issues in science and are responsible in their actions and decisions to promote ethical practices.

By the end of this course, students should develop attitudes and values associated with:

- understanding that science is a human endeavour with consequent limitations
- becoming flexible and persistent learners, appreciating the need for lifelong learning
- appreciating the contribution of science to everyday life and global issues
- working cooperatively with others in a range of group and individual activities
- commitment to a responsible and productive work ethic.

3. Course organisation

3.1 Time allocation

This course of study requires a minimum of 55 hours per semester of timetabled school time, including assessment. It will usually be completed over four semesters (220 hours).

This course of study consists of the study area core integrated into units of work.

Each unit of work should be a minimum of 20 hours.

3.2 Designing a course of study

Approach B of the Science SAS offers flexibility in structure. Schools have the opportunity to build, consolidate and/or extend student skills through units of work, depending on the interests and abilities of students and the resources of the school.

No vocational units of competency may be offered in Approach B.

There are five course organisers (described in detail in Section 3.7 Course organisers) which provide sources or stimuli for contexts when developing units of work. They are:

- science for the workplace
- resources, energy and sustainability
- health and lifestyles
- environments
- discovery and change.

Once contexts have been chosen, schools will select appropriate content as units of work are developed.

Schools must select a minimum of three course organisers across the four-semester course.

The structure of the unit of work and priority of the course organisers selected will be influenced by:

- the interests, cultural background, stages of development and abilities of students
- the traditions and practices in the school and the community
- the physical and human resources of the school and the local area
- the learning environment and approach, e.g. individual, small group and whole-class activities, workshops, guest speakers, real-life situations, access to available resource centres
- the assessment technique and instrument/s for the unit.

When devising a course of study, schools will design units of work that:

- embed the study area core (Section 3.6)
- use a contextualised approach as and are located in the course organisers (Section 3.7)
- are interdisciplinary across the disciplines of science (Biology, Chemistry, Earth Science, Physics)
- have a practical nature and provide students with opportunities to develop the key competencies.[3]

[3] KC1: collecting, analysing and organising information; KC2: communicating ideas and information; KC3: planning and organising activities; KC4: working with others and in teams; KC5: using mathematical ideas and techniques; KC6: solving problems; KC7: using technology

3.3 Developing contexts as units of work

Learning occurs best when the learner considers it to be real and relevant. 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 engaging with scientific concepts in a range of contexts, students have the opportunity to develop informed and transferable understandings.

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.

3.4 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. This may range from local, short duration activities to an extended excursion, for example visiting local industries, places of work, laboratories, museums, accessing mobile laboratories, displays, resources as well as local natural environments (bushland, creek, dam).

3.5 Technology

Science in Practice courses 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 the learning outcomes of this Authority-registered subject.

Schools should consider the use of:

- computers (e.g. spreadsheets, accessing the internet, creation of websites or blogs)
- data-loggers and interactive whiteboards
- presentation software such as PowerPoint
- podcasts and vodcasts
- wikis
- electronic databases
- web conferencing
- telecommunication technologies.

3.6 Study area core

The study area core underpins the SAS and is essential to realising the aims of the course. It is delivered through the specific unit choices of the school. **The study area core is mandatory**, and must be embedded and progressively developed throughout a school's course of study.

A minimum of 20 hours is allocated to the study area core.

The core topics are designed to encourage students to develop an understanding of the principles and practices of:

- working scientifically and scientific literacy
- workplace health and safety
- effective communication and self-management skills.

These are outlined in Table 2. below.

Table 2: Study area core topics

Study area core topics
Working scientifically and scientific literacy
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; and 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." (Queensland Schools Curriculum Council 1996, *Years 1 to 10 Science Key Learning Area Syllabus*, Brisbane, p. 1). In the context of the Science SAS, working scientifically stems from the Aims (Section 1) and includes the General objectives (Section 2). Students should: • engage in conversations of and about science • be sceptical and questioning • identify questions and draw evidence based conclusions • make and communicate informed decisions • value ideas and seek explanations • respect evidence and reasoning • think creatively and laterally • demonstrate ethical behaviour • have regard for the consequences of decisions and the wellbeing of the living and non-living components of the environment.

Study area core topics
Workplace health and safety

This core topic is designed to introduce students to the principles and practices of workplace health and safety when operating in a scientific context. In a scientific context, workplace health and safety is concerned with protecting the safety and health of people using a laboratory and the associated equipment. Workplace health and safety legislation usually requires that a risk assessment be carried out prior to performing laboratory procedures.

Refer to the criterion *Investigating* in Table 8: Standards associated with exit criteria.

This assessment should:

- identify the hazards
- identify who may be affected by the hazard and how
- evaluate the risk
- identify any required actions.

Students should:

- refer to workplace health and safety resources such as:
  - material safety data sheets (MSDS)
  - standard operating procedures
  - *The MERCK Index: An encyclopedia of chemicals, drugs and biologicals*, (Whitehouse Station, NJ, Merck. Parts of this resource are available online at <www.merck.com.au> under Support)
  - relevant Australian standards
- identify, assess and report hazards in the laboratory and in the field in relation to various tasks
- identify hazardous substances from labels and MSDS, and consequently:
  - use appropriate personal protection equipment (PPE) when conducting practical work in the laboratory and in the field
  - adapt their surroundings to meet safety requirements
- take appropriate precautions to prevent injury, e.g. when handling glass and/or hot objects
- recognise and demonstrate the correct procedures when:
  - using hazardous substances
  - handling and using a range of tools, technologies and equipment
  - handling biological materials such as live animal and plant specimens, micro-organisms and materials for dissection
  - working in the laboratory and in the field
- carry out emergency procedures established for a particular hazard, e.g. chemical spill, fire evacuation.

Study area core topics
Communication and self management skills
This core topic is designed to increase awareness that there needs to be a balance between discipline-specific skills and employability skills. In a world where knowledge rapidly becomes obsolete, the ability to identify, access, network and communicate new information is vital for career success. The Australian government commissioned the Australian Chamber of Commerce and Industry (ACCI) and the Business Council of Australia (BCA) to undertake research to provide a detailed understanding of the employability skills that employers seek in order to grow and compete in an era of globalisation. The report identified the need for the following broad skills: communication, teamwork, problem solving, initiative and enterprise, planning and organising, self-management, learning and technology. (Dept of Education, Employment and Workplace Relations 2002, *Employability Skills for the Future*, p. 7, accessed 28 Apr 2010, <www.deewr.gov.au/Schooling/CareersandTransitions/EmployabilitySkills>) This core topic is designed to encourage students to: • 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. Students should: • 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 • complete tasks within agreed time frames • access information from a variety of relevant and valid sources.

3.7 Course organisers

A course of study is to be based on the course organisers outlined in Table 3 below.

Table 3: Course organisers

Course organisers
Science for the workplace
New skills in the workplace are in demand all the time, at the same time many skills are becoming obsolete. The nature of work and the skills required by it change rapidly. Many employers argue that employability skills are as important as professional, paraprofessional and technical skills. The Australian government have outlined the need for workers to have skills in communication, teamwork, problem solving, initiative and enterprise, planning and organising, self-management, learning and technology. (Dept of Education, Employment and Workplace Relations 2002, *Employability Skills for the Future*, p. 7, accessed 28 Apr 2010, <www.deewr.gov.au/Schooling/CareersandTransitions/EmployabilitySkills>) Depending on ease of access to resources, the local trades and industry within a community and the needs and interests of students, a unit of work may be designed which could provide opportunities to apply scientific knowledge and skills to specific work roles and/or environments. Employment opportunities within this area include: • laboratory manager • horticulturalist • animal breeder / wildlife carer • hairdresser • 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. Individuals 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 APEC leaders' declaration on climate change, energy security and clean development", accessed 28 Apr 2010, <www.apec.org/apec/leaders__declarations/2007/aelm_climatechange.html>) Individuals and industry have a responsibility to both themselves and society to think globally and act locally. Employment opportunities within this area include: • environmental health officer • fisheries inspector • conservation worker • miner (open-cut and underground) • museum interpreter / guide.

Course organisers
Health and lifestyles
Individuals and industry have a responsibility both to themselves and to society to promote health. For the first time in history, the Western world has produced a generation that may not outlive its parents. Increasing numbers of individuals are being diagnosed with diseases such as asthma, arthritis, cancer, obesity, lupus and cardiovascular disease. Science impacts 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 other 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, D.A., Nightingale, E.O. 1984, Health Affairs, vol. 3, no. 3 pp.94–109.) Employment opportunities within this area include: • enrolled nurse • dispensing assistant • fitness instructor • dental assistant / technician / hygienist • alternative health therapist.
Environments
Environments can be geological and ecological, large or small, natural or manufactured. 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 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 hundred 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. (Suzuki D 2008, "The challenge of the 21st century — setting the real bottom line [part 1]", accessed 28 Apr 2010, <www.sciencealert.com.au/opinions/20081804-17207.html>) Employment opportunities within this area include: • aquaculture technician • gardener / pest and weed controller / greenkeeper • park ranger • farmer • ecotourism guide.

Course organisers
Discovery and change
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. (Dept of Education, Employment and Workplace Relations; *Research summary,* accessed 16 Oct 2008, <www.dest.gov.au/sectors/research_sector>) 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. 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 within this area include: • ultrasound technician • telecommunications technician • computer service technician • journalist • research assistant.

3.8 Study plan requirements

A study plan is the school's plan of how the course will be delivered and assessed, based on the school's interpretation of Approach B 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>. Consult this information before completing a study plan. Updates of the requirements for study plan approval may occur periodically.

4. Sample units of work

Table 4: Examples of contexts for units of work

	Course organisers which may be relevant					Possible interdisciplinary nature			
Examples of contexts for units of work	**Science for the workplace**	**Resources, energy & sustainability**	**Health & lifestyles**	**Environments**	**Discovery & change**	**Biology**	**Chemistry**	**Earth Science**	**Physics**
Is it safe to eat?			✓			✓	✓		
True, false, uncertain or just misleading	✓		✓	✓		✓	✓		
Clean energy: energy efficient homes and industries		✓		✓	✓	✓	✓	✓	✓
Sport and performance science		✓	✓		✓	✓	✓		✓
Biospheres, terrariums and aquaponics	✓	✓		✓		✓	✓		✓
Genetics and disease			✓	✓	✓	✓	✓		
Consumer microbiology	✓		✓	✓		✓	✓		
Processed and preserved foods	✓		✓		✓	✓	✓		✓
Social drugs and their impacts			✓		✓	✓	✓		✓
Plague and pestilence	✓		✓	✓	✓	✓	✓		
Water studies	✓	✓		✓	✓	✓	✓		
Geological scene investigator				✓	✓	✓	✓	✓	✓
Global warming and climate change		✓		✓	✓	✓	✓	✓	✓
New materials in medicine			✓		✓	✓	✓		✓
Mining, mines and rehabilitation	✓	✓		✓	✓	✓	✓	✓	✓

Table 5: Sample unit 1 — Water, water everywhere, and not a drop to drink!

<table>
<tr><th colspan="5">Unit: Water, water everywhere, and not a drop to drink!</th><th colspan="4">Time: 55 hours</th></tr>
<tr><th colspan="5">Course organisers which may be relevant</th><th colspan="4">Interdisciplinary nature of unit</th></tr>
<tr><th>Science for the workplace</th><th>Resources, energy & sustainability</th><th>Health & lifestyles</th><th>Environments</th><th>Discovery & change</th><th>Biology</th><th>Chemistry</th><th>Earth Science</th><th>Physics</th></tr>
<tr><td></td><td>✓</td><td></td><td>✓</td><td></td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><th colspan="9">Unit description</th></tr>
<tr><td colspan="9">In this unit, students will explore the fundamentals of safe water supply. In doing so, they will develop understandings of the chemical properties of water, and in particular, safe drinking water.
Students will investigate contaminated water supply, including the causes and effects of contamination, and the impact of these in developing nations and in Australia in post-disaster scenarios. Students will learn techniques for assessing the health of catchments, including chemically and with the use of biosensors.
They will examine the water treatment options from low tech (e.g. filtering through sari cloth, water sterilising tablets) to the chemistry of water treatment. In this context, students will also explore the meteorological causes of water shortage in Australia and the possible water provision scenarios.
Students will consider issues connected with water security, such as the use of recycled water and desalination. Students will also critically evaluate the marketing of bottled water and debate issues such as the fluoridation of drinking water.</td></tr>
<tr><th colspan="9">Study area core embedded in this unit</th></tr>
<tr><th colspan="3">Working scientifically and scientific literacy</th><th colspan="3">Workplace health and safety</th><th colspan="3">Communication and self-management skills</th></tr>
<tr><td colspan="3">• Engage in conversations and be questioning about science.
• Identify questions and draw evidence-based conclusions.
• Make and communicate informed decisions.
• Value ideas, seek explanations, respect evidence and reasoning.
• Think creatively and laterally.
• Demonstrate ethical behaviour.
• Have regard for the consequences of decisions and the wellbeing of the living and non-living components of the environment.</td><td colspan="3">• Identify, assess and report hazards.
• Use workplace health and safety documentation to identify required actions associated with hazards.
• Demonstrate correct procedures when working in the laboratory and in the field.</td><td colspan="3">• Use appropriate formats and technology to record written information about investigations.
• Communicate oral and written information using appropriate everyday and scientific language.
• Identify, organise and prepare materials and/or equipment for investigations.
• Complete investigations and tasks within agreed time frames.
• Access information from a variety of valid and reliable sources.</td></tr>
<tr><th colspan="9">Scientific concepts and content</th></tr>
<tr><td colspan="5">• Molecular nature of water.
• Solubility.
• Water contaminants (biological and chemical).
• Pathogens.
• Diseases from contaminated water.
• Chemistry of water treatment.</td><td colspan="4">• Ecosystem and catchments.
• Biosensors (e.g. daphnia).
• Water cycle.
• Meteorological causes of drought (e.g. El Niño).
• Water recycling.
• Desalination.</td></tr>
</table>

Unit: Water, water everywhere, and not a drop to drink! Time: 55 hours

General objectives

Knowing and understanding	Investigating	Connecting and concluding
• Describe and explain: – the importance of safe water supply – the causes of water contamination – the causes and effects of water borne disease – the causes of water shortage – the processes of water treatment. • Collect, interpret and apply information about the safety of drinking water.	• Plan and conduct investigations of catchments and water treatment. • Collect, record, present and manipulate data from field and laboratory investigations. • Identify and manage potential risks associated with handling potentially contaminated water.	• Propose solutions to water supply scenarios. • Predict outcomes of contamination threats. • Determine the reliability and relevance of procedures for water treatment. • Determine the reliability and relevance of sources about water security. • Communicate scientific information in a variety of modes.

Learning experiences, field work and practical opportunities

- Analysis of secondary data on chemical/industrial contamination of water (e.g. viewing the movie *Erin Brockovich*).
- Analysis of secondary data on water-borne disease.
- Practical investigation with biosensors.
- Practical investigations of water treatment options.
- Catchment study — from source to water treatment plant.
- Case study of water recycling and desalination.

Assessment ideas

- Practical project: Report on field studies.
- Assignment: Persuasive oral about a water security issue.
- Supervised assessment: Response to stimulus.
  Students prepare a report on securing a safe water supply for an isolated town after a disaster incident.
- Portfolio: Media collection.
  Collection and reflection on relevant newspaper/journal articles, advertisements, letters to editor.

Table 6: Sample unit 2 — True, false, uncertain or just misleading?

Unit: True, false, uncertain or just misleading?								Time: 28 hours
Course organisers which may be relevant					**Interdisciplinary nature of unit**			
Science for the workplace	**Resources, energy & sustainability**	**Health & lifestyles**	**Environments**	**Discovery & change**	**Biology**	**Chemistry**	**Earth Science**	**Physics**
✓		✓			✓	✓		

Unit description

In this unit, students are encouraged to view information sceptically. Scepticism is a provisional approach to claims. It is embodied in the scientific method that involves gathering data to formulate and test explanations for natural phenomena. To be sceptical means to have a questioning attitude. Being sceptical invites and encourages inquiry and supports the development of critical thinking skills. When a fantastic claim is presented, students are encouraged to say, “that’s nice, prove it”.

Some claims, such as spontaneous generation, have been tested often enough that a provisional conclusion of “not valid” can be made. Other claims, such as the origins of Alzheimer's disease, have been tested, but results are inconclusive. In this case, formulating and testing hypotheses need to continue until a provisional conclusion is reached.

A range of case studies that may be researched and investigated by the student include the historically notable (e.g. claims of safety around X-rays and smoking, thalidomide — then and now), an advertisement for a consumer product (e.g. the Ribena controversy), or the effectiveness of a particular diet or medication (e.g. the blood type diet).

Students will then choose a particular aspect of a case study and develop an experimental investigation.

Study area core embedded in this unit

Working scientifically and scientific literacy	Workplace health and safety	Communication and self-management skills
• Engage in conversations of and about science. • Be sceptical and questioning. • Identify questions and draw evidence based conclusions. • Value ideas and seek explanations. • Respect evidence and reasoning.	• Identify, assess and report hazards. • Use workplace health and safety documentation to identify required actions associated with hazards. • Demonstrate correct procedures when working in the laboratory.	• Use appropriate formats and technology to record written information about investigations. • Communicate oral and written information using appropriate everyday and scientific language. • Identify, organise and prepare materials and/or equipment for investigations. • Complete investigations and tasks within agreed time frames. • Access information from a variety of valid and reliable sources.

Scientific concepts and content

- Experiments are a way of finding things out.
- A scientific investigation has a sequence, i.e. observation, hypotheses, prediction, testing.
- The aim of objectivity in the scientific method.
- The limitations of the scientific method.
- The role of scientific investigation in the development of scientific knowledge.
- Analysis of product labels and advertiser claims.
- The science behind warning labels.
- Physiology of drug absorption.

Unit: True, false, uncertain or just misleading?		Time: 28 hours
General objectives		
Knowing and understanding	**Investigating**	**Connecting and concluding**
• Describe and explain scientific facts, processes, concepts and principles. • Apply scientific knowledge and understanding in a range of situations.	• Formulate questions and hypotheses. • Plan and conduct investigations. • Collect, record, present and manipulate data from field and laboratory investigations. • Identify and manage potential risks and hazards and use materials, equipment and technology safely.	• Analyse and synthesise information in order to make inferences, propose solutions, predict outcomes and draw conclusions. • Determine the reliability and relevance of sources, data and procedures. • Communicate scientific information in a variety of modes.

Learning experiences, field work and practical opportunities

- **Collecting and interpreting primary data**
  Investigating an advertiser's claims for a consumer product e.g. the effectiveness of anti-bacterial products, Vitamin C content of juices, stain-removing laundry soaps, toothpastes, plant fertilisers, zippers, cosmetics, flammability of wool or nylon.
- **Interpreting secondary data**
  Investigating the effectiveness of a diet or medication, effects of low-level radiation on health, cancer clusters.

Assessment ideas

- Practical project: experimental investigation
- Portfolio and Assignment: case study

5. Learning experiences

5.1 Guidelines for learning experiences

Learning experiences should draw on a range of pedagogical approaches, for example, guided inquiry and discovery, cooperative learning, individualised instruction and direct instruction.

Learning experiences should be presented in a supportive environment where:

- academic risk-taking is supported through scaffolding of thinking skills
- students are encouraged to learn and their opinions and views are respected and listened to
- 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 general objective but, where possible, should encompass elements of all objectives. So when learning experiences require students to use *Investigating* and *Connecting and concluding*, they must also call on their understandings gained in *Knowing and understanding*.

5.2 Planning learning experiences

The range of learning experiences provided for students in Science in Practice should allow students to demonstrate the objectives of the study area. They should provide variety, challenge and reward to maintain students' interest.

In selecting learning experiences, teachers have many opportunities to deal with the key competencies (KCs), all of which are essential to the study of science:

- KC1: collecting and organising information
- KC2: communicating ideas and information
- KC3: planning and organising activities
- KC4: working with others and in teams
- KC5: using mathematical ideas and techniques
- KC6: solving problems
- KC7: using technology.

The following list offers some suggestions for suitable learning experiences:

- reading and listening to information
- field studies
- observation, identification and classification exercises
- audiovisual presentations
- student demonstrations and discussions
- teacher exposition and discussion
- research, collation and analysis of information from a variety of sources
- developing multimedia presentations e.g. website, DVD, PowerPoint, podcasts
- listening to guest speakers
- constructing models
- simulations
- conducting surveys
- interpreting charts, models, tables and graphs

- compiling reports, assignments and logbooks
- field work
- participating in decision-making processes
- recognising issues and posing questions which are science or technology related
- identifying reputable sources of relevant information and/or data
- making decisions based on the best available information
- researching from primary and secondary sources
- conducting practical experiments or field research
- accessing and using computers, including internet research
- interpreting data from a wide range of sources including media
- solving problems
- formulating hypotheses and testing them through field work, experiments, interviews and research
- synthesising ideas in a variety of forms e.g. oral, written, practical
- predicting the impact of recommendations.

6. Legislation relevant to Science in Practice

In Science in Practice, a significant amount of the course should be devoted to practical experiences in the laboratory and in the field. These practical experiences could expose students to a variety of hazards, such as corrosive and poisonous substances, or injury from glass, sharp and hot objects. Besides a teacher's duty of care, there are other legislative and regulatory requirements that will influence the nature and extent of practical work.

6.1 Guidelines for workplace, health and safety

Schools should refer to the *Education policy and procedures register* (EPPR) which is the Department of Education, Training and the Arts' centralised location for departmental (corporate) policies, procedures, guidelines and other administrative instructions and directives including health and safety, equipment and storage. EPPR includes current policies and procedures from international, non-state and higher education, Education Queensland and Corporate and Professional Services. EPPR replaced the Department of Education Manual in 2006 and has gradually expanded coverage since then.

The EPPR is located at <http://education.qld.gov.au/strategic/eppr>.

It is the school's responsibility to ensure that its practices meet current guidelines.

6.2 Animal welfare

The *Animal Care and Protection Act 2001* (ACPA) and the accompanying Animal Care and Protection Regulation 2002 govern the treatment and use of all animals in Queensland. The Department of Primary Industries and Fisheries (DPI) is responsible for enforcement of the legislation. The purpose is to prevent animal suffering, to improve the welfare of animals and to ensure all use of animals for scientific purposes is justified, open and accountable. "Scientific purposes" is defined to include activities for the purposes of demonstration and teaching. The legislation covers animals described as "any live vertebrate, including live prenatal or prehatched creatures in the last half of gestation or development", and includes amphibians, birds, fish, mammals and reptiles. It does not include the eggs, spat or spawn of fish, nor invertebrates such as octopi, squid, crabs, crayfish, lobsters and prawns. Further details of the categories covered by the legislation are available on the DPI website <www.dpi.qld.gov.au>. From the home page, search for "A guide to the use of animals for scientific purposes".

The Act also requires compliance with the *Australian Code of Practice for the Care and Use of Animals for Scientific Purposes 7th edition 2004*, also available through the DPI website, or through the National Health and Medical Research Council's site: <www.nhmrc.gov.au/publications/synopses/ea16syn.htm>. The Code defines an animal for the purposes of using in teaching as "any live non-human vertebrate, that is, fish, amphibians, reptiles, birds and mammals, encompassing domestic animals, purpose-bred animals, livestock, wildlife, and also cephalopods such as octopus and squid." 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. These Model Codes of Practice are available from the CSIRO website, <www.csiro.au>.

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

- you (or your employing institution) must register with the DPI and nominate the Animal Ethics Committee (AEC) that will assess your animal use
- you must ensure all animal use is approved by the AEC prior to the activity

- you must provide an annual report to the DPI of activities where animals are used.

An employer may register with the DPI as a “user of animals for scientific purposes” to cover employee activities requiring the use of animals for scientific purposes. An animal ethics application must be made to the Animal Ethics Committee (AEC) for each “use of animals” or “type of use of animals” for a series of similar events. AECs may approve activities that are frequently repeated in a school course. Approval can be sought for a three-year period but activities must be reported annually to the AEC.

The Queensland Schools Animal Ethics Committee (QSAEC) is required to meet and assess written applications for every educational activity that involves using animals for scientific purposes in Queensland schools. The QSAEC is a cross-sector committee linking Education Queensland, Queensland Catholic Education Commission and Independent Schools of Queensland, and includes members drawn from the scientific and wider community to bring a diversity of knowledge, values and beliefs to the committee.

Animals must not be used for scientific purposes in any Queensland school without prior written approval from the QSAEC. 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 QSAEC is to weigh up the benefits and costs of using animals in schools. The QSAEC members decide whether the proposed activities have justified the use of animals, and that the welfare of those animals has been considered. More information on the QSAEC and its activities can be found at:
<http://education.qld.gov.au/curriculum/area/science/qsaec.html>.

Employing authorities are currently considering ways they can support schools to comply with requirements. You should check with your employing authority for the details of any guidelines or processes in place to assist you to meet the requirements of the legislation.

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

7. Assessment

Assessment is an integral part of the teaching and learning process. The major purposes of assessment in Senior Authority-registered subjects are to:

- promote, assist and improve learning
- inform programs of teaching and learning
- provide information for students, parents and teachers about the progress and achievements of individual students to help them achieve as well as they are able
- provide Levels of Achievement in each Authority-registered subject to be recorded in students' learning accounts. The Levels of Achievement may contribute credit to the awarding of the Queensland Certificate of Education
- be used for tertiary entrance purposes (Queensland Tertiary Admissions Centre schedules)
- provide information about how well groups of students are achieving for school authorities and the State Education and Training Minister.

7.1 Principles of exit assessment

An assessment program for a course of study requires consideration of the following principles. **These principles of exit assessment are to be considered together and not individually in the development of an assessment program.**

- 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 SAS as being mandatory.
- Assessment of a student's achievement is in the significant aspects of the course of study identified in the SAS and the school's study plan.
- 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.

7.1.1 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 help students attain higher levels of performance. When students exit the course of study, teachers make **summative** judgments about their Levels of Achievement in accordance with the standards associated with exit criteria.

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

7.1.2 Balance

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

Balance of assessment means judgments about students' 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.

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

7.1.3 Mandatory aspects of the SAS

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

The mandatory aspects are:

- the general objectives of *Knowing and understanding*, *Investigating* and *Connecting and concluding*
- the study area core (see Section 3.6)
- selection of a minimum of three course organisers (see Section 3.7).

To make the judgment of student achievement at exit from a course of study about the mandatory aspects, the standards associated with exit criteria stated in Section 7.6.2 must be used.

7.1.4 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 Approach B.

Significant aspects are those areas described in the school's study plan that have been selected from the choices permitted by the SAS to meet local needs.

The significant aspects must be consistent with the general objectives of the SAS and complement the developmental nature of learning in the course.

7.1.5 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
  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.
- to individual students
  A school determines the assessment folio for exit from the course of study. 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 SAS requirements and the school's approved study plan.

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

7.1.6 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.

7.2 Planning an assessment program

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

- general objectives (see Section 2)
- the learning experiences (see Section 5)
- the principles of exit assessment (see Section 7.1)
- variety in assessment techniques over the course (see Section 7.3)
- conditions in which assessment instruments are undertaken (see Section 7.3)
- exit criteria and standards (see Section 7.5)

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. They should also have knowledge of the criteria to be used for each assessment instrument.

7.2.1 Special consideration

Guidance about the nature and appropriateness of special consideration and special arrangements for particular students may be found in the Authority's policy, *Special provisions for school-based assessments in Authority and Authority-registered subjects* (2009), available from <www.qsa.qld.edu.au> under Years 10-12 > Moderation & quality assurance > Special provisions

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

To enable special consideration 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 consideration might involve alternative teaching approaches, assessment plans and learning experiences.

7.2.2 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 and 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> under Publications > Reports & papers > QSA. 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 citations and referencing where appropriate.

7.3 Assessment techniques

The assessment techniques most suited to the judgment of student achievement in this subject are described in this section. The criteria to which each technique is best suited are also indicated.

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 categories of assessment techniques should be considered and should include practical situations:

- practical project
- assignment
- portfolio
- supervised assessment.

Assessment of student achievement should not be seen as a separate activity, but as an integral part of the developmental learning process which reflects the learning experiences of students. There should be variety and balance in the types of assessment instruments used, thereby enabling students with different learning styles to demonstrate their learning. Assessment should provide valuable data to assist with future planning and direction of student learning.

The required length of student responses should be considered in the context of the task — longer is not necessarily better. The assessment approaches that could be used in a Science in Practice course are diverse in nature, word lengths and time limits are given as guides. Extended responses are not required and may be inconsistent with the intent of course, general objectives and standards associated with exit criteria.

Teachers should consider the following recommendations:

- word limit for written responses — 400 to 600 words
- time limit for oral/multi-modal presentations — 3 to 6 minutes
- time limit for supervised assessments — 45 to 90 minutes
- number of instruments in a portfolio — 3 to 5 (depending on the complexity of the items).

7.3.1 Category: Practical project

What is a practical project?
Practical projects are student-focused and are developed in response to a scientific question or issue. They can be completed in teams or individually. Project questions may be supplied by the teacher, or created by students. It is more likely that students will be able to generate their own project questions the further they progress in the course of study. Practical project work should be conducted over an extended time frame. Students should develop the planned course of action and maintain a journal. The journal would document the research, decisions and modifications made, planning and detail over the course of the project. *Aspects of each of the three criteria could be evident in practical projects.* Projects could include the following techniques: • **experimental investigation** This could be student-designed, and based in the laboratory or conducted using provided procedures as part of a field-based study. Teachers can provide the research question, or it may be instigated by the student. • **delivery of demonstrations** This could include demonstrations of given or student-designed experimental procedures. • **model building** e.g. computer simulations, energy efficient models, DNA models • **setting up, monitoring and maintaining systems** e.g. aquariums, ecosystems and habitats • **organising and delivering presentations tasks** e.g. segments at events such as a science competition, forum or Science Week events.

7.3.2 Category: Assignment

What is an assignment?
An assignment has as its focus the collection and analysis of secondary data obtained through research in response to a scientific question or issue. Assignments should be conducted over an extended time frame. Assignments could be persuasive argument or informative text. Presentation could be supported by the appropriate use of data, diagrams, flowcharts, tables and graphics. *Assignments should draw on at least two of the exit criteria.* Assignments could include the following presentation formats: • essay • letter to the editor • brochure • report • magazine or publication article • orals • debate • seminar • webpage • video • slide presentation. Non-written formats should be supported by explanatory notes, references, data and diagrams.

7.3.3 Category: Portfolio

What is a portfolio?
A portfolio is an assessment instrument that requires students to respond to a series of tasks relating to a single context. Portfolios should be assembled over an extended time frame. The assessable outcome of a portfolio is a collection of shorter student responses to a variety of assessment situations. *Portfolios should draw on at least two of the exit criteria.* A portfolio could 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 research data or of data gathered on a field trip or industry site visit • oral, electronic or multimodal presentation • flowcharts and diagrams • components of supervised assessments.

7.3.4 Category: Supervised assessment

What is a supervised assessment?
A supervised assessment is an assessment instrument that is conducted under supervised conditions. The individual items making up the task must provide adequate opportunities for students to demonstrate their level of expertise in science across the full range of standards in the syllabus. *Supervised assessments should draw on at least two of the exit criteria.* The supervised assessment may be constructed from the following four types of techniques: • **short items** requiring multiple-choice, single word, sentence or short paragraph (up to 50 words) responses • **practical exercises** using laboratory equipment, graphs, tables, diagrams, data or the application of simple algorithms • **paragraph responses** these are used when explanations are required, and should be 50–150 words • **responses to seen or unseen stimulus materials** this may take the form of a series of short items, practical exercises and paragraph responses Stimulus materials should be succinct enough to allow students to engage with them in the time provided for the supervised assessment. Perusal time may be required, or if the stimulus materials are lengthy, they may need to be shared with students prior to the administration of the supervised assessment.

7.3.5 Criteria sheets

Before students undertake assessment, criteria sheets specific to each instrument must be developed and provided.

These instrument-specific criteria sheets are to:

- be derived from the exit criteria
- describe standards congruent with the exit standards
- provide a clear specification of each of the five standards (A–E)
- inform teaching and learning practice
- be annotated to indicate student achievement
- provide the basis for teacher judgment about student achievement
- provide students with the opportunity to develop self-evaluative expertise.

The extent to which the exit standards are reflected in the criteria sheet will vary according to the general objectives associated with the instrument and according to the stage in the course at which the instrument is undertaken.

7.4 What do teachers do when planning and implementing the assessment categories?

The teacher should:

- suggest topics/issues and stimulus to trigger student interest
- construct questions that are unambiguous
- format the papers and handouts to allow for ease of reading and responding
- consider the individual needs of the students
- ensure the assessment instruments reflect the classroom learning experiences and ultimately provide opportunities to demonstrate the full range of standards
- negotiate with students to ensure safety and the likelihood of success
- allow some continuous class time for students to be able to effectively undertake each component of their practical project and/or assignment
- implement strategies to ensure authentication of student work
  e.g. annotated notes such as journals or experimental logs in response to issues that emerged during research, teacher observation sheets, research and skills checklists, referencing and reference lists
- consult, negotiate and provide feedback prior to and during the practical project and/or assignment development to help ensure occupational health and safety requirements are followed, to provide ethical guidance and to monitor student work and provide support to students as required. Feedback and assistance should be given judiciously, gradually being reduced with the development of student experience and confidence
- provide scaffolding. When a practical project and/or assignment is undertaken for the first time, the scaffolding should help students complete the assessment by modelling the process and the expectations for the presentation of the project/assignment. However, the scaffolding provided should not specify the science, nor 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 project/assignment process.

7.5 Exit criteria and standards

The purpose of exit criteria and standards is to make judgments about students’ levels of achievement at exit from a course of study. The criteria are stated in the same categories as the assessable general objectives of the SAS. The standards describe how well students have achieved the general objectives and are stated in Table 8: Standards associated with exit criteria in Section 7.6.2.

The following criteria must be used:

Criterion 1: Knowing and understanding
Criterion 2: Investigating
Criterion 3: Connecting and concluding

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

7.6 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 these students, judgments are based on exit folios providing evidence of achievement in relation to all general objectives of the SAS and in accordance with the criteria and standards.

7.6.1 Determining a standard

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

When standards have been determined in each of the criteria 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 criteria for each level.

Table 7: Awarding exit levels of achievement

VHA	Standard A in any two criteria and no less than a B in the remaining criterion
HA	Standard B in any two criteria and no less than a C in the remaining criterion
SA	Standard C in any two criteria and no less than a D in the remaining criterion
LA	At least Standard D in any two criteria
VLA	Standard E in the three criteria

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

Further information can be found in *A-Z of Senior Moderation* available at <www.qsa.qld.edu.au> under Years 10-12 > Moderation & quality assurance > Authority subjects > Moderation handbook, procedures and forms

7.6.2 Table 8: Standards associated with exit criteria

Standards associated with exit criteria					
Criterion	**A**	**B**	**C**	**D**	**E**
Knowing and understanding	The student work has the following characteristics: • description, explanation of links between scientific facts, processes, concepts and principles • application of knowledge and understanding in multi-step and unfamiliar or abstract situations.	The student work has the following characteristics: • description and explanation of scientific facts, processes, concepts and principles • application of knowledge and understanding in multi-step or unfamiliar or abstract situations.	The student work has the following characteristics: • definition and description of scientific facts, processes, concepts and principles • application of knowledge in familiar, concrete situations.	The student work has the following characteristics: • statements of scientific information • identification of scientific aspects of situations.	The student work has the following characteristics: • reproduction of isolated facts.

Standards associated with exit criteria					
Criterion	**A**	**B**	**C**	**D**	**E**
Investigating	The student work has the following characteristics: • formulation and justification of researchable questions/hypotheses • planning, implementation and timely refinement of investigations • collection, presentation and manipulation of valid data in an efficient manner to discuss trends • reference to workplace, health and safety documentation to inform identification and management of risks and hazards, safe selection and use of materials, equipment and technology.	The student work has the following characteristics: • formulation of researchable questions/hypotheses • planning and implementation of investigations • collection, presentation and manipulation of valid data to describe trends • identification and management of risks and hazards, safe selection and use of materials, equipment and technology.	The student work has the following characteristics: • identification of researchable questions/hypotheses • selection and implementation of investigations • collection, presentation and manipulation (using given techniques) of data to identify obvious trends • management of identified risks, safe selection and use of materials, equipment and technology.	The student work has the following characteristics: • implementation of given investigations to collect and present data • safe use of materials, equipment and technology.	The student work has the following characteristics: • safe directed use of equipment to collect and record data.

Standards associated with exit criteria					
Criterion	**A**	**B**	**C**	**D**	**E**
Connecting and concluding	The student work has the following characteristics: • analysis and synthesis of information and data to make informed and reasoned inferences, predictions, proposals and conclusions • critical evaluation of the reliability and relevance of sources, data and procedures • coherent, concise and logical communication according to the conventions of a range of formats.	The student work has the following characteristics: • analysis of information and data to make informed inferences, predictions, proposals and conclusions • evaluation of the reliability and relevance of sources, data and procedures • coherent and logical communication according to the conventions of a range of formats.	The student work has the following characteristics: • selection of information and data to make plausible inferences, predictions, proposals and conclusions • questioning of the reliability of sources and identification of errors in data and procedures • coherent communication according to the conventions of a range of formats.	The student work has the following characteristics: • use of supplied information to respond to given situations • identification of errors in data or straightforward procedures • communication of intended meaning.	The student work has the following characteristics: • use of supplied information to make statements.

8. Language education

Teachers of 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 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.

Students studying a course developed from Science in Practice should understand and use appropriate scientific terms and phrases. In order to achieve understanding of appropriate scientific terms, it may be necessary for students to develop their own glossaries as they progress through the course.

Care must be given to using terminology that is essential to communicating experiences. Terms are important to scientific communication. For students to be able to communicate efficiently about phenomena, some technical terms are helpful. However, concentrating on vocabulary rather than on understanding carries the risk of mistaking fluency with terms for understanding (AAAS, <www.project2061.org>).

Table 9 below shows ways to link language education to a Science in Practice course.

Table 9: Linking language education to a Science in Practice course

Students should be engaged in learning experiences and assessment which involve them in		
drawing upon sources of information, such as:	**using language for the purposes of:**	**presenting information in forms such as:**
• observations • demonstrations • experiments • textbooks • handbooks of data • manuals of procedures • product brochures • specification sheets • computer files • journal articles • magazines • newspapers • broadcast media • internet • CD-ROM or DVD • advertisements • videos or films • lectures • interviews • discussions.	• restating information • reporting results • giving instructions • formulating an hypothesis • designing an experiment • explaining a relationship • arguing a proposition • proposing action • defending a position • justifying a stand • evaluating an argument • developing an idea • interpreting a theory • persuading • making conclusions • following instructions • predicting the results of an experiment • evaluating scientific arguments.	• laboratory field notes and reports • formal reports • letters • abstracts • biographies • précis • reviews • oral presentations • seminars • discussions • expositions • demonstrations • charts • graphs • sketches • models • photographs • electronic media.

9. 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, use algebraic procedures, implement algorithms
- make use of 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 for teachers, in the context of their own subjects, having to encourage 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.

Because of the mathematical underpinnings of this subject it will require the development and use of mathematical concepts, including:

- quantitative relationships — relationships between quantities are identified and used for analysis
- graphical analysis — the relationship between quantities is often best explored by plotting observed data, this can make relationships more apparent.
- measurement — precise and accurate measurement of quantities is essential in uncovering relationships between quantities or predicting one from the other. Precise measurement is integral to successful use of many pieces of equipment.

10. Educational equity

Equity means fair treatment of all. In developing study plans from Approach B of this SAS, 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 criteria and standards stated in Approach B of this SAS. The criteria 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 study plan:

ACACA 1996, *Guidelines for Assessment Quality and Equity*, available from <www.acaca.org.au>

ANTA 2004, *A Guide to Equity and the AQTF*, available from Australian Training Products Ltd <www.atpl.net.au>

QSA 2009, *Special provisions for school-based assessments in Authority and Authority-registered subjects*, available from <www.qsa.qld.edu.au>

QSA 2006, *Policy Statement: Equity*, available from <www.qsa.qld.edu.au>

EQ 2006, *CRP-PR-009: Inclusive Education*, available from <http://education.qld.gov.au/strategic/eppr>

EQ 2005, *Inclusive education*, available from <http://education.qld.gov.au/studentservices/inclusive>

QSCC 2001, *Equity Considerations for the Development of Curriculum and Test Material*, available from <www.qsa.qld.edu.au>.

11. Resources

11.1 Text and reference books

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

11.2 World Wide Web

Many websites can be used to enhance a course in Science in Practice. Note that websites may change often — the resources listed below were current at the time of publication. Some useful sites include:

Australian Science Teachers Association (ASTA) <www.asta.edu.au>
resources for Australian science teachers and students

Australian Academy of Science — Science Education <www.science.org.au/scied/index.htm>
resources for Australian science teachers

Curriculum Corporation (CC) <www.curriculum.edu.au/ccsite>
professional resources for teachers

Oresome Resources <www.oresomeresources.com>
free online educational resources relating to Queensland's minerals and energy sector

Queensland Science Teachers <http://qldscienceteachers.tripod.com>
copyright-free secondary school science teaching materials

Science Teachers Association of Queensland <www.staq.qld.edu.au>
resources for Queensland science teachers and students

TeachNET <www.cew.wisc.edu/teachnet>
a US-based professional development network for contextual teaching and learning

11.3 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.

11.4 Periodicals

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

- *Australian Science Teachers' Journal*
- *The Queensland Science Teacher*
- *Scientific American*
- *New Scientist*
- *Australasian Science*

School librarians should be able to provide assistance with identifying and locating other useful periodicals.

11.5 Electronic media and learning technology

A wide range of videos, DVDs and television recordings are available on a variety of topics related to science. A variety of computer software programs and CD-ROMs may be useful for a course in Science in Practice, 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.

11.6 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 Science in Practice. Some of these include:

- Australian Science Teachers Association (ASTA) <www.asta.edu.au>
- Science Teachers Association of Queensland (STAQ) <www.staq.qld.edu.au>
- Australian Academy of Science <www.science.org.au>
- Commonwealth Science and Industrial Research Organisation (CSIRO) <www.csiro.au>
- Bureau of Meteorology (BOM) <www.bom.gov.au>

Glossary

Abstract situation
In the context of the Science SAS, an abstract situation is one that has not been dealt with directly in the classroom. It could be imaginary or hypothetical.

Analyse
Break up a whole into its parts; examine in detail to determine the nature of; look more deeply into and detect the relationships between parts.

Assessment instruments
The tools or devices used to gather information about student achievement.

Assessment task
A particular type of assessment instrument. It involves students applying and using relevant knowledge and theoretical and practical skills to create a response to a meaningful problem or issue.

Assessment techniques
The methods used to gather evidence about student achievement.

Authority-registered subject
A subject devised from a Queensland Studies Authority-developed SAS, for which a school's study plan is approved.

Concise
Communication that has the following characteristics:

- succinct use of language that avoids repetition
- use of appropriate terminology and symbols.

Coherent
Communication that is expressed in a orderly, clear, consistent manner that is easy to understand; all parts relate to each other and the topic at hand.

Concrete situation
In the context of the Science SAS, a concrete situation is one that has been dealt with directly in the classroom or is within the realm of students' experience.

Context
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. It provides a meaningful application of concepts in real-world situations. A contextualised unit of work provides a group of related situations, phenomena, technical applications and social issues likely to be encountered by students.

Criteria (singular: criterion)
Properties, dimensions or characteristics by which something is judged or appraised. In senior syllabuses, the criteria are the significant dimensions of the subject used to categorise the general objectives and exit criteria.

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.

Data
In the context of the Science SAS, data is documented information or evidence of any kind that lends itself to scientific interpretation. Data may be quantitative or qualitative.

Primary data
Data that has been collected first hand that has not yet been processed.

Qualitative data
Data concerned with quality; verbal analysis.

Quantitative data
Data concerned with measurement; mathematical analysis.

Secondary data
Data that has been collected by someone else or data that has been processed.

Evaluate
Establish the value, quality, importance, merit, relevance or appropriateness of information, data or arguments based on logic as opposed to subjective preference.

Exit level of achievement
The standard reached by students at exit, judged by matching standards in student work with the exit criteria and standards stated in a syllabus.

Explain
Make clear or understandable; show knowledge in detail.

External review
An external review is carried out by an officer of the QSA in order to gather evidence to determine whether the school conforms to the *Requirements for the Quality Assurance of Student Achievement.* External reviews support schools in meeting the quality assurance requirements.

Formative assessment
Used to provide feedback to students, parents and teachers about achievement throughout the course of study. This enables students and teachers to identify the students' strengths and weaknesses so students may improve their achievement and better manage their own learning.

General objectives
General objectives are those which the school is intended to pursue directly, and student achievement of these is assessed by the school.

Hypothesis (plural: hypotheses)
A tentative explanation for a phenomenon, used as a basis for further investigation.

Interdisciplinary
In the context of the Science SAS, units of work must be interdisciplinary, that is, each unit of work must draw from at least two disciplines (branches) of science i.e. Biology, Chemistry, Earth Science, Physics.

Internal review
An internal review is conducted by the school to assist in the implementation and evaluation of their quality management systems. The review is to ensure the school conforms to the *Requirements for the Quality Assurance of Student Achievement.*

Justify
Provide sound reasons based on logic or theory to support response; prove or show statements are just or reasonable; convince. Justification may include:

- providing evidence (words, diagrams, symbols etc) to support processes/decisions/arguments
- providing reasoned, well-formed, logical sequence within a response

Key competencies (KCs)
Defined skills essential for effective participation in adult life, including further education and employment.

Moderation
Part of the process for assuring the quality of judgments made about a cohort of students. The focus of moderation meetings will be consistency of teacher judgments, course implementation and the assessment package.

Procedure
A list of sequential instructions that is to be used to solve a problem or perform a task.

Random sampling
Random sampling informs the QSA of the effectiveness of the processes concerned with quality assurance, It involves schools submitting nominated student folios for particular Authority-registered subjects. Teachers from around the state will conduct random sampling as part of the moderation meetings they attend.

Reliability
Ability to be trusted to be accurate or correct or to provide a correct result.

Scaffolding
The scaffolding analogy comes from the building industry, and refers to the process of supporting a student's learning to solve a problem or perform a task that could not be accomplished by that student alone. The aim is to support the student as much as necessary while they build their understanding and ability to use the new learning, and then gradually reduce the support until the student can use the new learning independently.

Sceptical
In the context of the Science SAS, to be sceptical means to have a questioning attitude. Being sceptical invites and encourages inquiry and supports the development of critical thinking skills. For example, questioning in the context of common social ideas, media and advertising claims.

Standard
A fixed reference points for describing how well students have achieved the outcomes, objectives or essential learnings in syllabuses.

Student folio
A student folio of work in an Authority-registered subject is the collection of direct and indirect evidence of student achievement. Schools retain this evidence for every student in the cohort.

Student profile of achievement
This records information about student performance on assessment tasks undertaken periodically throughout the course of study.

Study area specification (SAS)
A syllabus for an Authority-registered subject.

Study plan
A course of study outline that is a translation of the requirements of a study area specification into the context of a school. Study plans are approved by the QSA.

Summative assessment
Provides cumulative information on which levels of achievement are determined at exit from the course of study. It follows, therefore, that it is necessary to plan the range of assessment instruments to be used, when they will be administered, and how they will contribute to the determination of exit levels of achievement.

Synthesise
Assemble constituent parts into a coherent new product. The new product could be set in a new context.

Timely refinement
In the context of the Science SAS, the process of timely refinement of investigations involves students making modifications (if required) during the implementation of planned investigations.

Unit of work
A unit of work is a 6–12 week planned course of study that embeds the study area core, is located in the Course organisers, is interdisciplinary and uses a contextualised and hands-on approach.

Validity

Sound, reasonable, relevant, defensible, well grounded, and able to be supported with logic or theory.