Science Extension 2027 v1.0

General (Extension) senior syllabus — DRAFT for consultation

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This is a draft document provided for consultation and is not to be implemented.

Queensland Government

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Queensland syllabuses for senior subjects

In Queensland, a syllabus for a senior subject is an official 'map' of a senior school subject. A syllabus's function is to support schools in delivering the Queensland Certificate of Education (QCE) system through high-quality and high-equity curriculum and assessment.

Syllabuses are based on design principles developed from independent international research about how excellence and equity are promoted in the documents teachers use to develop and enliven the curriculum.

Syllabuses for senior subjects build on student learning in the Prep to Year 10 Australian Curriculum and include General, General (Extension), Senior External Examination (SEE), Applied, Applied (Essential) and Short Course syllabuses.

More information about syllabuses for senior subjects is available at www.qcaa.qld.edu.au/senior/senior-subjects and in the 'Queensland curriculum' section of the *QCE and QCIA policy and procedures handbook*.

Teaching, learning and assessment resources will support the implementation of a syllabus for a senior subject. More information about professional resources for senior syllabuses is available on the QCAA website and via the QCAA Portal.

Course overview

Rationale

At the core of all scientific endeavour is the curiosity that drives inquiry into the nature of the universe. Scientists apply this curiosity in systematic way of thinking, involving creative and critical reasoning, to expand knowledge and understanding. Scientists recognise that knowledge is not fixed but is fallible and open to challenge. As such, scientific endeavour is never conducted in isolation but builds on and challenges an existing body of knowledge in the pursuit of more reliable knowledge. This collaborative process, whereby the body of knowledge is extended, is essential to the cooperative advancement of science, technology, health and society in the 21st century.

Science Extension provides a pathway for students to deepen and extend their understanding of scientific concepts and inquiry processes beyond the scope of general science subjects. The subject develops students' capacity to engage critically with the nature of scientific thinking, examine how new scientific knowledge is generated, and apply advanced skills essential to scientific practice. Through student-directed independent inquiries, students design, conduct, and evaluate original investigations that foster creativity, innovation, and insight into the processes that drive scientific discovery.

Science Extension aims to further develop students:

- capacity in scientific thinking processes
- understanding of how scientific investigations are designed
- ability to analyse and evaluate data to support valid conclusions
- understanding of how scientific understanding is developed and refined
- ability to communicate complex ideas and finding to a range of audiences
- appreciation of the significant contributions science has made to society.

Science Extension is designed for students driven by curiosity with a keen interest in science. Students who study extension science will develop valuable skills and mindsets that provide a strong foundation for future studies in science and are valued across a broad range of fields.

In undertaking an extension course in science, students are expected to already be introduced to one or more scientific disciplines from the suite of seven General Science subjects on offer in Queensland, specifically Agricultural Science, Biology, Chemistry, Earth and Environmental Science, Marine Science, Physics and Psychology. To study Science Extension, students should have completed two units of at least one or more senior general sciences. In Year 12, students undertake Units 3 and 4 of Science Extension concurrently with, or after, Units 3 and 4 of at least one or more senior general sciences. The science Extension course offers opportunity to explore the nature of scientific thinking and research in more depth than other Science courses and further develops their scientific understanding and scientific inquiry skills.

Syllabus objectives

The syllabus objectives outline what students have the opportunity to learn.

1. **Explain ideas and findings**

   Students select and use scientific representations and language in to communicate detailed accounts of phenomena, concepts, theories, models and systems and methodologies. Students explain how scientific knowledge is developed and describe the essential elements of scientific research. They communicate their accounts using a range of data displays and genres scientifically demonstrating an awareness of audience and purpose.

2. **Apply understanding**

   Students select and use scientific concepts, theories, models, systems and methodologies. They systematically apply algebraic, visual and graphical representations of scientific relationships and data to determine unknown scientific quantities or features.

3. **Analyse data.**

   Students analyse information from primary and secondary sources to identify trends and patterns, relationships, limitations and uncertainty. In qualitative analysis, they describe the essential elements, features or components. In quantitative analysis, they select and use appropriate mathematical processes and algorithms. They identify evidence to support hypotheses, inferences or decisions.

4. **Interpret evidence.**

   Students use their understanding of selected scientific phenomena, concepts, theories, models and systems and methodologies and their limitations to develop justified scientific arguments and draw reasoned conclusions. They select relevant secondary sources and make meaning of a range of scientific texts. Students deduce, extrapolate, infer, justify and make predictions based on their analysis of primary and secondary data.

5. **Evaluate conclusions, decisions and processes**

   Students select and critically reflect on evidence from primary and secondary sources and make judgements about reliability and validity. Students apply this evaluation of evidence to makes reasoned scientific arguments and design improvements and extensions to investigations. They examine underlying scientific assumptions when drawing conclusions and analyse the reasoning behind conclusions.

6. **Investigate phenomena.**

   Students select and apply the processes used in credible scientific research to develop research questions and testable hypotheses. Students design and conduct and modify independent investigations to collect relevant data. They identify and manage risks, regulatory requirements, environmental and ethical issues. Students acknowledge all sources of information.

Designing a course of study in Science Extension

Syllabuses are designed for teachers to make professional decisions to tailor curriculum and assessment design and delivery to suit their school context and the goals, aspirations and abilities of their students within the parameters of Queensland's senior phase of learning.

The syllabus is used by teachers to develop curriculum for their school context. The term *course of study* describes the unique curriculum and assessment that students engage with in each school context. A course of study is the product of a series of decisions made by a school to select, organise and contextualise subject matter, integrate complementary and important learning, and create assessment tasks in accordance with syllabus specifications.

It is encouraged that, where possible, a course of study is designed such that teaching, learning and assessment activities are integrated and enlivened in an authentic setting.

Course structure

Science Extension is a General (Extension) senior syllabus. It contains two QCAA-developed units from which schools develop their course of study.

Each unit has been developed with a notional time of 55 hours of teaching and learning, including assessment. This subject is an extension of the related General subject and is studied either concurrently with, or after, Units 3 and 4 of the General course.

A General (Extension) senior syllabus may only be started after completion of Unit 1 and Unit 2 of the General senior syllabus. Units 3 and 4 are studied as a pair.

More information about the requirements for administering senior syllabuses is available in the 'Queensland curriculum' section of the *QCE and QCIA policy and procedures handbook*.

Curriculum

Senior syllabuses set out only what is essential while being flexible so teachers can make curriculum decisions to suit their students, school context, resources and expertise.

Within the requirements set out in this syllabus and the *QCE and QCIA policy and procedures handbook*, schools have autonomy to decide:

- how and when subject matter is delivered
- how, when and why learning experiences are developed, and the context in which learning occurs
- how opportunities are provided in the course of study for explicit and integrated teaching and learning of complementary skills.

These decisions allow teachers to develop a course of study that is rich, engaging and relevant for their students.

Assessment

Senior syllabuses set out only what is essential while being flexible so teachers can make assessment decisions to suit their students, school context, resources and expertise.

General (Extension) senior syllabuses contain assessment specifications and conditions for the assessment instruments that must be implemented with Units 3 and 4. These specifications and conditions ensure comparability, equity and validity in assessment.

Within the requirements set out in this syllabus and the *QCE and QCIA policy and procedures handbook*, schools have autonomy to decide:

- specific assessment task details
- assessment contexts to suit available resources
- how the assessment task will be integrated with teaching and learning activities
- how authentic the task will be.

In Units 3 and 4, schools develop three assessments using the assessment specifications and conditions provided in the syllabus.

More information about assessment in senior syllabuses is available in 'The assessment system' section of the *QCE and QCIA policy and procedures handbook*.

Subject matter

Each unit contains a unit description, unit objectives and subject matter. Subject matter is the body of information, mental procedures and psychomotor procedures (see Marzano & Kendall 2007, 2008) that are necessary for students' learning and engagement with the subject. Subject matter itself is not the specification of learning experiences but provides the basis for the design of student learning experiences.

Subject matter has a direct relationship with the unit objectives and provides statements of learning that have been constructed in a similar way to objectives.

Aboriginal perspectives and Torres Strait Islander perspectives

The QCAA is committed to reconciliation. As part of its commitment, the QCAA affirms that:

- Aboriginal peoples and Torres Strait Islander peoples are the first Australians, and have the oldest living cultures in human history
- Aboriginal peoples and Torres Strait Islander peoples have strong cultural traditions and speak diverse languages and dialects, other than Standard Australian English
- teaching and learning in Queensland schools should provide opportunities for students to deepen their knowledge of Australia by engaging with the perspectives of Aboriginal peoples and Torres Strait Islander peoples
- positive outcomes for Aboriginal students and Torres Strait Islander students are supported by successfully embedding Aboriginal perspectives and Torres Strait Islander perspectives across planning, teaching and assessing student achievement.

Guidelines about Aboriginal perspectives and Torres Strait Islander perspectives and resources for teaching are available at www.qcaa.qld.edu.au/k-12-policies/aboriginal-torres-strait-islander-perspectives.

Where appropriate, Aboriginal perspectives and Torres Strait Islander perspectives have been embedded in the subject matter.

Complementary skills

Opportunities for the development of complementary skills have been embedded throughout subject matter. These skills, which overlap and interact with syllabus subject matter, are derived from current education, industry and community expectations and encompass the knowledge, skills, capabilities, behaviours and dispositions that will help students live and work successfully in the 21st century.

These complementary skills are:

- literacy — the knowledge, skills, behaviours and dispositions about language and texts essential for understanding and conveying English language content
- numeracy — the knowledge, skills, behaviours and dispositions that students need to use mathematics in a wide range of situations, to recognise and understand the role of mathematics in the world, and to develop the dispositions and capacities to use mathematical knowledge and skills purposefully
- 21st century skills — the attributes and skills students need to prepare them for higher education, work, and engagement in a complex and rapidly changing world. These skills include critical thinking, creative thinking, communication, collaboration and teamwork, personal and social skills, and digital literacy. The explanations of associated skills are available at www.qcaa.qld.edu.au/senior/senior-subjects/general-subjects/21st-century-skills.

It is expected that aspects of literacy, numeracy and 21st century skills will be developed by engaging in the learning outlined in this syllabus. Teachers may choose to create additional explicit and intentional opportunities for the development of these skills as they design the course of study.

Additional subject-specific information

Additional subject-specific information has been included to support and inform the development of a course of study.

Science understanding

The science understanding subject matter in each unit develops students’ understanding of the key concepts, models and theories that underpin the subject, and of the strengths and limitations of different models and theories for explaining and predicting complex phenomena. It uses cognitions from Objectives 1–4.

Science as a human endeavour (SHE)

Each Queensland senior science subject requires students to learn and apply aspects of the knowledge and skill of the discipline. However, it is recognised that students should also develop an appreciation for the *nature* and *development* of science, and its *use* and *influence* on society.

While this appreciation is not directly assessed, the syllabus provides guidance as to where it may be developed. Importantly, this guidance draws students’ attention to the way in which science operates, both in relation to the development of understanding and explanations about the world and to its influence on society.

Students should become familiar with the following SHE concepts:

- Science is a global enterprise that relies on clear communication, international conventions, peer review and reproducibility.
- Development of complex models and/or theories often requires a wide range of evidence from multiple individuals and across disciplines.
- Advances in science understanding in one field can influence other areas of science, technology and engineering.
- The use and acceptance of scientific knowledge is influenced by social, economic, cultural and ethical contexts.
- The use of scientific knowledge may have beneficial and/or harmful and/or unintended consequences.
- Scientific knowledge can enable scientists to offer valid explanations and make reliable predictions.
- Scientific knowledge can be used to develop and evaluate projected economic, social and environmental impacts and to design action for sustainability.
- ICT and other technologies have dramatically increased the size, accuracy and geographic and temporal scope of datasets with which scientists work.
- Models and theories are contested and refined or replaced when new evidence challenges them, or when a new model or theory has greater explanatory power.
- Scientific knowledge can be used to inform the monitoring, assessment and evaluation of risk.
- Science can be limited in its ability to provide definitive answers to public debate; there may be insufficient reliable data available, or interpretation of the data may be open to question.
- International collaboration is often required when investing in large-scale science projects or addressing issues for the Asia–Pacific region.

To support the development of these concepts, this syllabus identifies SHE subject matter in each unit. This highlights opportunities for teachers to contextualise the associated science understanding and science inquiry subject matter and provides stimulus for the development of claims and research questions for investigation.

Additional opportunities include:

- practicals provide opportunities for students to witness the *nature* of science
- the written rationale (incorporating a literature review) provides an opportunity for students to appreciate the use and influence of scientific evidence
- the research plan and extended investigation provides opportunity for students to experience how the development of new science knowledge is built upon existing knowledge.

Science inquiry

Defining *inquiry* in science education

In order to support the school's task of aligning their chosen pedagogical framework with the curriculum and assessment expectations outlined in this syllabus, some guidance has been provided in the form of clarification of the use of the term *inquiry* and the articulation of a framework to describe the process of inquiry. The purpose of this guidance is to prevent misunderstandings and problematic conflations and their subsequent negative impact on student learning. As Abrams, Southerland and Silva (2008, p. xv) stated in their book, *Inquiry in the Classroom: Realities and opportunities*:

> Inquiry in the classroom can be conceived as a complex set of ideas, beliefs, skills, and/or pedagogies. It is evident that attempting to select a singular definition of inquiry may be an insurmountable and fruitless task. Any single definition of inquiry in the classroom would necessarily reflect the thinking of a particular school of thought, at a particular moment in time, or a particular goal, and such a singular definition may serve to limit legitimate and necessary components of science learning. **However, operating without a firm understanding of the various forms of inquiry leaves science educators often 'talking past' one another, and often results in very muddled attempts in the classroom** [emphasis added].

Uses of the term *inquiry*

Common phrases involving the term *inquiry* have been listed below:

- science inquiry
- science inquiry skills
- the inquiry process
- inquiry-based learning.

This syllabus refers to the first three uses listed above. The first, *science inquiry*, defines the practical work of a scientist (Harlen 2013). The second, *science inquiry skills*, refers to the skills required to do the work of a scientist (Harlen 2013). The third, *the inquiry process*, is a framework that can be used to describe the process of asking a question and then answering it.

The final phrase, *inquiry-based learning*, refers to a variety of teaching and learning strategies an educator may choose to use within their school's pedagogical framework. Although a school may choose to adopt an inquiry-based pedagogy, this syllabus is *not* intended to endorse or recommend an inquiry-based learning approach.

Framework to describe the inquiry process

In order to support student engagement in activities involving inquiry, it is useful to establish a common language or framework to distinguish between stages of the process.

The stages involved in any inquiry are:

- forming and describing the inquiry activity
- finding valid and reliable evidence for the inquiry activity
- analysing the evidence collected
- interpreting the evidence selected
- evaluating the conclusions, processes or claims.

This framework uses reflection as the connection between, and driver of, all the stages. The progression through the inquiry process requires reflection on the decisions made and any new information that has emerged during the process to inform the next stage. Each stage of the inquiry process is worthy of reflection, the result of which may be the revision of previous stages (Marzano & Kendall 2007).

Figure 1: Stages of inquiry process

Science inquiry and science inquiry skills

Science inquiry involves identifying and posing questions and working to answer them. It is concerned with evaluating claims, investigating ideas, solving problems, reasoning, drawing valid conclusions and developing evidence-based arguments. It can easily be summarised as the ‘work of a scientist’ (Hackling 2005).

Within this syllabus, students are expected to undertake aspects of the work of a scientist by participating in scientific inquiry (Tytler, 2007). This expectation is reflected in the inclusion of practical and investigative components within the subject matter, and particularly through the research proposal, pilot study, and extended investigation that comprise the internal assessment tasks in Science Extension.

Science inquiry skills are the skills required to do the work of a scientist. They include writing research questions, planning, conducting, recording information, and reflecting on investigations; processing, analysing and interpreting evidence; evaluating conclusions, processes and claims; and communicating findings (ACARA 2015).

In Science Extension, students are required to develop and apply science inquiry skills (Krajcik et al., 2000), many of which are described throughout the syllabus. The student-directed nature of the internal assessment tasks provides flexibility in how specific inquiry skills are selected, applied, and integrated within individual research contexts.

Science Extension is focused on extending students science inquiry skills beyond those in the general science syllabus. Students will build on the skill developed in their study of the general sciences while studying extension science. It is the prerogative of the educator to determine how listed practicals and investigations are used as opportunities to:

- develop, rehearse and refine science inquiry skills
- engage students in scaffolded or open-ended science inquiry tasks
- formatively assess science inquiry skills.

Science inquiry skills

Science Extension focuses on extending students’ science inquiry skills beyond those developed in the general science syllabuses, enabling them to demonstrate a greater range of skills and processes used in authentic scientific research. As students determine their own research topics, the specific inquiry skills they develop will vary according to the nature and requirements of their investigations. In Science Extension, students build on their existing inquiry capabilities by selecting and applying appropriate inquiry skills for their particular focus area and stage of the research process.

Throughout the course of study, students will:

- identify, research, construct and refine questions for investigation
- design investigations, including the procedure/s to be followed, the materials required, and the type and amount of primary and/or secondary data required to obtain valid and reliable evidence
- identify the types of errors, extraneous variables or confounding factors that are likely to influence results and implement strategies to minimise systematic and random error
- propose testable hypotheses and/or predict possible outcomes e.g. identify null and alternative hypotheses

- identify and implement appropriate strategies to manage risks, ethics and/or environmental impact where relevant to their investigation e.g.
  - cultural guidelines, protocols for working with the knowledges of First Nations peoples
  - workplace health and safety guidelines
  - appropriate disposal methods
- use appropriate equipment, techniques, procedures and sources to systematically and safely collect primary and secondary data
- use appropriate scientific language and representations to systematically record information, observations, data and measurement error
- translate information between graphical, numerical and/or algebraic forms
- use select appropriate mathematical techniques to summarise data in a way that allows for identification of relevant trends, patterns, relationships, limitations and uncertainty
- select and construct appropriate representations to present data and communicate findings
- analyse data to identify trends, patterns and relationships, recognising error, uncertainty and limitations of evidence
- interpret data displays in terms of the relationship between dependent and independent variables
- select, synthesise and use evidence to construct scientific arguments and draw conclusions
- extrapolate findings to determine unknown values, predict outcomes and evaluate conclusions
- use data and reasoning to discuss and evaluate the validity and reliability of evidence
- suggest improvements and extensions to minimise uncertainty, address limitations and improve the overall quality of evidence
- communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes
- acknowledge sources of information and use standard scientific referencing conventions
- appreciate the role of peer review in scientific research.

Science inquiry subject matter uses cognitions from across all objectives and is primarily assessed through the internal assessments. To support the development of these science inquiry skills, this syllabus identifies suggested investigations. These highlight opportunities for students to directly experience the associated science understanding subject matter and provide stimulus for their assessed scientific investigations.

Safety and ethics

Workplace health and safety

Science Extension is designed to expose students to the practical components of science through practical experiences in the laboratory and the field. These experiences expose students to a variety of hazards, from biological and poisonous substances to injury from equipment. Besides a teacher's duty of care that derives from the *Education (General Provisions) Act 2006*, there are other legislative and regulatory requirements, for example the *Work Health and Safety Act 2011*, that will influence the nature and extent of practical work.

All practical work must be organised with student safety in mind. The *Department of Education and Training (DET) Policy and Procedure Register* (https://ppr.qed.qld.gov.au) provides guidance about current science safety protocols.

It is the responsibility of all schools to ensure that their practices meet current legislation requirements.

Care and use of animals for scientific purposes

Governing principles

The QCAA recognises that school personnel involved in the care and use of animals for scientific purposes have legal obligations under the Animal Care and Protection Act 2001 (the Act). Queensland schools intending to use animals for scientific purposes must apply for and receive animal ethics approval from the Queensland Schools Animals Ethics Committee (QSAEC) prior to conducting these activities. The purpose of the Act is to promote the responsible care and use of animals, provide standards for the care and use of animals, protect animals from unjustifiable, unnecessary or unreasonable pain, and ensure that the use of animals for scientific purposes is accountable, open and responsible.

The Act also requires mandatory compliance with the *Australian Code of Practice for the Care and Use of Animals for Scientific Purposes 2013 (8th edition)*, available from the National Health and Medical Research Council's publications website.

It should also be recognised that school personnel and students are not carrying out essential, groundbreaking research. Therefore, standards in schools should be more stringent than those used in universities and research and development organisations.

Separate to the Act and ethical approval, best practice includes referring to the *3Rs* principle f animal welfare:

- **replacement** — any investigations involving animals should initially consider replacing the animals with cells, plants or computer simulations
- **refinement** — refinement of the investigation should aim to alleviate any harm or distress to the animals used
- **reduction** — reduce the number of animals used.

Respect for animals must underpin all decisions and actions involving the care and use of animals. The responsibilities associated with this obligation apply throughout the animal's lifetime, including acquisition, transport, breeding, housing, husbandry and the use of animals in a project. Experiments that require the endpoint as the death of any animal (e.g. lethal dose LD_{50}) are unacceptable.

Animal dissections

There is no requirement for students to witness or carry out a dissection of any animal, invertebrate or vertebrate in this course. If animal dissections are chosen by the teacher as an important educational experience, the *3Rs* principle of animal welfare should be applied (i.e. replacement, refinement and reduction — see above for more information). Teachers should always discuss the purpose of the dissection and allow any student, without requirement for explanation, to opt out if they wish. Teachers should be respectful of the variety of reasons students may have for choosing not to participate.

Experimental studies using humans

If teaching and learning activities include experimental investigations using human subjects, teachers and schools have a legal and moral responsibility to ensure that students follow ethical principles at all times. Best practice includes:

- **protection from harm** — any investigations that create harm, distress or discomfort for participants are not permitted. This includes investigations involving ingestion (e.g. food, drink, smoking or drugs) and deprivation (e.g. sleep, food)
- **gaining informed consent** — any experiments involving humans must be with their written permission. Students under the age of 16 should have written permission from a parent or guardian. All participants should be above the age of 12 and of sound mind. The process of being informed requires that participants understand the purpose of the investigation and that they can withdraw from the process at any stage
- **ensuring confidentiality and anonymity** —all data collected must be kept in a confidential and responsible manner and not divulged to any other person. Anonymity for each participant must be guaranteed.

Teachers should refer to the following for detailed advice:

- the National Statement on Ethical Conduct in Human Research (2007), issued by the National Health and Medical Research Council (NHMRC) in accordance with the *NHMRC Act 1992* (Cwlth)
- the National Privacy Principles in the *Privacy Amendment (Private Sector) Act 2000* (Cwlth)
- the Code of Ethics of the Australian Psychological Society (APS).

Strategies for retaining and recalling information for assessment

The following practices[1] can support preparation for senior assessment in Science Extension.

The spacing effect

The spacing effect draws on research about forgetting and learning curves. By recalling and revisiting information at intervals, rather than at the end of a study cycle, students remember a greater percentage of the information with a higher level of accuracy. Exposing students to information and materials numerous times over multiple spaced intervals solidifies long-term memory, positively affecting retention and recall.

Teachers should plan teaching and learning sequences that allow time to revisit previously taught information and skills at several intervals. These repeated learning opportunities also provide opportunities for teachers to provide formative feedback to students.

The retrieval effect

The retrieval effect helps students to practise remembering through quick, regular, low-stakes questioning or quizzes that exercise their memories and develop their ability to engage in the deliberate act of recalling information. This has been shown to be more effective at developing long-term memories than activities that require students to search through notes or other resources.

Students may see an inability to remember as an obstacle, but they should be encouraged to understand that this is an opportunity for learning to take place. By trying to recall information, students exercise or strengthen their memory and may also identify gaps in their learning. The more difficult the retrieval practice, the better it can be for long-term learning.

Interleaving

Interleaving involves interspersing the concepts, categories, skills or types of questions that students focus on in class or revision. This is in contrast to blocking, in which these elements are grouped together in a block of time. For example, for concepts A, B and C:

- Blocking A A A A A B B B B B C C C C C
- Interleaving A B C B C A B A C A C B C A B

Studies have found that interleaving in instruction or revision produces better long-term recall of subject matter. Interleaving also ensures that spacing occurs, as instances of practice are spread out over time.

Additionally, because exposure to one concept is interleaved with exposure to another, students have more opportunities to distinguish between related concepts. This highlighting of differences may explain why studies have found that interleaving enhances inductive learning, where participants use exemplars to develop an understanding of broader concepts or categories. Spacing without interleaving does not appear to benefit this type of learning.

Interleaving can seem counterintuitive — even in studies where interleaving enhanced learning, participants often felt that they had learnt more with blocked study. Despite this, their performance in testing indicated greater learning through the interleaving approach.

[1] Based on Agarwal, Roediger, McDaniel & McDermott (2020); Birnbaum, Kornell, Ligon Bjork & Bjork (2013); Carpenter & Agarwal (2020); Chen, Paas & Sweller (2021); Ebbinghaus (1885); Rohrer (2012); Taylor & Rohrer (2010).

Reporting

General information about determining and reporting results for senior syllabuses is provided in the ‘Determining and reporting results’ section of the *QCE and QCIA policy and procedures handbook*.

Reporting standards

Reporting standards are summary statements that describe typical performance at each of the five levels (A–E).

A
The student gives detailed and accurate accounts of complex scientific phenomena, concepts, theories, models and systems. They give informed accounts of the development of scientific knowledge and provides thorough descriptions of the steps in the science inquiry process. They effectively communicate scientific findings in a variety of formal and informal formats with clear awareness of both audience and purpose. They describe the essential elements of scientific writing and communicate complex concepts to expert and non-expert audiences with accuracy and clarity. The student develops detailed and relevant research questions and testable hypotheses. They insightfully analyse and evaluate secondary sources for both validity and credibility. They plan and conduct valid and reliable investigations that collect relevant primary data that clearly addresses the research question. They apply a thorough understanding of the inquiry process to design, select and modify methodologies that collect relevant primary data and address novel research questions. They assess and effectively manage risks, regulatory requirements, environmental and ethical issues. The student systematically and effectively analyses scientific evidence from primary and secondary sources to identify trends, patterns, limitations and uncertainty. In qualitative data, they describe the essential elements, features or components. They accurately select and use relevant mathematical processes, algorithms and apply inferential statistical analysis to support or reject hypotheses, inferences or decisions. The student draws accurate conclusions and presents justified scientific arguments demonstrating clear understanding of scientific concepts, theories, models and systems and their limitations. They deduce, extrapolate, infer and make justified predictions based on their analysis of data. They generate primary data that they process and analyse to produce evidence that supports or reject hypotheses, inferences or decisions. The student insightfully evaluates the available evidence and makes accurate judgments about how effectively the evidence addresses a research question. They perceptively evaluate the reliability and validity of inquiry processes and methodologies, and quality of the evidence to design targeted improvements and extensions to investigations. They critically examine underlying assumptions to develop justified conclusions. The student insightfully interprets scientific research and assesses its credibility They effectively use standard conventions of citation, referencing and acknowledgement of all sources

B
The student gives accurate accounts of complex scientific phenomena, concepts, theories, models and systems. They give informed accounts of the development of scientific knowledge and provide detailed descriptions of the steps in the science inquiry process. They communicate scientific findings in a variety of formal and informal formats with clear awareness of both audience and purpose. They describe the essential elements of scientific writing and communicate complex concepts to expert and non-expert audiences with accuracy. The student develops detailed research questions and testable hypotheses. They analyse and evaluate secondary sources for both validity and credibility. They plan and conduct valid and reliable investigations that collect relevant primary data that clearly addresses the research question. They apply an understanding of the inquiry process to design, select and modify methodologies to address novel research questions and collect relevant primary data. They assess and manage risks, regulatory requirements, environmental and ethical issues. The student effectively analyses scientific evidence from primary and secondary sources to identify trends, patterns, limitations and uncertainty. In qualitative data, they describe the essential elements, features or components. They select and use mathematical processes, algorithms and apply inferential statistical analysis to support or reject hypotheses, inferences or decisions. The student draws accurate conclusions and presents justified scientific arguments demonstrating clear understanding of scientific concepts, theories, models and systems and their limitations. They deduce, extrapolate, infer and make justified predictions based on their analysis of data. They generate primary data that they process and analyse to produce evidence that supports or reject hypotheses, inferences or decisions. The student evaluates the available evidence and makes judgments about how effectively the evidence addresses a research question. They evaluate the reliability and validity of inquiry processes and methodologies, and quality of the evidence to design targeted improvements and extensions to investigations. They examine underlying assumptions to develop reasonable conclusions. The student interprets scientific research and assesses its credibility. They use standard conventions of citation, referencing and acknowledgement of all sources.
C
The student accurately describes scientific phenomena, concepts, theories, models and systems. They give accounts of the development of scientific knowledge and provide descriptions of the steps in the science inquiry process. They communicate scientific findings in formal and informal formats with awareness of audience and/or purpose. They describe the essential elements of scientific writing and communicate concepts to expert and non-expert audiences The student develops research questions and testable hypotheses. They plan and conduct investigations that collect relevant primary data that addresses the research question. They apply an understanding of the inquiry process to select and modify methodologies to address research questions and collect relevant primary data. They assess risks, regulatory requirements, environmental and ethical issues. The student analyses scientific evidence from primary and secondary sources to identify trends, patterns, limitations and uncertainty. In qualitative data, they describe the essential elements, features or components. They use mathematical processes, algorithms and apply statistical analysis to support or reject hypotheses, inferences or decisions. The student draws conclusions and presents scientific arguments demonstrating understanding of scientific concepts, theories, models and systems. They deduce, extrapolate, infer and make predictions based on data. They generate primary data that they use to produce evidence that supports or reject hypotheses, inferences or decisions. The student evaluates the available evidence and makes judgments about how effectively the evidence addresses a research question. They evaluate the quality of the evidence to design targeted improvements and extensions to investigations. They describe underlying assumptions to develop conclusions. The student interprets scientific research and assesses its credibility. They use standard conventions of citation, referencing and acknowledgement of all sources.

D
The student a describes scientific concepts, theories, models and systems. They give accounts of the development of scientific knowledge by inquiry. They communicate scientific findings by using scientific representations or language to present information. The student develops research questions. They plan and conduct investigations that collect primary data. They assess risks, regulatory requirements, environmental and ethical issues. The student analyses scientific evidence from primary and secondary sources by identifying elements features and components of qualitative data. They use mathematical processes, to support or reject decisions. The student interprets evidence and draws conclusions and makes predictions based on data.
E
The student describes scenarios and communicates by referring to representations of information. They discuss physical phenomena and evidence. They follow established methodologies in research situations. They discuss elements of scientific evidence. The student carries out elements of experiments and research investigations.

Determining and reporting results

Units 3 and 4

Schools mark each of the three internal assessment instruments implemented in Unit 3 and 4 using instrument-specific marking guides (ISMGs).

Schools report a provisional mark by criterion to the QCAA for each internal assessment.

Once confirmed by the QCAA, these results will be combined with the result of the external assessment developed and marked by the QCAA.

The QCAA uses these results to determine each student's subject result as a mark out of 100 and as an A–E.

Units

Unit 3: Introduction to scientific research

In Unit 3, students explore the essential processes and methodologies that underpin scientific investigation. They are introduced to the diverse ways scientific research is conducted and describe the essential features of scientific research. These understandings are then applied to the planning and development of their own scientific research proposal and feasibility study.

The steps in the scientific inquiry process are described and applied, with explanations of how these steps interconnect. Students will differentiate different approaches to research and categorise various types of data. The features of valid and reliable scientific investigations are examined, along with strategies to reduce bias through effective controls, triangulation, blinding and appropriate sampling methods, where relevant. The collaborative nature of scientific research is explored, as well as how science impacts society and how society and culture, in turn, influence science and scientific practices.

Knowledge and skills in data analysis are extended from earlier science studies and applied to the chosen research focus area, potentially engaging with a wider range of data across multiple scientific disciplines. Appropriate analysis techniques are selected and applied to measure uncertainty in data, with statistical values interpreted to draw meaningful conclusions.

Throughout the unit, students develop their suite of science inquiry and research skills through teacher-led learning and investigations situated in the context of their research focus area. These understandings are applied to the development of their own unique research, through the construction of a research proposal and the conduct of a feasibility study.

Unit objectives

1. Explain ideas and findings about research methodologies and analysing and evaluating evidence.
2. Apply understanding about research methodologies and analysing and evaluating evidence.
3. Analyse data about research methodologies and analysing and evaluating evidence.
4. Interpret evidence about research methodologies and analysing and evaluating evidence.
5. Evaluate conclusions, decisions and processes about research methodologies and analysing and evaluating evidence.
6. Investigate phenomena about research methodologies and analysing and evaluating evidence.

Subject matter

Topic 1: Exploring research methodologies

Science understanding

- Explain how the scientific inquiry process is not a linear process but instead involves continual feedback and refinement.
- Compare different types of research methodologies, and explain how they each produce different types of evidence, including
  - experimental studies
  - observational studies
  - correlational studies
  - simulations
  - a combination of methodologies.
- Contrast fundamental and applied scientific research and describe how both are essential to scientific progress.
- Classify scientific research as either empirical or theoretical.
- Identify dependent, independent, controlled, confounding and extraneous variables in investigations.
- Describe bias in investigation and explain how it can be addressed to improve validity, including
  - positive and negative controls in experimental investigations
  - placebos in clinical studies
  - blinding
  - triangulation of method and data.
- Explain the impact of sampling techniques have on the validity of the study outcomes and describe the different methods of sampling in a study, including
  - simple random sampling
  - stratified sampling
  - cluster sampling
  - convenience sampling.
- Classify how data produced by scientific investigations can be qualitative, qualitative, or a combination of both.
- Explain how operationalizing variables involves the process of assigning a measurement for a phenomenon that is not measurable directly, and the selection of an appropriate indicator for a variable impacts the reliability and validity of the data e.g.
  - levels of the hormone cortisol are used as a measure of stress
  - turbidity as a measure bacterial growth in liquid culture.

Science as a human endeavour (SHE)

- Appreciate that scientific advances are both a driving force behind developments in society and culture and is shaped by the cultural, economic, and political contexts in which it occurs.
- Recognise how the methodology selected when performing research is influenced by a range of considerations and explore why each of these impacts the feasibility of an investigation.
- Recognise that research is governed by legislation and codes of practice that guide and regulate how research in conducted and explore the regulatory and legislative requirements that govern research in Australia.
- Recognise the application of scientific knowledge and research may have both beneficial and/or harmful and/or unintended consequences.
- Explore the role of Citizen Science and consider examples of effective Citizen Science projects.
- Explore how technological advances impacted research methodologies and the speed in which discovers can be made e.g. Square Kilometre Array, DNA sequencing, electron microscope.

Science inquiry

- Conduct an experiment using a positive and negative control to demonstrate the validation of experimental process and establish a baseline to which comparisons are made.
- Explore how to select appropriate sampling techniques when designing a study.
- Model the impact of different sampling techniques on investigation outcomes.
- Assess investigation methods for safety, ethics and/or environmental impact.
- Conduct an investigation using the scientific inquiry process.

Topic 2: Analysing and evaluating evidence

Science understanding

- Apply appropriate analysis techniques to qualitative data to identify, trends, patterns and relationships, including
  - identify sources of variability in qualitative data
  - thematic, content, Iterative analysis
  - categorisation and classification
- Apply appropriate analysis techniques to quantitative data to identify trends, patterns and relationships, including
  - measures of central tendency
  - identify variability in a quantitative data.
- Compare
  - precision and accuracy
  - reliability and validity
  - systematic and random error
  - standard deviation with standard error.

- Interpret the impact of anomalous data in scientific research e.g. outliers, contradictory evidence.
- Explain the nature of uncertainty in scientific data and describe sources of uncertainty.
- Explain how improving methodology can reduce but not eliminate uncertainty entirely from data sets.
- Interpret the statistical measures of p-value, correlation coefficient (*r*) and coefficient of determination (R^2) and identify the situations in which they are best applied.
- Describe the purpose of confidence intervals and explain how they are used to make judgements to be made about the certainty of the data.
- Contrast correlation and causation.
- Interpret mathematical models to explain scientific phenomena representing a real system and consider the hypotheses and assumptions that underpin these models.
- Interpret data displays and explain the association between variables.

Science as a human endeavour

- Appreciate that rapid advances in technology have resulted in very large sets of data being produced in short periods of time leading to a shift from hypothesis driven research data driven research.
- Examine the role artificial intelligence (AI) may play in assisting scientists to analyse complex data sets.

Science inquiry

- Model how to classify and address outliers in scientific data.
- Investigate the difference between accuracy and precision in measurements and how they impact the interpretation of results.
- Perform an investigation to collect, organise and analyse qualitative data.
- Use a spreadsheet to record and process data and prepare graphical representations of data.
- Perform inferential statistical analysis on sample data sets.

Unit 4: Communicating scientific findings and understanding scientific thinking

In Unit 4 students explore the ways which scientific findings are presented and communicated. and pace this in the broader context of scientific discovery reviewing the fundamental nature of science and scientific discoveries.

Students explain the importance of record keeping in scientific research and investigate the many ways scientific findings are communicated. They learn the features of formal scientific writing and how these are shaped by audience and purpose, examine the process of peer review, and analyse how communication between scientists differs from communication with the broader public. Students develop skills to evaluate scientific communication and apply these to present the findings of their own scientific investigation.

Students also explore the nature of scientific thinking and develop an understanding of how new scientific knowledge is acquired, and how science compares with other academic disciplines. They investigate historical and cultural examples to illustrate how scientific research has changed over time and examine the complex, collaborative and multidisciplinary nature of modern scientific discovery. Students consider key philosophical ideas that shape scientific thinking, describe the empirical basis of scientific discovery, compare inductive and deductive reasoning, and explain how falsification guides the development of testable hypotheses. They describe the nature and importance of paradigm shifts in scientific discovery and compare these with the steady, cumulative development of scientific understanding

Unit objectives

1. Explain ideas and findings about communicating scientific findings and understanding scientific thinking.
2. Apply understanding about communicating scientific findings and understanding scientific thinking.
3. Analyse data about communicating scientific findings and understanding scientific thinking.
4. Interpret evidence about communicating scientific findings and understanding scientific thinking.
5. Evaluate conclusions, decisions and processes communicating scientific findings and understanding scientific thinking.
6. Investigate phenomena about communicating scientific findings and understanding scientific thinking.

Subject matter

Topic 1 Communicating scientific findings

Science understanding

- Explain the importance of consistent and detailed record keeping when conducting research and describe implications of insufficient record keeping.
- Explain why different types of displays including tables, graphs and visuals are used to effectively communicate support for scientific findings.
- Describe the basic conventions for formal scientific communication.
- Identify how the mode and genre of science communication changes with the intended audience.
- Describe the nature and purpose of different scientific publications including primary investigations, case studies, review articles and meta studies.
- Explain the importance of peer review and describe the publication processes for expert and further (e.g. retractions and amendments) reviews.
- Explain the importance of effective science communication in disseminating new scientific knowledge.
- Identify examples miscommunication in scientific communication and explain the impact it has on the interpretation of scientific findings.
- Identify instances of misrepresentation of findings in science communication and explain their impact.

Science inquiry

- Use a logbook to produce detailed accounts of investigative processes.
- Explore how scientific findings are communicated through different formats. Compare the presentation of novel findings in peer reviewed scientific papers with reporting in the wider media.
- Model different modes of scientific communication for different audiences and purposes.
- Explore the submission requirements for a research paper in a scientific journal.
- Explore the links between research and the development of government policies and guidelines.
- Analyse scientific articles to demonstrate how structure and language features are used to convey information.

Science as a human endeavour

- Appreciate the significant role formal scientific communication plays in advancing science in the form of research articles, grant proposals, conference presentations and poster presentations.
- Recognise that formal scientific communication can be difficult for nonexpert audiences to engage with and the communication gap between experts and non-experts. Appreciate that this communication gap contributes to increased scepticism about scientific findings and can result in mistrust of scientists and the scientific process.

- Appreciate the need for scientists to communicate complex ideas in a clear and accurate way to a broader audience.
- Explore the different media scientists use to engage with public audiences e.g. radio, podcasts, popular science media, social media etc.

Topic 2: Understanding scientific thinking

Science understanding

- Describe how the development of knowledge through scientific thinking is multidimensional, complex and often crosses more than one scientific discipline.
- Describe how empiricism has shaped scientific thinking.
- Distinguish between the application of inductive and deductive reasoning to scientific problems and explain how each contributes to scientific thinking.
- Describe how the heuristic principles of parsimony and Occam's razor can guide the development of a plausible scientific hypothesis.
- Apply Popper's Falsification Principle and explain how it directs the development of testable hypotheses in science.
- Contrast scientific theories, laws and models and describe how these terms in science differ from their use in non-scientific applications.
- Explain the concept of a paradigm shift as described by Kuhn where anomalies and contradictory evidence can be used to disrupt established theories and models.

Science inquiry

- Investigate how empirical observations differentiate the development of scientific knowledge from other fields such as philosophy e.g. work of Galileo Galilei and his observations of Venus and of Jupiter's moons.
- Use Popper's Falsification to propose testable hypotheses to conduct a simple investigation.
- Perform experiments to model inductive reasoning/analysis.

Science as a human endeavour (SHE)

- Appreciate that modern scientific discovery is not achieved in isolation and involves a wide range of evidence from globally collaborative groups of scientists across disciplines e.g.
  - Human genome project
  - the impact of Chlorofluorocarbons (CFC) on the ozone layer
  - Conseil européen pour la Recherche Nuclèaire (CERN)/ European Council for Nuclear Research
  - Intergovernmental Panel on Climate Change (IPCC).
- Appreciate the significant contributions of scientists such as Ada Lovelace, Antoine Lavoisier, Louis Pasteur and Jennifer Doudna who work led to scientific revolutions and paradigm shifts on the progression of science and society.
- Explore the role of serendipity and curiosity in scientific discovery and the importance of detailed observations e.g. discovery of penicillin and the discovery of pulsars.

- Appreciate the significance of First Nations peoples' cultural observational knowledge to the development of scientific understanding e.g. the use of fire to maintain vegetation and enhance biodiversity.
- Explore the historical, social and cultural barriers that have excluded a range of diverse groups from science and the impact this has had in scientific discoveries.

Assessment

Internal assessment 1: Research proposal (1010%)

Students will select a research focus area and review credible scientific sources to identify a foundational research question for a scientific investigation. This assessment provides opportunities to assess science inquiry skills learned through Unit 3.

Assessment objectives

1. Explain ideas and findings about research methodologies and analysing and evaluating evidence.
2. Apply understanding about research methodologies and analysing and evaluating evidence.
6. Investigate phenomena about research methodologies and analysing and evaluating evidence.

Specifications

This task requires students to:

- select a research focus to be investigated, from a list provided by the teacher
- identify relevant scientific concepts associated with the research focus
- conduct research to gather evidence from scientifically credible sources to inform the development of a research question and methodology
- pose a research question to be investigated
- identify relevant evidence to construct scientific arguments that address the feasibility of a proposed research methodology
- communicate findings in an appropriate scientific genre, e.g. report, poster presentation, presentation.

It is recommended that this task is designed so that students can develop a response in approximately 5 hours of class time.

Conditions

- Students can develop their responses in class time and their own time.
- This is an individual task.

Response requirements

One of the following:

- Multimodal (at least two modes delivered at the same time): up to 7 minutes
- Written: up to 1000 words

Mark allocation

Criterion	Assessment objectives	Marks
Forming	1, 6	5
Finding	1, 2, 6	5
	Total marks:	10

Instrument-specific marking guide (IA1)

Forming	Marks
The student response has the following characteristics:	
• a considered rationale for the research focus • a specific and relevant research question • appropriate use of genre and referencing conventions	4–5
• a reasonable rationale for the research focus • relevant research question • use of basic genre and referencing conventions	2–3
• a vague or irrelevant rationale for the research focus • an inappropriate research question • inadequate use of genre and referencing conventions.	1
The student response does not match any of the descriptors above.	0

Finding	Marks
The student response has the following characteristics:	
• a methodology that enables the collection of sufficient and relevant data • considered discussion of feasibility of methodology • fluent and concise use of scientific language and representations	4–5
• a methodology that enables the collection of relevant data • reasonable description of feasibility of methodology • competent use of scientific language and representations	2–3
• a methodology that enables the collection of insufficient and irrelevant data • inadequate description of feasibility of methodology • simplistic use of scientific language and representations.	1
The student response does not match any of the descriptors above.	0

Internal assessment 2: Feasibility study (15%)

Students design and conduct an experiment relevant to their chosen area of research to address their own related hypothesis. This assessment provides opportunities to address science inquiry skills learned through Unit 3.

Assessment objectives

1. Explain ideas and findings about research methodologies and analysing and evaluating evidence.
2. Apply understanding about research methodologies and analysing and evaluating evidence.
3. Analyse data about research methodologies and analysing and evaluating evidence.
4. Interpret evidence about research methodologies and analysing and evaluating evidence.
5. Evaluate conclusions, decisions and processes about research methodologies and analysing and evaluating evidence.
6. Investigate phenomena about research methodologies and analysing and evaluating evidence.

Specifications

This task requires students to:

- identify a hypothesis to be tested from a previously identified research question
- develop a suitable experiment to test their hypothesis
- conduct a risk assessment and account for risks in the methodology
- conduct the study
- collect relevant qualitative and/or quantitative data to address the research question
- process and present the data appropriately
- analyse the evidence to identify trends, patterns and/or relationships
- analyse the evidence to identify uncertainty and limitations
- interpret the evidence to draw conclusion/s about the feasibility of future investigations
- suggest possible improvements and/or extensions to the study
- communicate findings in an appropriate scientific genre, e.g. report, poster presentation, journal article, conference presentation.

Scientific inquiry is a non-linear, iterative process. Students will not necessarily complete these steps in the stated order; some steps may be repeated or revisited.

It is recommended that this task is designed so that students can develop a response in approximately 10 hours of class time.

Conditions

- Students can develop their responses in class time and their own time.
- This is an individual task.

Response requirements

Findings

One of the following:

- Multimodal (at least two modes delivered at the same time): up to 10 minutes
- Written: up to 1500 words

Reflection

One of the following

- Spoken:

Mark allocation

Criterion	Assessment objectives	Marks
Forming and Finding	1, 2, 6	5
Analysing and Interpreting	2, 3, 4	5
Evaluating	4, 5	5
	Total marks:	15

Instrument-specific marking guide (IA2)

Forming and Finding	Marks
The student response has the following characteristics:	
• a considered hypothesis to the research question • a methodology that enables the collection of sufficient and relevant data • considered management of risks/ethical issues/environmental issues • collection of sufficient and relevant raw data • acknowledgement of sources of information through appropriate use of referencing conventions	4–5
• a reasonable hypothesis to the research question • a methodology that enables the collection of relevant data • management of risks/ethical issues/environmental issues • collection of relevant raw data • use of basic referencing conventions	2–3
• a considered rationale for the experiment • a methodology that enables the collection of sufficient and relevant data • a specific and relevant hypothesis • considered management of risks/ethical issues/environmental issues • inadequate acknowledgement of sources.	1
The student response does not match any of the descriptors above.	0

Analysing and Interpreting	Marks
The student response has the following characteristics:	
correct and relevant processing of data thorough identification of relevant trends/patterns/relationships thorough and appropriate identification of the uncertainty and limitations of evidence justified conclusion/s linked to hypothesis fluent and concise use of scientific language and representations	4–5
• relevant processing of data • identification of obvious trends/patterns/relationships • basic identification of uncertainty and/or limitations of evidence • reasonable conclusion/s relevant to the hypothesis • competent use of scientific language and representations	2–3
• incorrect or irrelevant processing of data • identification of incorrect or irrelevant trends/patterns/relationships • incorrect or insufficient identification of uncertainty and/or limitations of evidence • inappropriate or irrelevant conclusion • simplistic use of scientific language and representations.	1
The student response does not match any of the descriptors above.	0

Evaluating	Marks
The student response has the following characteristics:	
• justified discussion on the reliability and validity of the study • extrapolation of credible findings to the feasibility of the research question • suggested improvements and extensions to the study that are logically derived from the analysis of evidence	4–5
• reasonable description of the reliability and/or validity of the study • application of relevant findings to the feasibility of the research question • suggested improvements and extensions to the study that are logically derived from the analysis of evidence	2–3
• cursory or simplistic statements about the reliability and validity of the study • application of insufficient or inappropriate findings to the research question • suggested improvements and extensions to the study that are logically derived from the analysis of evidence.	1
The student response does not match any of the descriptors above.	0

Internal assessment 3: Scientific investigation (25%)

Students engage in an extended investigation that considers previous research and evaluate a research question. This assessment provides opportunities to assess science inquiry and sciences as a human endeavour subject matter.

Assessment objectives

1. Explain ideas and findings about communicating scientific findings and understanding scientific thinking.
2. Apply understanding about communicating scientific findings and understanding scientific thinking.
3. Analyse data about communicating scientific findings and understanding scientific thinking.
4. Interpret evidence about communicating scientific findings and understanding scientific thinking.
5. Evaluate conclusions, decisions and processes communicating scientific findings and understanding scientific thinking.
6. Investigate phenomena about communicating scientific findings and understanding scientific thinking.

Specifications

This task requires students to:

- identify the research question to be investigated
- research relevant background scientific information to inform the modification of a previous methodology
- conduct a risk assessment and account for risks in the methodology
- conduct the investigation
- maintain a record of findings and reflections
- process and present the data appropriately
- analyse the evidence to identify trends, patterns and/or relationships
- analyse the evidence to identify uncertainty and limitations
- interpret the evidence to draw conclusion/s to the hypothesis and research question
- suggest possible improvements and/or extensions to the research
- reflect on learnings from investigation through response to unseen questions
- communicate findings in an appropriate scientific genre, e.g. report, poster presentation, journal article, conference presentation.

It is recommended that this task is designed so that students can develop a response in approximately 15 hours of class time.

Stimulus specifications

The teacher provides three unseen questions for the Reflection.

Conditions

- Students can develop their responses in class time and their own time.
- This is an individual task.
- The teacher must provide students with 5 minutes planning time for the Reflection.

Response requirements

Findings

One of the following:

- Multimodal (at least two modes delivered at the same time): up to 10 minutes
- Written: up to 1500 words

Reflection

One of the following:

- Spoken: up to 5 minutes
- Written: up to xxxx words

Mark allocation

Criterion	Assessment objectives	Marks
Forming	1, 2, 6	5
Finding	2, 6	5
Analysing	2, 3, 4	5
Interpreting	2 ,3, 4	5
Evaluating	1, 5, 6	5
	Total marks:	25

Instrument-specific marking guide (IA3)

Forming	Marks
The student response has the following characteristics:	
• a considered rationale for the investigation • justified modifications to the methodology • a specific and relevant research question • a methodology that enables the collection of sufficient and relevant data • appropriate use of genre and referencing conventions	4–5
• a reasonable rationale for the investigation • feasible modifications to the methodology • a relevant research question • a methodology that enables the collection of relevant data • use of genre and referencing conventions	2–3
• a vague or irrelevant rationale for the investigation • inappropriate modifications to the methodology • an inappropriate research question • a methodology that enables the collection of insufficient and irrelevant data • appropriate use of genre and referencing conventions.	1
The student response does not match any of the descriptors above.	0

Finding	Marks
The student response has the following characteristics:	
• considered management of risks/ethical issues/environmental issues • collection of sufficient and relevant raw data • thorough and appropriate record keeping of findings and reflections	4–5
• management of risks/ethical issues/environmental issues • collection of relevant raw data • appropriate record keeping of findings and/or reflections	2–3
• management of risks/ethical issues/environmental issues • collection of insufficient and irrelevant raw data • inappropriate or insufficient record keeping of findings and reflections.	1
The student response does not match any of the descriptors above.	0

Analysing	Marks
The student response has the following characteristics:	
• correct and relevant processing of data • thorough identification of relevant trends/patterns/relationships • thorough and appropriate identification of the uncertainty and limitations	4–5
• relevant processing of data • identification of obvious relevant trends/patterns/relationships • basic identification of the uncertainty and/or limitations	2–3
• incorrect or irrelevant processing of data • identification of incorrect or irrelevant trends/patterns/relationships • incorrect or insufficient identification of the uncertainty and limitations	1
The student response does not match any of the descriptors above.	0

Interpreting	Marks
The student response has the following characteristics:	
• justified scientific argument/s • justified conclusion/s linked to the research question • fluent and concise use of scientific language and representations	4–5
• reasonable scientific argument/s • reasonable conclusion/s linked to the research question • competent use of scientific language and representations	2–3
• inappropriate or irrelevant scientific argument/s • inappropriate or irrelevant conclusion/s • incorrect use of language/representations	1
The student response does not match any of the descriptors above.	0

Evaluating	Marks
The student response has the following characteristics:	
• justified discussion of the reliability and validity of the investigation • suggested improvements and extensions to the investigation that logically derived from the analysis of evidence • a considered reflection on learnings from investigation	4–5
• reasonable description of the reliability and/or validity of the investigation • suggested improvements and/or extensions to the investigation are related to the analysis of evidence • a reasonable reflection on learnings from investigation	2–3
• cursory or simplistic statements about the reliability and validity of the investigation • ineffective or irrelevant suggestions • inappropriate reflections	1
The student response does not match any of the descriptors above.	0

External assessment: Examination (5050%)

External assessment is developed and marked by the QCAA. The external assessment in Science Extension is common to all schools and administered under the same conditions, at the same time, on the same day.

Assessment objectives

1. Explain ideas and findings about research methodologies, analysing and evaluating evidence, communicating scientific findings and the foundations of scientific thinking.
2. Apply understanding about research methodologies, analysing and evaluating evidence, communicating scientific findings and the foundations of scientific thinking.
3. Analyse data research methodologies, analysing and evaluating evidence, communicating scientific findings and the foundations of scientific thinking.
4. Interpret evidence about research methodologies, analysing and evaluating evidence, communicating scientific findings and the foundations of scientific thinking.
5. Evaluate processes, claims and conclusions research methodologies, analysing and evaluating evidence, communicating scientific findings and the foundations of scientific thinking.
6. Investigate phenomena associated with research methodologies, analysing and evaluating evidence, communicating scientific findings and the foundations of scientific thinking.

Specifications

- includes two papers. Each paper consists of a number of different types of questions relating to Units 3 and 4
- may ask students to respond using
  - multiple choice
  - sentences or paragraphs
- may ask students to
  - calculate using algorithms
  - interpret unseen stimulus, including graphs, tables or diagrams.

Conditions

Paper 1

- Mode: written
- Time allowed
  - Perusal time: 5 minutes
  - Working time: 90 minutes
- Students may use a QCAA-approved graphics or scientific calculator.

Paper 2

- Mode: written
- Time allowed
  - Perusal time: 5 minutes
  - Working time: 90 minutes
- Students may use a QCAA-approved graphics or scientific calculator.

Glossary

The syllabus glossary is available at www.qcaa.qld.edu.au/downloads/senior-qce/common/snr_glossary_cognitive_verbs.pdf.

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Version history

Version	Date of change	Information
1.0	February 2026	Draft released for consultation.