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Education and Innovation Committee
Parliament House
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Dear Ms Watson

On behalf of the Board of the Queensland Studies Authority, I would like to provide the attached submission to the Parliamentary inquiry into assessment methods for senior Mathematics, Chemistry and Physics in Queensland schools.

Yours sincerely

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13 / 05 / 2013

enc.

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Parliamentary inquiry into assessment methods used in senior Mathematics, Chemistry and Physics in Queensland

A submission from the Board of the Queensland Studies Authority

13 May 2013

Queensland Government

Queensland Studies Authority

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Queensland Studies Authority

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Introduction

This submission has been prepared by the Board of the Queensland Studies Authority (QSA) to assist the Queensland Parliament's Education and Innovation Committee as it conducts its inquiry into the assessment methods used in senior Mathematics, Chemistry and Physics in Queensland schools (hereafter referred to as “the Inquiry”).

The board of the QSA welcomes this inquiry into assessment. The way young Queenslanders are assessed is an important subject, worthy of discussion in the broader community.

Assessment is fundamental to the teaching and learning process as it provides students, parents and teachers with valuable information about individual student achievement. It is also critical in charting students’ progress in subjects leading to further education, training and employment.

The system of assessment in place in Queensland today has evolved over 40 years — it is not new, and bears no relationship to the system of outcomes based assessment recently discarded in Western Australia. Its evolution has been an ongoing process of inquiry and feedback, both internal and external to the QSA, and international research about high performing education systems.

Since 2010, Australia has been moving toward a national framework for schooling aimed at raising education standards and achieving nationally consistent curriculum, assessment and reporting.

Significantly for this Parliamentary Inquiry, the Queensland Minister and all other Australian Ministers for Education endorsed 14 senior secondary Australian Curriculum subjects in December 2012. The senior secondary Australian Curriculum subjects (which include curriculum content and achievement standards) developed by the Australian Curriculum, Assessment and Reporting Authority (ACARA) represent the next step towards national consistency in what is being taught to young Australians from Prep to Year 12, and in how it is being reported to students, parents and the community.

The 14 Australian Curriculum subjects include the content and achievement standards for Chemistry, Physics, Mathematics Methods (Mathematics B) and Specialist Mathematics (Mathematics C).

The Inquiry’s Terms of Reference require the Committee to investigate the following key issues in relation to the assessment methods used in Senior Mathematics, Chemistry and Physics in Queensland schools:

1. Ensuring assessment processes are supported by teachers
2. Student participation levels
3. The ability of assessment processes to support valid and reliable judgments of student outcomes.

While the focus of the Inquiry is on assessment in senior Mathematics, Chemistry and Physics, its recommendations may have a significant impact on how all senior syllabuses are developed to support the implementation of the Australian Curriculum in Queensland and how locally developed courses are revised.

This submission will therefore address the Inquiry's Terms of Reference in the context of the Queensland system of assessment's capacity to support valid and reliable judgments of student achievements. It will also address the specific areas of concern about the assessment methods used in senior Mathematics, Chemistry and Physics that have been raised with the Committee during the public briefings held on 6, 7 and 20 March 2013 and the expert advisory forum convened on 1 May 2013. The submission expands upon the information provided by the QSA during these events.

There are four main sections in this submission designed to address the Inquiry's Terms of Reference.

- Section 1 provides an historical background to Queensland's system of school-based and standards-based assessment and identifies the context for future changes.
- Section 2 demonstrates how the assessment processes that comprise Queensland's system of externally moderated school-based assessment support valid and reliable judgments about student achievements.
- Section 3 discusses key assessment processes in Queensland's system of assessment in the context of the areas that have led to the establishment of the Inquiry.
- Section 4 discusses issues associated with student participation in senior Mathematics, Chemistry and Physics subjects in Queensland.

While recognising there are opportunities to revitalise and refresh current approaches, this submission demonstrates that Queensland does have in place assessment processes that ensure reliability and validity, and that these processes will support effective implementation of the Australian Curriculum.

Section 1: Background

Queensland's system of externally moderated, standards-based, school-based assessment is not new. It was introduced in the early 1970s and has continued to evolve in response to challenges in the broader educational environment.

Introducing school-based assessment

What is school-based assessment?

School-based or internal assessment refers to teachers and schools being responsible for developing assessment programs based on the content and achievement standards prescribed in an approved syllabus.

Teachers are responsible for making judgments about the evidence of learning in students' work (i.e. what students know and can do) matched to the syllabus standards. This evidence collected at suitable intervals as part of the teaching and learning program.

School-based assessment broadens the ways in which students can demonstrate what they have learnt rather than try and predict what examiners might be looking for.

School-based assessment puts teachers' professional knowledge and practice at the centre of aligning what is taught, how it is taught, how student learning is assessed and how learning is reported.

School-based assessment is not unique to Queensland — other Australian states and territories use school-based assessment to varying degrees to determine students' final Year 12 results:

- Australian Capital Territory — 100 per cent is school-based assessment
- New South Wales — 50 per cent is school-based assessment
- Victoria — up to 40 per cent is school-based assessment
- South Australia and the Northern Territory — 70 per cent is school-based assessment.

Queensland's system of school-based assessment in secondary schools was introduced in response to concerns about the ability of the Senior Public Examination set by the University of Queensland to serve the dual purposes of selecting students for tertiary study and as the culmination of school studies for students not intending to go to university. The Senior Physics examinations of 1966 and 1967 attracted widespread criticism from students, teachers, parents, the media and elected representatives for being unrealistic and extremely difficult.

In 1968, the then Board of Senior Secondary School Studies (BSSSS) commissioned Professor George Bassett, Professor of Education at the University of Queensland, to chair a committee to investigate the possibility of introducing a "leaving certificate" for the growing number of senior secondary school students who did not progress to tertiary education. The findings became known as the Bassett Report.

In 1969, the BSSSS discussed Professor Bassett's report and recommended to government that a committee be established to consider his findings. The findings of this committee are commonly referred to as the "Radford Report".

In December 1970, the Minister for Education, the Hon Alan Fletcher introduced a Bill in State Parliament to give effect to the recommendations for schooling in the Radford Report. In supporting the Bill, he stated:

> This is what is suggested for students – continuous assessment by the teacher. This would be more reliable and penetrating. But the most serious objection to the external examination is that it does not test the extent to which the objectives of the syllabus in each subject have been met. Only limited areas in the syllabus can be examined in the Junior and Senior examinations.
>
> Let us admit, too, that the build-up of tension in examinations constitutes a great disadvantage to a child whose achievement over the years is to be assessed in two hours.
>
> The external examinations also bring about a rigidity within syllabuses. Teachers, in fact, consult past papers more frequently than they consult the syllabuses. (*Queensland Parliamentary Debates*, vol. 255, December 1970).

Following passage of the legislation and implementation of the new system, assessment instruments devised by teachers, and the judgments they made about how well the students had learnt, became the major component of students' final results.

Teachers were required to use syllabuses developed by the Board of Secondary School Studies (BSSS) to document the main aspects of a course of study, develop and implement a range of assessment instruments, including assignments and tests, and to report on student achievement using a norm-based method.[1]

Selected teachers were also involved in 'moderation' meetings to ensure that the proposed grades for students were comparable between schools. The BSSS managed and supported this activity.

For the purpose of ranking students for entry into universities, the Australian Scholastic Aptitude Test (ASAT) was introduced in 1974 to enable tertiary entrance scores to be derived from school assessments scaled against the test.

Improving the system

The first major improvements to the system occurred after two research studies were commissioned in the mid-1970s to investigate implementation issues in schools. These studies concluded that norm-referenced, school-based assessment had not realised many of the expectations in the Radford Report. An expert committee, chaired by Professor Edward Scott from James Cook University, was established to assess the implications of these observations.

The final report of this committee, the Review of School-Based Assessment in Queensland Secondary Schools (or "ROSBA"), proposed the replacement of norm-based assessment with a criteria-based approach. The weakness of norm-referencing was that it compared students rather than reported what students had actually achieved. The ROSBA recommendations were phased into Queensland secondary schools in the early 1980s.

The criteria-based approach introduced into the system the component that teachers had been missing when they met to confirm results — a set of standards against which they could objectively judge student performance. This development also meant that student performance standards could be validly compared from year to year and over time.

[1] Norm-referencing involves awarding students grades on the basis of their ranking within a particular cohort. Norm-referencing involves fitting a ranked list of students' 'raw scores' to a pre-determined distribution for awarding grades. Usually, grades are spread to fit a 'bell curve'.

What is standards-based assessment?

Standards-based assessment means that teacher judgment is guided by achievement standards that are fixed reference points describing what is valued as important for young people to know, understand and do.

The standards describe the expected qualities of student work (i.e. "how well" students have achieved the objectives in the syllabus).

Predefined standards ensure that:

- students and teachers know what is expected for each level of achievement and can work together to achieve the best result for the student
- a common frame of reference supporting comparability from school to school can be achieved
- a shared language to describe student achievement supports teachers to discuss standards with parents/carers when reporting a student's achievements.

In 1990, Nancy Viviani, Professor and Head of Political Science at the Australian National University, conducted a review of tertiary entrance procedures in Queensland. Reforms resulting from the Viviani Report included the introduction in 1992 of a new rank for tertiary entrance purposes – the Overall Position (or OP) – and a common test derived from the Queensland curriculum to scale school-based assessment – the Core Skills Test.

While there have not been any similar public, system-wide reviews of Queensland's system of externally moderated, standards-based, school-based assessment and tertiary entrance since the early 1990s, the system has not remained static. Since the Viviani Report, a number of improvements have been made by the Board of Senior Secondary School Studies (BSSSS) and its successor organisation, the Queensland Studies Authority, on the basis of consultant reports and feedback from Queensland schools and education stakeholders. They include:

- P-12 syllabus design principles based on international research into the features of the curriculum documents used in high performing education systems. The principles inform syllabus development and ensure that the syllabuses make clear what is essential, including centralised standards and syllabus mandates, and support teachers to exercise their professional judgment about how best to teach and assess.
- Improving the reliability of the system by commencing a process of annually reviewing randomly selected student folios to measure comparability within the system. Random sampling has facilitated additional and ongoing research into the review panel moderation process.
- Implementing a systemic annual process, by which state review panels look at sample folios for each subject across all districts, to ensure that the standards are being consistently implemented across Queensland.
- Providing regular training and support for state and district review panel chairs to better equip them to support schools and teachers with both the assessment and moderation aspects of the system.
- Introducing an online senior assessment resource to provide schools with exemplar assessment instruments as well as student responses.

- Publishing the *A–Z of Senior Moderation* which documents all of the principles and procedures of the moderation process.
- Developing a range of support materials to assist teachers in developing valid assessment instruments.
- Revising the assessment section of syllabus templates that outlines conditions and task demand of assessment techniques.

Responding to change: Implementing the Australian Curriculum

In December 2012, Australian Ministers for Education endorsed 14 senior secondary Australian Curriculum subjects as the agreed and common base for the development of local courses. As a contemporary curriculum based on international and national best practice, the Australian Curriculum is standards-based.

The Australian Curriculum content descriptions detail the knowledge, understanding and skills to be taught and learned within a given subject, including the Australian Curriculum general capabilities and cross-curriculum priorities that naturally align with the subject. The content is very similar to the current Queensland syllabuses especially in Chemistry, Physics, Mathematics B and C.

The Australian Curriculum achievement standards refer to the quality of learning (the depth of understanding, extent of knowledge and sophistication of skill) demonstrated by students within a given subject. The senior secondary achievement standards are subject-specific and align with the major dimensions of learning as described in the learning outcomes and detailed in the content for the subject. Typically these dimensions are categorised into knowledge and understanding, and skills, and are written as five levels of achievement, A to E. (ACARA 2012, p. 24)

The standards are very similar to those used in Queensland syllabuses (see Appendix 1: Comparison of Australian Curriculum standards and Queensland standards for sciences and mathematics).

While issues to do with content and achievement standards have been resolved through national agreement, it is now the responsibility of state and territory curriculum, assessment and certification authorities to implement the senior secondary curriculum including assessment, certification and the attendant quality assurance mechanisms. Each of the authorities will act in accordance with its respective legislation and the policy framework of its state government and board.

The QSA board is currently consulting on a timeline for the development of revised senior syllabuses based on the Australian Curriculum content and achievement standards.

In addition, the Queensland Government has announced a review of senior assessment and reporting and tertiary entrance. The review will make recommendations about the Queensland system of assessment's ongoing capacity to meet the needs of students in a changing social and educational environment.

Section 2: Assessment processes to support valid and reliable judgments

Assessment is the purposeful collection of evidence about students' achievements. An awareness of what learning is assessed and how it is assessed helps students and parents/carers to develop an understanding of what is valued and where to focus attention. Focussing on the quality assurance processes of external moderation, this section demonstrates how the assessment processes that comprise Queensland's system of externally moderated, standards-based, school-based assessment support valid and reliable judgments about student achievements.

Goals of an assessment system

Assessment was once regarded as something that takes place after learning and as being quite separate from the process of learning. This view is no longer tenable; assessment is now acknowledged as a central part of education, with a proven role in helping learning as well as in reporting it.

The shift has been motivated by an economic imperative and the critical need for developing 21st century skills for an increasingly diverse, globalised, and complex, media-saturated society. For example, the Grattan Institute Report, *Catching Up: Learning from the best school systems in Asia* (February 2012) provides interesting insights into how high performing schools in Asia have approached education reform.

Two years after joining the Republic of China in 1999, Hong Kong engaged in systemic education reform to prepare students transitioning to a knowledge economy in a global labour market. The 2010 Organisation for Economic Cooperation and Development (OECD) Program for International Student Assessment (PISA) results show that Hong Kong is one of the world's four top performing schooling systems along with Korea, Singapore and Shanghai.

Hong Kong instituted a number of reforms including a move away from what has sometimes been described as the "drill and kill" approach to teaching.

> Hong Kong wanted students to develop learning skills rather than purely acquiring academic knowledge. Therefore it wanted teachers to move from directly transmitting knowledge to a constructivist approach: from the drilling of students to providing broad learning experiences. These included project and enquiry-based learning to help students develop critical thinking, problem solving and communication skills.
>
> Hong Kong also introduced integrated learning areas rather than compartmentalised subjects. It moved beyond an exclusive focus on textbooks to adopt diversified learning and teaching resources to deliver curriculum. Formative assessments were emphasised, showing how students were learning, rather than simply what they learnt.[2]

Since 2005, the Global Network of Science Academies (IAP) has held major international conferences on Inquiry-Based Science Education (IBSE) due to its increasing importance in developing those skills which are required by the current and future workforce. The IAP identified that the key issue for strategic planning for educational change is the central role of student assessment as it has a strong influence on what is taught and how it is taught. In 2012, the IAP conference focussed on assessment. Delegates from over 50 countries agreed that it is almost impossible

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[2] Jensen, B. *Catching up: Learning from the best school systems in East Asia: Summary report* (Grattan Institute Report no. 2012-3, November 2012), p.16.

for whole cohort tests of a reasonable length to provide the rich information needed to assess IBSE goals, and that several goals are better assessed by teachers.

In their recent publication, the IAP refers to the Queensland system to illustrate school-based and continuous assessment for high stakes assessment. The paper concludes that:

> … the openness of the on-going process of creating the portfolio means that at the end of the course there should be no surprises for either teachers or students. Further, the 'selective updating' and collection of 'fullest and latest' evidence allow poor starts, atypical performances, and earlier and temporary confusions (for whatever reason) to be ignored. Importantly, these processes facilitate the use of assessment to help learning, for students benefit from the feedback they receive on earlier assessments. They also have the opportunity for self-assessment in deciding when to replace an earlier piece of work in their portfolio. (Harlen 2013, p. 66)

Some important local research (as yet unpublished) attests to the fact that the Queensland system promotes higher order thinking — a benchmark of all high performing education systems. Professor Peter Fensham and Dr Alberto Bellocchi of the Queensland University of Technology have compared how the assessment systems in four Australian states encourage or discourage deeper levels of learning or higher order thinking in students studying Chemistry. They are referring to assessments that encourage students to combine facts and ideas and synthesise, generalise, explain, hypothesise or arrive at some conclusion or interpretation — the transformation of information and ideas.

They concluded that Queensland leads the group, attributing this fact to its system of assessment. The existence of mandated criteria and standards means that Queensland teachers need to design assessment instruments that allow students to demonstrate the higher levels of response.

While all state and territory Chemistry syllabuses examined by the researchers had the goal of promoting higher order thinking, Queensland was the only one to achieve an appropriate focus in its exams. Marks based systems tended to emphasise lower-order thinking, while examinations based on criteria in syllabuses tended to award greater credit for higher-order thinking questions.

Furthermore, by limiting the focus of examinations in the assessment program, Queensland students have greater opportunity to engage in assessment tasks (such as Extended Experimental Investigations) that encourage higher order thinking and hands-on science, and have these tasks contribute equally to their overall grades.

The goals of the Queensland assessment system are consistent with the goals described by international assessment expert, Dylan Wiliam (2008), who argues that the following features, in combination, should be the goal for all assessment systems:

- Distributed — so that evidence collection is not undertaken entirely at the end of a course of study.

  Queensland students are judged on their performance over two years rather than in a once-only exam. Evidence of learning collected over time allows students to demonstrate the depth and breadth of their learning.

- Synoptic — so that learning has to accumulate.

  Queensland students have the opportunity to demonstrate what they know and can do over a course of study. Assessing students over time allows teachers to give timely and comprehensive feedback to students about how to improve their knowledge and understanding, and to help them achieve the highest standards they can within their own capabilities. The concept of "latest information" means that earlier assessments that are no longer relevant are replaced by more recent evidence. The ultimate aim is to represent the state of knowledge and capability as typically demonstrated by the student towards the end of the course.

- Extensive — so that all important aspects are covered (breadth and depth).

  The QSA develops or approves syllabuses from which teachers develop work programs to show how they will meet the requirements of the syllabuses. Within the work program, the assessment program must assess the achievement of the objectives and the mandatory requirements prescribed in the syllabus. Queensland students are assessed using a variety of techniques, including group work, oral presentations, assignments and supervised examinations. This caters for students' various learning styles. The assessment program covers all the valued knowledge and skills to be assessed, and teachers have available sufficient and suitable evidence of learning to enable defensible judgments to be made. The concept of "fullest information" means that assessment information must be available on all mandatory aspects of the syllabus. Important criteria cannot be skipped; the assessment evidence in the portfolio must cover all the required aspects of the course.

- Manageable — so that costs are proportionate to benefits.

  Using externally moderated school-based assessment to achieve comparable standards by the end of Year 12 is less expensive than high-stakes public examinations for a range of subjects.

- Trusted — so that stakeholders have faith in the outcomes.

  Queensland's assessment system is standards-based. Pre-defined standards provide open and transparent information for students, teachers and parents/carers about what is valued as important for young people to know, understand and do, and describe the expected qualities in student work on a five point scale, usually A to E.

  Queensland's moderation process is made up of a number of phases designed to ensure that the levels of achievement in subjects match the requirements of syllabuses. This rigorous quality-assurance ensures reliable and comparable assessment of student achievement. Schools, teachers and the QSA are accountable within the moderation process, so they have "ownership" of the system.

  External moderation also helps teachers improve their knowledge of assessment and their assessment practices, thus improving their own teaching. Thousands of teachers have received ongoing professional training by the QSA in how to make comparable judgments on student achievement.

Queensland's system of assessment achieves each of these goals. It has continued to attract international interest largely because it facilitates the three elements that combine to create a quality assessment program:

- assessment *for* learning — which occurs when teachers monitor student progress to inform their teaching.
- assessment *as* learning — which occurs when students reflect on their progress to inform their future learning
- assessment *of* learning — which occurs when teachers use evidence of student learning to make judgements on student achievement against clearly stated standards.

Over the past two decades, the system has been used as a case study in international articles by a range of academics and researchers (e.g. Allen (2012), Elwood (2006), Gipps (1996), Gipps & Stobart (2003), Harlen (2005; 2013), Myford (1999), Shavelson et al. (2004), Strachan (2002). As Matters (2006) states, the Queensland system has become and "…remains a referent for other parts of the world."

In addition, assessment approaches in all QSA assessment products follow the national guidelines for Assessment Quality and Equity set out by the Australasian Curriculum, Assessment and Certification Authorities (ACACA 1995).

Reliability and validity

Any high-stakes assessment system is judged by two important dimensions: reliability and validity.

Reliability refers to how accurate the assessment is as a measurement if it is repeated. That is, the extent to which a second result agrees with the first. It is a measure that works well for standardised tests. Gipps (1994, p. 171) suggested that the term "comparability" is a better term when looking at a broader range of assessment approaches. Comparability aims to ensure that students who take the same subject in different schools and who attain the same standard through assessment programs based on a common syllabus will be awarded the same level of achievement. This does not imply that two students who receive the same level of achievement have had the same collection of experiences or have achieved equally in any one aspect of the course. Rather, it means that they have, on-balance, reached the same broad standard.

Validity means that the assessment actually assesses what it was designed to assess. It can refer to the match between the content assessed with the content of a curriculum and how well the assessment requires students to use the intended skills and knowledge in the assessment process.

Harlen (2013 p.10) discusses the interaction between reliability and validity. He shows that there is a trade-off — increasing reliability decreases validity and vice versa. For any test there is a large number of possible items and only a small sample of them can be included in a test of a reasonable length. A different selection would produce a different result, giving rise to what is described as the "sampling error". The sampling error can be much larger than is generally realised. For example, Wiliam estimated that for national tests in England about 40 per cent of students will be assigned to the 'wrong' grade level, even though these levels each span roughly two years. A way of reducing this source of error would be to increase the number of contexts included for each competence assessed and thus the number of items used. But the length of a test cannot be greatly increased without incurring other forms of error (student fatigue, for instance) so more items per skills or concept would mean fewer skills and concepts included, thus reducing the range of what is assessed and so reducing the validity of the test.

In his research on the validity and reliability of assessment by teachers, he concluded that the most dependable approaches were those where criteria were detailed but generic, being applicable to a range of classroom activities and which guide the selection of evidence without prescribing it. He states that there are several effective ways in which reliability can be improved, to a level equal to and even exceeding that of tests. The main ones are:

- group moderation
- using examples that are annotated to highlight features which are significant in relation to the judgements to be made and that the exemplar material is in a portfolio

of work from one student rather than single pieces of work from several students. This helps teachers to apply the criteria in a holistic manner.

- using a common short test or special task as a means of moderation or checking teachers' judgements but not as a separate measure of achievement. (Harlen 2013 pp. 62–64)

The Queensland assessment system involves a number of processes that ensure its reliability (or comparability) and validity. Together these are referred to as external moderation.

What is external moderation?

Queensland's system of external moderation is a set of processes designed to ensure that results recorded for Authority subjects match the requirements of the syllabus (Authority subjects are those subjects based on QSA syllabuses that, when taken collectively by students, qualify them for university entrance on exit from Year 12). The aim of moderation is to ensure comparability of standards across schools.

The Queensland system for Years 11 and 12 is founded on a partnership between schools and the QSA. Central to the Queensland system, and one of its unique features, is the involvement of teachers and schools in all facets of moderation. It is this engagement of teachers that allows the system to work effectively.

All Queensland teachers of senior students have some involvement in the system, whether as a member of a syllabus writing committee, a teacher assessing a student's achievements, a teacher developing a school's work program or as a member of a review panel.

A diagram of the moderation system is included at Appendix 6.

The key processes are summarised below:

- **developing approved syllabuses** that set the parameters for reliability and validity. The syllabus objectives and mandatory requirements (such as key content or concepts) make clear what students are expected to know and be able to do, and achievement standards make clear how students will be graded.
- **developing predefined standards** that provide open and transparent information for students, teachers and parents/carers about what is valued as important for young people to know, understand and do, and describe the expected qualities in student work on a five point scale, usually A to E.

  Predefined standards are essential for comparability because all schools and all teachers use a common language for making judgments about and reporting student achievement. Queensland senior syllabuses have included achievement standards since the 1980s. The Australian Curriculum, other Australian states and most education systems around the world, report student performance with reference to standards. As Stanley (2012, p. 1) observed, "This move has been hastened by the impact of international testing and the public policy focus on education in the development of human and social capital. Standards are intended to make explicit system goals and to assist teachers in focusing on what students at varying stages need to know and be able to do."
- **developing assessment programs** that set out a school's plan for collecting sufficient and suitable evidence to enable fair, defensible judgments to be made

about how well the evidence of student learning matches the standards in the approved syllabus. Many high achieving education systems include a range of assessment tasks to assess student achievement in the skills needed for success in the new economies.

- **applying external scrutiny** or moderation that establishes a set of checks and balances to ensure that teachers' judgments about student achievement are accurate and comparable.

  Moderation involves over 4000 experienced, registered teachers in State, Catholic and Independent schools trained by the QSA to peer review other teachers' judgments. The moderation process includes:

  - approximately 400 district review panels that consider comparability within each district and examine:
    - school work programs to ensure they meet the requirements of the approved syllabus
    - school assessment programs to ensure they provide opportunities for students to meet the syllabus standards
    - folios of student work to determine how well school judgments about the qualities of student work match the syllabus standards and school decisions about levels of achievement. In 2011 and 2012, over 19,000 Year 12 folios in Mathematics B, Chemistry and Physics were reviewed. As in previous years, agreement was reached for 99 per cent of submissions. The remaining 1 per cent were reviewed by the State Review Panels and all were resolved without going to the final referee (i.e., the QSA, a district panel chair from outside the district and the state review panel chair).
  - approximately 50 state review panels (one for each subject) that examine folios 'on the borderline' of each level of achievement from each district to ensure that the same standards are being implemented. This process focuses on the comparable application of standards across districts in the state.
  - QSA Quality Assurance Officers who check to ensure schools have acted on the advice from the panels.

- **conducting random sampling** of Year 12 folios from schools across the state and analysing comparability within the system. Schools are notified by the QSA in November regarding the subjects and the specific student folios that are required. The folios are reviewed by district review panellists not from the original reviewing district.

  Random sampling has been undertaken annually since 1994 and the reports are published on the QSA website. The data confirm that teachers consistently achieve a high rate of agreement in the assignment of levels of achievement — the system is consistent within each year and across years. In over 15 years, the rate of agreement has been between 84 per cent and 93 per cent. The 2012 result is the second highest achieved — 92 per cent — since the first year of random sampling in 1994. The highest was 93.1 per cent, recorded in 2005.

In 2011, the Australasian Curriculum, Assessment and Certification Authorities commissioned a project to explore options for ensuring reasonable comparability, both year-to-year and across Australia, for senior secondary Australian Curriculum subjects.

Dr Scott Marion, advisor to the United States Department of Education on assessment and accountability issues, with two senior experts from the Victorian and South Australian qualifications authorities, evaluated the QSA's processes and procedures and found that Queensland's "current procedures for ensuring both within-year and year-to-year comparability were strong overall".

The review made recommendations for some enhancements to the random sampling processes but concluded that "Queensland has created an internationally respected model of assessment". In particular, the review commended the QSA on:

- the sophisticated statistical analyses undertaken to support comparability and inform future adjustments to the system
- random sampling of student folios as a useful method for ensuring comparability
- an approach to assessment that focused on the skills and knowledge students demonstrate
- the professional development support and training available to moderation panellists, including high quality online and print publications
- the assessment system's ability to empower teachers and enhance their professional practice.

Section 3: Assessment processes

This section discusses key processes in Queensland's system of assessment relevant to the Inquiry's Terms of Reference. It also addresses the main areas of concern that have led to the establishment of the Inquiry.

Supporting teacher professionalism

One of the guiding principles in the *Education (Queensland Studies Authority) Act 2002* is that the professional role of teachers in schools should be recognised.

The legislation recognises the professional role of teachers who, together with the Authority, develop syllabuses and determine procedures of assessment and moderation that acknowledge the professionalism of teachers.

The method of assessment outlined in this submission – the basis of Queensland's system of externally moderated, standards-based, school-based assessment — acknowledges the role of teachers as professionals in the teaching and assessment process.

Like other professionals, there are certain things teachers should know and be able to do, regardless of whether they are recent graduates or highly experienced practitioners. The Australian Professional Standards for Teachers classify this knowledge and skills into seven categories:

- Know students and how they learn
- Know the content and how to teach it
- Plan for and implement effective teaching and learning
- Create and maintain supportive and safe learning environments
- Assess, provide feedback and report on student learning
- Engage in professional learning
- Engage professionally with colleagues, parents/carers and the community.

Assessment, moderation and certification in Queensland provides the context for teachers to demonstrate these standards. Inherent in the system is the expectation that teachers who meet these professional standards, and are able to put them into practice, will deliver quality learning outcomes for students.

How teachers are involved

The Queensland system is based on a high level of participation and collaboration. The QSA has a number of representative committees that include teachers and academics. These committees are closely involved in the development of QSA products, including syllabuses, and curriculum and assessment resources and policies.

The QSA board, its peak decision-making mechanism, includes teacher and union representatives, along with representatives of the schooling sectors, parents, higher education, and industry.

By far, the greatest support from teachers is demonstrated through their representation on review panels. The network of approximately 50 state and 400 district review panels covering the length and breadth of Queensland includes over 4000 experienced, registered teachers from State, Catholic and Independent schools.

The teacher's professional role in assessment

One of the Professional Standards listed above is that teachers assess, provide feedback and report on student learning. This involves the important process of making judgments about student work. Teachers learn how to apply standards in pre-service courses at university. Like all professionals they hone their abilities when they commence work and regularly discuss student achievement with their colleagues. It is one of their fundamental professional skills, and must be as complex as is necessary to achieve accurate, defensible and meaningful judgments about the qualities in a student's work. It involves a range of practices and a professional language, which may not be easily understood by non-teachers.

It is important to note that this aspect of assessment is quite different to the process of providing feedback to students and parents. In providing feedback, teachers develop skills in explaining the achievements of their students in terms of the standards identified in the syllabuses so that students and parents/carers can easily understand what has been achieved and how to improve.

Syllabuses

A syllabus is defined as an official "map" of a school subject that aims to set the parameters to shape and influence the curriculum. A syllabus represents an agreed position on teaching, learning, assessment and standards for a particular learning area or subject and includes a set of integrated elements that provide the basis for schools to make decisions about the curriculum they offer.

The syllabus is not the curriculum. The curriculum is the sum total of the teaching and learning experiences and resources used in classrooms and other learning environments.

Syllabus development

All QSA syllabuses are developed in consultation with teachers, academics, industry, parents and other education stakeholders and are based on national and international best practice.

Teachers, school administrators and discipline area academics actively participate in the syllabus development process through membership of a Learning Area Reference Committee, writing teams and focus groups.

All educators are invited to provide feedback on draft versions of revised syllabuses which are routinely posted on QSA's website.

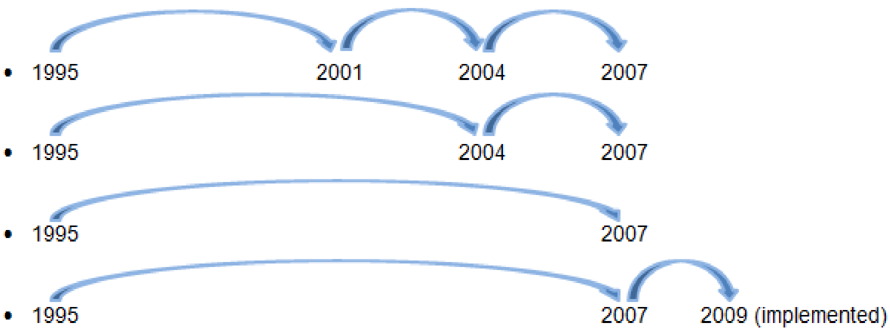
The syllabus revision and syllabus implementation process typically includes:

- Scoping — QSA researches and develops a design brief based on a review of practice within Australian states and territories and internationally, a consideration of the emphasis within tertiary courses and national and international research
- Substantial draft — the writing team develops a substantial draft for consultation
- Final draft — the writing team refines the substantial draft based on the feedback to produce a final draft for approval by the QSA board
- Publishing and resource development — the writing team develops initial resources and the syllabus is published
- In the first year after publication, schools use the revised syllabus with Year 11 and the old syllabus with Year 12
- In the second year, schools use the revised syllabus for both Year 11 and 12.

This did not occur for Chemistry (2007) and Physics (2007) and, to some extent, explains why there has been a challenging transition for some mathematics and science teachers (see Appendix 3). Since 1995, four syllabuses have been developed for each of Chemistry and Physics:

- 1995 syllabus
- 2001 trial syllabus used in 24 schools (Chemistry) and 26 schools (Physics)
- 2004 extended trial syllabus used in 117 schools (Chemistry) and 102 schools (Physics)
- 2007 syllabus (for general implementation, that is all schools).

Therefore, from 2001 to 2009 schools have had different Chemistry and Physics syllabus implementation histories as illustrated below.



QSA data show that approximately 68 per cent of schools moved directly from the 1995 Senior Chemistry syllabus to the 2007 Senior Chemistry syllabus (257 schools). For Physics, this figure was approximately 70 per cent (272 schools). The consequence of this late move was that many teachers may not have engaged in the valuable professional development associated with the revised syllabuses during the previous six years.

The reason for this protracted revision process was because the BSSSS and then the QSA was responding to feedback from the independent evaluators.

When syllabuses are in trial or pilot they are independently evaluated. The evaluations must include discussions with teachers and, in many cases, students. The evaluator makes recommendations which inform the revision process.

A panel of independent, external evaluators surveyed teachers and students regarding the implementation of the 2001 and 2004 Chemistry and Physics trial syllabuses. The survey findings from the 2004 evaluation led to recommendations which informed the development of the current 2007 syllabuses.

After issues were brought to QSA's attention about the assessment requirements of the 2007 Physics and Chemistry syllabuses and the 2008 Mathematics A, B and C syllabuses further refinements were undertaken.

In addition to addressing the concerns of the evaluators, the 2007 syllabuses for Physics and Chemistry were informed by a range of texts that describe best practice in science education, including:

- Tytler, R. (2007) *Re-imagining Science Education: Engaging students in science for Australia's future*, Australian Council for Educational Research, Camberwell.
- Goodrum, D., Hackling, M. & Rennie, L. (2001) *The National Review of the Status and Quality of Teaching and Learning of Science in Australian Schools*, Department of Education, Training and Youth Affairs, Canberra.

- National Science Council. (1996) *The National Science Education Standards*, National Academy Press, Washington, DC.

Appendix 2 provides a summary of the similarities and differences in the 1995 and 2007 syllabuses.

The endorsement of the senior secondary Australian Curriculum subjects in December 2012 means that once the timeline for the implementation of the Australian Curriculum subjects in Queensland is settled, all schools will move to revised syllabuses based on the Australian Curriculum.

Initial mapping of the Australian Curriculum for Chemistry, Physics and Mathematics Methods and Specialist Mathematics shows that Queensland schools using the 2007 science syllabuses and the 2008 mathematics syllabuses are well-prepared for the Australian Curriculum.

Syllabus content in science and mathematics

Every Queensland syllabus includes mandatory requirements that must be taught and assessed over the two years of senior schooling. In mathematics, Chemistry and Physics syllabuses, the mandatory requirements are the general objectives and the key concepts or topics.

The curriculum content in Queensland syllabuses is highly consistent with syllabuses across the country. A 2007 study by the Australian Council for Educational Research, *Year 12 Curriculum Content and Achievement Standards*, found there was about 85 per cent commonality in Physics and 95 per cent in Chemistry across the states and territories.

There is a high degree of similarity between the Queensland curriculum for Physics, Chemistry and Mathematics B and C and the recently endorsed Australian Curriculum content and achievement standards for these subjects (see Appendix 1: Comparison of Australian Curriculum standards and Queensland standards for sciences and mathematics).

Future senior syllabuses will use the Australian Curriculum content and achievement standards that were endorsed by Australian Ministers for Education in December 2012 as the common and agreed basis for state syllabuses.

Assessment in Physics, Chemistry, Mathematics B and C

Number of assessment tasks

There are fewer summative assessment tasks[3] required in the current science syllabuses than in previous syllabuses. For example, in the 1995 Physics syllabus a total of 5 to 11 pieces of assessment were required. In the 2007 syllabus it is 5 to 7.

Education authorities across Australia require students to complete several assessment tasks in a variety of forms in individual senior subjects. All states use internal assessment in the final grades in Year 12. An analysis of the assessment requirements in New South Wales, Victoria, South Australia and Western Australia indicates that, in addition to the external examination, internal assessment requirements range from 3 to 12 assessment tasks during Year 12 (see Appendix 4).

The Queensland syllabuses provide scope for some flexibility for schools to determine the number, type and timing of assessment tasks. An assessment audit tool is provided

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[3] The major purpose of summative assessment is to indicate the achievement status or standards achieved at particular points of schooling. It is geared toward reporting or certification. In contrast, formative assessment is used to improve teaching and student achievement. Formative assessment is more typically used in Year 11.

in the online resources for senior syllabuses to assist schools in reviewing their assessment programs to minimise the workload for students at any stage in the year.

Range and balance of assessment tasks

By setting an appropriate range of assessment tasks, a teacher can be sure they have sufficient information to make fair and defensible judgments about a student's achievements and arrive at a final level of achievement.

The assessment demands in QSA syllabuses reflect the range and balance of assessment tasks considered appropriate for Years 11 and 12 in other Australian states (see Appendix 4).

The table below summarises the assessment requirements in the 2007 Chemistry and Physics syllabuses and the 2008 Mathematics B and C syllabuses.

Table 1: Assessment requirements and assessment types: Mathematics B and C, Physics and Chemistry

Syllabus	Total summative assessment Year 12	Required types of assessments in an Exit Folio		
		Report or Extended response task (ERT)	Extended experimental investigation (EEI)	Supervised assessment (test or examinations)
Mathematics B (2008) Mathematics C (2008)	5 to 11 assessments	2 extended modelling and problem solving or report		3 to 9
Chemistry (2007) Physics (2007)	5 to 7 assessments	Optional	At least 1 (1000–1500 words for discussion, evaluation, conclusion and recommendations)	Minimum of 1

Extended experimental investigations and extended response tasks

Research in science education indicates the need to develop in students:

- an interest in science and an understanding of how science works
- problem solving, critical thinking and reasoning skills
- a solid foundation in science knowledge, understanding, skills and values.

In response to these developments in science education, the 2001 trial syllabuses for Chemistry and Physics introduced assessment that focused on applying scientific understandings in new situations and developing research, analysis and critical thinking skills:

- an extended experimental investigation (EEI) which is a project that involves students developing a hypothesis or answering a practical research question, conducting experiments and writing a report – for example, investigating the factors affecting the solubility of carbon dioxide in drinks
- an extended response task (ERT) which is research focused on the work of others, for example to analyse and describe the motion of traffic in a local area under a range of environmental conditions.

While research, projects and reports were listed as options in the 1995 syllabuses, the 2007 syllabuses specifically required that at least one of the 5 to 7 assessments in Year 12 must be an EEI.

EEIs or similar assessment techniques are used in other science curriculum in Australia (Appendix 4) and internationally, for example:

- In New South Wales, students are required to undertake an open-ended investigation in senior Chemistry and Physics (Board of Studies NSW, 2007).
- In Victoria, students are required to undertake a student-designed extended practical investigation (Victorian Curriculum and Assessment Authority, 2008).
- Scotland has an Advanced Higher Investigation Report which has a very similar structure to Queensland's EEIs (Scottish Qualifications Authority, 2011).
- The International Baccalaureate requires students to produce an extended essay. Students can choose to undertake this in the area of Chemistry and/or Physics (or any other academic discipline).

The senior secondary Australian Curriculum for Chemistry and Physics focuses on developing students' inquiry skills. For example, the *Australian Curriculum: Chemistry* states that science inquiry skills will be taught and assessed in each unit. Authentic evidence of student understanding of Science Inquiry Skills is collected through investigations. In discussing the structure of the Chemistry curriculum it states:

> The senior secondary Science subjects have been designed to accommodate, if appropriate, an extended scientific investigation within each pair of units. States and territories will determine whether there are any requirements related to an extended scientific investigation as part of their course materials. (http://www.australiancurriculum.edu.au/SeniorSecondary/Science/Chemistry/Structure-of-Chemistry)

The QSA acknowledges that some teachers have experienced difficulties in administering EEIs and ERTs, such as managing time requirements, workload and resourcing issues. However, the rationale for the introduction of EEIs and ERTs remains sound.

To support teachers, QSA has developed and will continue to develop sample assessment instruments that provide teachers with examples of student responses for EEIs and ERTs as well as advice about planning their use in classrooms. Additionally:

- online instructional videos are being developed
- moderation panel chairs will receive a detailed briefing on this issue
- free workshops will be available for teachers on EEIs
- an information statement on enforcing recommended word lengths will be distributed to moderation panellists
- panel training in Semester 2, 2013 will include a focus on providing feedback to schools about word length.

Assignments in mathematics

Extended tasks were first introduced into the Queensland Mathematics curriculum in 1994 under the category "Alternative Assessments". The aim was to introduce students to longer open-ended investigations that were not traditionally included in written pen-and-paper tests.

In the 2001 and 2008 syllabuses, the tasks were renamed "Extended modelling and problem-solving tasks and reports".

Since their inclusion in the mathematics syllabuses, schools tend to require students to do two assignments per year.

Assignments and investigations are included in the school-based assessment components of other states and territories.

The Australian Curriculum mathematics subjects include a requirement to collect, analyse, model and interpret data in order to investigate and understand real-world phenomena and solve problems in context. It emphasises that the ability to transfer skills to solve problems based on a wide range of applications is a vital part of mathematics. It states that both calculus and statistics are widely applicable as models of the world around us and students should have opportunities for problem solving throughout the mathematics subjects.

Authentication of student work

All syllabuses refer to strategies for authenticating student work for learning and assessment. The strategies provide advice about:

- plagiarism
- variety of assessment conditions (supervised exam / non-supervised assignment)
- the role of the teacher.

Mathematics syllabuses stipulate that every assessment must include a clear statement from each student to confirm their authorship and ownership.

Chemistry and Physics syllabuses include advice regarding strategies to ensure authentication of student work, such as the use of journals or log books to record collection of data and the use of class time to work on assignments.

All Queensland syllabuses from 2013 have detailed advice on managing students' draft responses to assessment.

Word length requirements

Physics and Chemistry students are required to do one EEI in Year 12. The recommended word length for the discussion, evaluation, conclusion and recommendations is currently 1000–1500 words. The final word lengths required for individual assessment tasks is determined by schools.

At the time of the first trial syllabus, there was no word length specified for EEIs. As a result of feedback from the independent syllabus evaluators, the 2007 syllabuses for Chemistry and Physics included a more comprehensive explanation about the EEI, including a recommended word length in Year 12 of 2000–2500 words for the discussion, evaluation, conclusion and recommendations components of the task. There has never been a recommended word length of 10,000 words.

Use of marks

The QSA policy on the use of standards, *Using standards to make judgments about student achievement in Authority and Authority-registered subjects* (January 2010) recognises that teachers use a range of ways to record their judgments about student achievement in individual tasks. This is determined at the school level.

Teachers can and do use marks in grading assessment and then use these marks to determine the standard awarded.

However, the policy makes clear that assessment approaches which do not consider the standards across the range of assessments when arriving at a level of achievement do not validly or reliably assess student achievement.

This is important because the use of marks without reference to what the mark means in terms of what students know and can do can only describe ‘how much’ not ‘how well’.

The standards in the syllabus are the common reference point for teachers, students, parents, panels and schools. They ensure comparability from school to school because they are to be used by all schools when marking student work and assigning levels of achievement.

This is a key point — the standards are used by thousands of teachers across the state to describe how well students in every school have achieved the general objectives of the syllabus — not just one teacher in one classroom.

The Australian Curriculum standards will be used in the same way, enabling comparability across Australia.

Using feedback

Listening to the views of educators and the community is integral to the development, implementation and review of syllabuses and the ongoing review of quality assurance processes to ensure curriculum and assessment in Queensland continues to be of the highest quality. This is achieved in a range of ways, including:

- QSA’s representative committee structure
- online surveys and surveys of workshop participants
- focus groups
- independent evaluators.

With reference to senior Chemistry, Physics and Mathematics, in addition to the consultation that occurred during the syllabus development process, the QSA facilitated meetings in January 2010 with mathematics and science teachers to work through their issues in a positive and collegial way. The following actions were implemented by QSA in response:

- improvements to policies on assessment requirements and making judgments about student work
- reduction in word length requirements for Chemistry and Physics assignments
- development of additional resources and support materials
- provision of advice and clarification for teachers and panel members
- provision of additional training for panellists and additional workshops for teachers.

It is worth noting that the satisfaction survey results for the 2011 workshops for teachers were very positive (see Appendix 5).

Section 4: Student participation in senior Mathematics, Chemistry and Physics

Enrolments in science and mathematics

Over the last two decades, enrolments in senior mathematics and science subjects in all jurisdictions in Australia have been declining. This trend has been identified in a number of studies. According to the Australian Government Chief Scientist:

> The decline in mathematics and science students is not unique to Australia; the global consensus is that enrolments in STEM (Science, Technology, Engineering, and Mathematics) studies and/or careers has been in decline for more than a decade. (Office of Chief Scientist 2012, p. 20)

The national *Choosing Science Study* (T. Lyons and F. Quinn 2010) found that the decline in the proportion of students choosing senior physics, chemistry, biology and advanced mathematics was part of a broader trend with similar falls in enrolments in other traditional academic subjects like economics, geography and history.

There is no single cause. The following factors have influenced this decline:

- Greater subject choice in Years 11–12 has meant more varied subject selections as students prepare for a broader range of post-school pathways.
- The increasing retention rate has meant that more students are staying at school to the end of Year 12 and pursuing pathways that do not involve the study of traditional mathematics and science subjects.
- Relaxed university pre-requisite requirements has meant that it is possible for a student to enrol in a Bachelor of Engineering course, for example, without having studied Physics in Years 11 and 12.
- Students not seeing the ‘value’ or relevance of key science subjects.

In Queensland, since the introduction of the 2007 Physics and Chemistry syllabuses and the 2008 mathematics syllabuses, enrolments are actually increasing in Mathematics B and C, Physics, Chemistry and Biology. In 2012, there were more Mathematics C students than in any year since its inception.

Importantly, the number of students completing mathematics and science courses is also rising.

It is also interesting to note that in 2012, the percentage of girls undertaking Physics in Victoria and New South Wales was 21 and 22 per cent respectively; in Queensland it was 26 per cent.

Table 2: Student enrolments for one or more semesters in Mathematics B and C, and Physics courses, 2010-12

Year	Subject	Enrolments	Cohort size	Weighted population	Percentage of cohort	Percentage of population
2010	Maths B	**15771**	44652	62082	35.32	25.40
2011	Maths B	**16007**	45681	62803	35.04	25.49
2012	**Maths B**	**16302**	**46798**	**63238**	**34.83**	**25.78**
2010	Maths C	**3445**	44652	62082	7.72	5.55
2011	Maths C	**3566**	45681	62803	7.81	5.68
2012	**Maths C**	**3783**	**46798**	**63238**	**8.08**	**5.98**
2010	Physics	**6635**	44652	62082	14.86	10.69
2011	Physics	**6654**	45681	62803	14.57	10.60
2012	**Physics**	**6804**	**46798**	**63238**	**14.54**	**10.76**

Table 3: Student semester 4 completions in Mathematics B and C, and Physics courses, 2010-12

Year	Subject	Semester 4 Completions	Cohort size	Weighted population	Percentage of cohort	Percentage of population
2010	Maths B	11759	44652	62082	26.33	18.94
2011	Maths B	12013	45681	62803	26.3	19.13
2012	**Maths B**	**12496**	**46798**	**63238**	**26.7**	**19.76**
2010	Maths C	3012	44652	62082	6.75	4.85
2011	Maths C	3125	45681	62803	6.84	4.98
2012	**Maths C**	**3360**	**46798**	**63238**	**7.18**	**5.31**
2010	Physics	5398	44652	62082	12.09	8.69
2011	Physics	5468	45681	62803	11.97	8.71
2012	**Physics**	**5665**	**46798**	**63238**	**12.11**	**8.96**

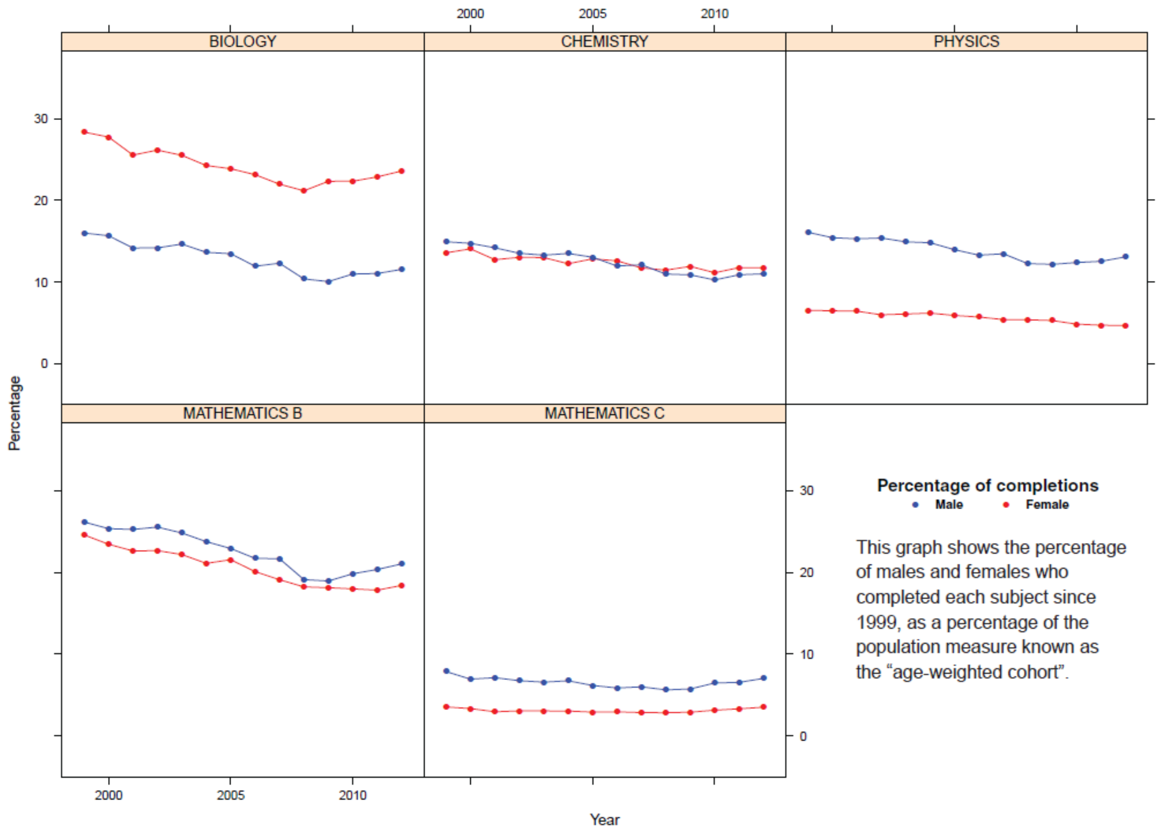
Subject enrolment and achievement data from 1992–2012 are publicly available on the QSA website: http://www.qsa.qld.edu.au/617.html

Achievement by gender

The following graphs show that completions in Chemistry, Physics, Biology, Mathematics B and C for males and females have remained stable.

Regarding the achievement of females, relative differences in gender performance are complex, and related to a number of factors including such things as subject selection and learning styles, which are broadly correlated with gender.

While the QSA acknowledges the challenges of developing assessments that cater for a range of abilities and learning styles, it is one of the strengths of school based assessment that it can accommodate differences in students in a way that a single mode of assessment, such as a one-off test, is unable to do.



Declining standards

Advice has been provided to the Committee that there has been a decline in Queensland students’ performance in mathematics over the past 30 years. The 2009 report by Professor Geoff Masters, *A Shared Challenge: Improving Literacy, Numeracy and Science Education in Australia*, is cited in support of this view.

The Masters report refers to a specific study by Afrassa and Keeves (1999) that concluded that Queensland students' performance in mathematics had declined by two years worth of growth over 30 years. It should be noted that this study examined lower secondary students and was referring to the period 1964–94, not the last 30 years.

It would be difficult to attribute the reported decline in mathematics ability to modern syllabuses produced over ten years after the data was collected or to Queensland's system of assessment in the senior years of schooling.

It also should not be assumed that NAPLAN results in Years 3, 5, 7 and 9 can be attributed to the assessment system and syllabus organisation in senior secondary. In addition, the Australian Capital Territory, which is often the highest ranked jurisdiction in NAPLAN, also has school-based assessment.

While there is currently no routine process for comparing standards between jurisdictions within Australia, one notable exception is the study undertaken in 2008 by the Australian Education Systems Officials Committee (AESOC) to examine the feasibility of a common scale for reporting all senior secondary subject results. Stage 1 of the project included the development of an agreed common scale for reporting. Stage 2 included the review of portfolios of student work graded A to E by the participating jurisdictions for Chemistry, English and Mathematics A, B and C. The study found:

> There was general agreement that all jurisdictions produced assessment packages which, while different in approach, worked well in terms of assessing the specified content, application, skills and communication while discriminating among student performance at the different levels of achievement.
>
> The results of the review exercise, where 94 per cent (Chemistry) and 96 per cent (English) of grades assigned by individual jurisdictions were agreed by at least two other jurisdictions, show there was an overwhelming consensus of agreement of the level of student performance and a clear understanding of the achievement at each of the national grades. The mathematics results at all three levels (79 per cent, 77 per cent, 78 per cent) show a high level of understanding and agreement of national achievement standards.
>
> This suggests that achievement standards can be consistently compared and national grades can be consistently applied across the jurisdictions. (AESOC 2008, pp. 1-2)

Conclusion

Queensland's system of externally moderated, standards-based, school-based assessment is an internationally respected model of assessment that delivers quality outcomes for students. It provides teachers and students with learning and development opportunities that other systems are unable to do to the same extent.

At this time, the Queensland community can be confident that its system of assessment has the capacity to create and foster an education culture that provides students with skills and values to meet global challenges and optimises regional strengths.

The system has not remained static during the past 40 years but has evolved in response to the needs of students and teachers and a changing evidence base. Its principles are sound, its processes are dependable, its workforce is capable, and its outcomes are fair and accurate. It is well placed to support the assessment of the Australian Curriculum following its implementation in Queensland.

The system is both reliable and valid. This is because it is underpinned by:

- **syllabuses** that make clear what teachers are expected to teach
- **predefined standards** that teachers use to make comparable and defensible judgments about students' achievements
- **a moderation system** that checks that the standards are applied consistently and provides opportunities for teachers to engage in professional discussions with each other about the standards evident in their students' work.

A range of quality assurance processes ensure that students have opportunities to demonstrate what they know and can do and that standards are comparable across all schools, all sectors, and for all students. This includes scrutiny of teachers' judgments by external moderation panels of trained teacher reviewers. Data shows that teachers consistently achieve a high rate of agreement in the assignment of levels of achievement – the system is consistent within itself and across time.

There is always room for improvement to ensure Queensland students have access to an education system based on excellence and equity and which positions them to take advantage of the opportunities in a globalised society.

Appendix 1: Comparison of Australian Curriculum standards and Queensland standards for sciences and mathematics

NB Appendix submitted separately to be printed on A3 paper.

Appendix 2: Similarities and differences between Queensland's 1995 and 2007 Chemistry and Physics syllabuses

	1995 syllabuses	**2007 syllabuses**
Assessable general objectives	4 general objectives: • Knowledge • Scientific processes • Complex reasoning processes • Manipulative skills	3 general objectives: • Knowledge and conceptual understanding • Investigative processes • Evaluating and concluding
Subject matter is similar but described differently	Core topics: • chemistry 8 core topics • physics 9 core topics	Organisers and key concepts: • chemistry 2 organisers with Key concepts and Key ideas • physics 3 organisers with Key concepts and Key ideas. • Each of the key concepts are to be covered at least twice.
Number of assessments required	5-11 summative assessments.	5–7 summative assessments including: • supervised assessment • extended experimental investigation.
Assessment techniques	The use of 1 summative instrument technique is not appropriate. Some instruments are better suited to deal with a particular exit criterion than another. Schools make selections from: • checklists • practical tests • formal reports of laboratory investigations • library research • research and projects • oral presentations • supervised tests.	Select from: • Supervised assessment • Extended experimental investigation • Extended response task (optional)

Appendix 3: Development of senior syllabuses Physics (2007) and Chemistry (2007)

1999	**Board of Senior Secondary School Studies approved the major revision of Chemistry (1995) and Physics (1995)**
2001	Syllabuses in Chemistry and Physics approved for trial-pilot. The revised syllabuses included similar subject matter and: • new standards for assessing student achievement • new assessment techniques to assess student achievement.
2002-2003	Trial-pilot of Chemistry (24 schools) Trial-pilot of Physics (26 schools) Professional development included teacher conferences, panel training for panellists
2003-2004	Trial-pilot syllabuses revised using the recommendations in the independent evaluation
2004	Syllabuses approved for extended trial-pilot
2005-2006	Extended trial-pilot of Chemistry (117 schools) Extended trial-pilot of Physics (102 schools) Professional development included teacher conferences, panel training for panellists
2006-2007	Extended trial-pilot syllabuses revised using the recommendations in the independent evaluation
2007	Syllabuses approved for general implementation by 2009 • 2008 – implementation by schools that had participated in the extended trial-pilot. • 2009 – implementation by all other schools.
2007-2008	District workshops, panel training, development of assessment instruments to support teachers.
2008	First year of implementation with Year 11 students
2009	All schools using the new syllabuses First year of verification of Year 12 results

Appendix 4: Year 12 assessment requirements and assessment types NSW, Victoria, SA and WA

	Total requirements	Types of assessments
New South Wales		
• Physics • Chemistry	HSC examination – 3 hours 3–5 tasks at least 1 open-ended investigation	Internal assessment tasks account for 50% of the final grade include: • reports • open-ended research using secondary sources • open-ended investigation using first hand data • seminar • oral presentation
• Mathematics	HSC examinations: • Mathematics – 3 hours • Mathematics I – 2 hours • Mathematics II – 3 hours 3–5 tasks	Internal assessment tasks include: • project 6–10 pages • open-ended investigation • assignment • practical task
Victoria		
• Physics	VCE examination Contribution of at least 5 coursework tasks to study score: • Unit 3 – 16% - at least 2 different tasks • Unit 4 – 24% - at least 3 different tasks	Internal assessment tasks include: • summary report of practical activities • investigation • multimedia presentation • report (written, oral annotated visual) • response to media article
• Chemistry	VCE examination – 2.5 hours Contribution of at least 5 coursework tasks to study score contributing: Unit 3 – 20% must include: • extended experimental investigation • written report of one practical • select one of: • written response to stimulus • analysis of first or second-hand data • report (written, oral, multimedia) Unit 4 – 20% must include: • written report of one practical • summary report of 3 practicals • select one of: • written response to stimulus • analysis of first or second-hand data • report (written, oral, multimedia)	Internal assessment tasks include: • extended experimental investigation • written report of practical activities • written response to stimulus • analysis of first or second-hand data • report (written, oral, multimedia) • summary report of practicals

	Total requirements	Types of assessments
• Mathematics	VCE examination Unit 3 – 20% must include: • 1 function and calculus task • 2 tests – multi-choice, short response, extended response • Unit 4 – 14% must include • 2 analysis tasks	Internal assessment tasks include: • assignment on a range of problems in a given context • short, focussed investigation on a problem or task • application questions requiring extended response • multiple choice tests
South Australia (and Northern Territory)		
• Physics • Chemistry	SACE examination – 3 hours – 30% 8-10 tasks including • Investigations folio – at least 3 investigations – 40% • Skills and applications tasks – at least 3 tasks – 30%	Internal assessment tasks include: • practical investigations • issues investigation • skills and applications
• Mathematics	SACE examination – 3 hours – 30% 9-12 tasks including: • 6 Skills and applications tasks 45% • Folio 25% including 2 investigations	Internal assessment tasks include: • skills and applications • investigations
Western Australia		
• Physics • Chemistry	WACE examination 50%	Internal assessment tasks include: • experiments • investigations • tests and examinations
• Mathematics	WACE examination 50%	Internal assessment tasks include: • response tasks • investigations (written, oral or multimedia).

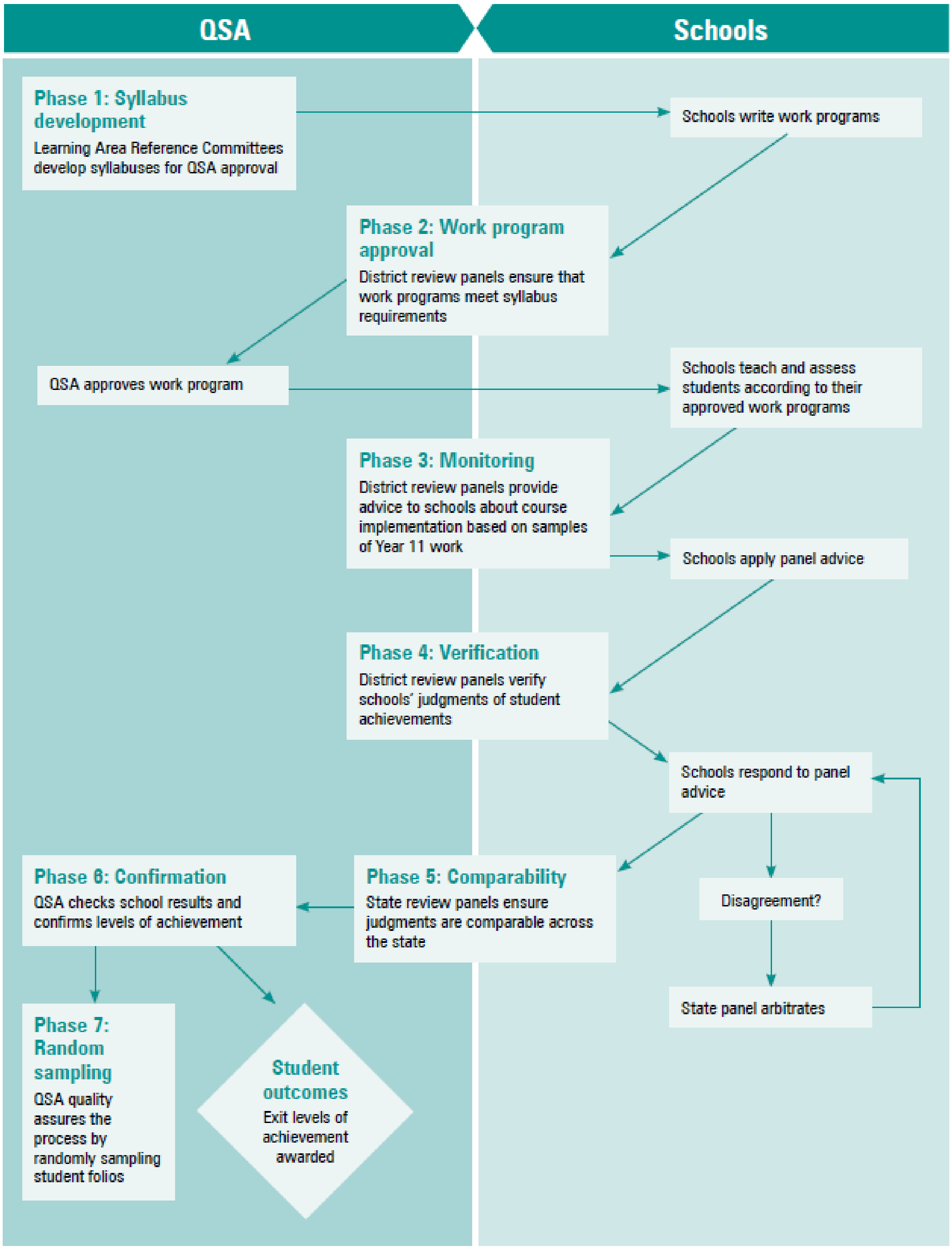
Appendix 5: Survey results for 2011 Mathematics, Physics and Chemistry workshops

The assessment workshops in Chemistry, Physics, Mathematics B and C.

- 206 teachers attended the Chemistry workshop (189 submitted an evaluation report)
- 187 teachers attended the Physics workshops (143 submitted an evaluation report)
- 323 teachers attended the Maths B workshops (322 submitted an evaluation report)
- 187 teachers attended the Maths C workshops (172 submitted an evaluation report).

	Chemistry	**Physics**	**Maths B**	**Maths C**
	satisfied/very satisfied			
Responsive to participants' needs	71%	79%	91%	95%
Informed my practice/helped me consider aspects of my practice	87%	92%	98%	98%
Will assist/apply what I have learned	81%	86%	97%	97%
Helped to develop my understanding	82%	83%	93%	93%

Appendix 6: The Moderation Process



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Queensland Chemistry Syllabus

Criterion	A	B	C	D	E
Knowledge and conceptual understanding	The student work has the following characteristics: • reproduction and interpretation of complex and challenging concepts, theories and principles • comparison and explanation of complex concepts, processes and phenomena • linking and application of algorithms, concepts, principles, theories and schema to find solutions in complex and challenging situations.	The student work has the following characteristics: • reproduction and interpretation of complex or challenging concepts, theories and principles • comparison and explanation of concepts, processes and phenomena • linking and application of algorithms, concepts, principles, theories and schema to find solutions in complex or challenging situations.	The student work has the following characteristics: • reproduction of concepts, theories and principles • explanation of simple processes and phenomena • application of algorithms, principles, theories and schema to find solutions in simple situations.	The student work has the following characteristics: • reproduction of simple ideas and concepts • description of simple processes and phenomena • application of algorithms, principles, theories and schema.	The student work has the following characteristics: • reproduction of isolated facts • recognition of isolated simple phenomena • application of simple given algorithms.
Investigative processes	The student work has the following characteristics: • formulation of justified significant questions/hypotheses which inform effective and efficient design, refinement and management of investigations • assessment of risk, safe selection and adaptation of equipment, and appropriate application of technology to gather, record and process valid data • systematic analysis of primary and secondary data to identify relationships between patterns, trends, errors and anomalies.	The student work has the following characteristics: • formulation of justified questions/hypotheses which inform design and management of investigations • assessment of risk, safe selection of equipment, and appropriate application of technology to gather, record and process data • analysis of primary and secondary data to identify patterns, trends, errors and anomalies.	The student work has the following characteristics: • formulation of questions and hypotheses to select and manage investigations • assessment of risk, safe selection of equipment, and appropriate application of technology to gather and record data • analysis of primary and secondary data to identify obvious patterns, trends, errors and anomalies.	The student work has the following characteristics: • implementation of given investigations • safe use of equipment and technology to gather and record data • identification of obvious patterns and errors.	The student work has the following characteristics: • guided use of given procedures • safe directed use of equipment to gather data • recording of data.
Evaluating and concluding	The student work has the following characteristics: • analysis and evaluation of complex scientific interrelationships • exploration of scenarios and possible outcomes with justification of conclusions/ recommendations • discriminating selection, use and presentation of scientific data and ideas to make meaning accessible to intended audiences through innovative use of range of formats.	The student work has the following characteristics: • analysis of complex scientific interrelationships • explanation of scenarios and possible outcomes with discussion of conclusions/ recommendations • selection, use and presentation of scientific data and ideas to make meaning accessible to intended audiences in range of formats.	The student work has the following characteristics: • description of scientific interrelationships • description of scenarios and possible outcomes with statements of conclusion/ recommendation • selection, use and presentation of scientific data and ideas to make meaning accessible in range of formats.	The student work has the following characteristics: • identification of simple scientific interrelationships • identification of scenarios or possible outcomes • presentation of scientific data or ideas in range of formats.	The student work has the following characteristics: • identification of obvious scientific interrelationships • statements about outcomes • presentation of scientific data or ideas.

Australian Curriculum Chemistry

Achievement Standard: Units 3 and 4

Chemistry concepts, models and applications

A	B	C	D	E
For the chemical systems studied, the student: • analyses how a range of interrelated factors affect atomic and molecular interactions and change the structure, properties and dynamics of chemical systems • analyses how interactions between matter and energy in complex chemical systems can be designed, monitored and controlled to produce desired outcomes • explains the theories and model/s used to explain the system, the supporting evidence, and their limitations and assumptions • applies theories and models of systems and processes to explain phenomena, critically analyse complex problems, and make reasoned, plausible predictions in unfamiliar contexts	*For the chemical systems studied, the student:* • explains how a range of interrelated factors change the structure, properties and dynamics of chemical systems • explains how interactions between matter and energy in chemical systems can be designed, monitored and controlled to produce desired outcomes • describes the theories and model/s used to explain the system, some supporting evidence, and their limitations • applies theories and models of systems and processes to explain phenomena, analyse problems, and make plausible predictions in unfamiliar contexts	*For the chemical systems studied, the student:* • explains how a range of factors change the structure, properties and dynamics of chemical systems • describes how chemical systems are controlled and monitored to produce desired outcomes • describes key aspects of a theory or model used to explain system processes, and the phenomena to which those processes can be applied • applies theories or models of systems and processes to explain phenomena, interpret problems, and make plausible predictions in some unfamiliar contexts	*For the chemical systems studied, the student:* • describes how some factors affect the properties of chemical systems • describes how chemical systems are manipulated to produce desired outcomes • describes key aspects of a theory or model used to explain a system process • describes phenomena, interprets simple problems, and makes predictions in familiar contexts	*For the chemical systems studied, the student:* • describes changes to chemical systems • describes how chemical systems are used to produce desired outcomes • identifies aspects of a theory or model related to a system process • describes phenomena and makes simple predictions in familiar contexts
the student: • analyses the roles of collaboration, debate and review, and technologies, in the development of chemical science theories and models • evaluates how chemical science has been used in concert with other sciences to meet diverse needs and inform decision making, and how these applications are influenced by interacting social, economic and ethical factors	*studied, the student:* • explains the roles of collaboration, debate and review, and technologies, in the development of chemical science theories and models • explains how chemical science has been used to meet diverse needs and inform decision making, and how these applications are influenced by social, economic and ethical factors	*studied, the student:* • describes the roles of collaboration and review, and technologies, in the development of chemical science theories or models • discusses how chemical science has been used to meet needs and inform decision making, and some social, economic or ethical implications of these applications	*studied, the student:* • describes the roles of communication and new evidence in developing chemical science knowledge • describes ways in which chemical science has been used in society to meet needs, and identifies some implications of these applications	*contexts studied, the student:* • identifies that chemical science knowledge has changed over time identifies ways in which chemical science has been used in society to meet needs

Chemistry inquiry skills

A	B	C	D	E
For the chemical science contexts studied, the student: • designs, conducts and improves safe, ethical investigations that efficiently collect valid, reliable data in response to a complex question or problem • analyses data sets to explain causal and correlational relationships, the reliability of the data, and sources of error • justifies their selection of data as evidence, analyses evidence with reference to models and/or theories, and develops evidence-based conclusions that identify limitations • evaluates processes and claims, and provides an evidence-based critique and discussion of improvements or alternatives • selects, constructs and uses appropriate representations to describe complex relationships and solve complex and unfamiliar problems • communicates effectively and accurately in a range of modes, styles and genres for specific audiences and purposes	*For the chemical science contexts studied, the student:* • designs, conducts and improves safe, ethical investigations that collect valid, reliable data in response to a question or problem • analyses data sets to identify causal and correlational relationships, anomalies, and sources of error • selects appropriate data as evidence, interprets evidence with reference to models and/or theories, and provides evidence for conclusions • evaluates processes and claims, provides a critique with reference	*For the chemical science contexts studied, the student:* • designs and conducts safe, ethical investigations that collect valid data in response to a question or problem • analyses data to identify relationships, anomalies, and sources of error • selects data to demonstrate relationships linked to chemical science knowledge, and provides conclusions based on data • evaluates processes and claims, and suggests improvements or alternatives • selects , constructs and uses	*For the chemical science contexts studied, the student:* • plans and conducts safe, ethical investigations to collect data in response to a question or problem • analyses data to identify trends and anomalies • selects data to demonstrate trends, and presents simple conclusions based on data • considers processes and claims from a personal perspective • constructs and uses simple representations to describe relationships and solve simple problems	*For the chemical science contexts studied, the student:* • follows a procedure to conduct safe, ethical investigations to collect data • identifies trends in data • selects data to demonstrate trends • considers claims from a personal perspective • constructs and uses simple representations to describe phenomena • communicates in a range of modes

Key:

- Interpreting, analysing and evaluating relationships, concepts and phenomena
- Using chemistry understandings to explain phenomena/theories/models and solve complex problems
- Designing and conducting investigations
- Analysing and explaining data
- Drawing conclusions and making recommendations
- Communication

Queensland Physics Syllabus

Criterion	A	B	C	D	E
Knowledge and conceptual understanding	The student work has the following characteristics: • reproduction and interpretation of complex and challenging concepts, theories and principles • comparison and explanation of complex concepts, processes and phenomena • linking and application of algorithms, concepts, principles, theories and schema to find solutions in complex and challenging situations.	The student work has the following characteristics: • reproduction and interpretation of complex or challenging concepts, theories and principles • comparison and explanation of concepts, processes and phenomena • linking and application of algorithms, concepts, principles, theories and schema to find solutions in complex or challenging situations.	The student work has the following characteristics: • reproduction of concepts, theories and principles • explanation of simple processes and phenomena • application of algorithms, principles, theories and schema to find solutions in simple situations.	The student work has the following characteristics: • reproduction of simple ideas and concepts • description of simple processes and phenomena • application of algorithms, principles, theories and schema.	The student work has the following characteristics: • reproduction of isolated facts • recognition of isolated simple phenomena • application of simple given algorithms.
Investigative processes	The student work has the following characteristics: • formulation of justified significant questions/hypotheses which inform effective and efficient design, refinement and management of investigations • assessment of risk, safe selection and adaptation of equipment, and appropriate application of technology to gather, record and process valid data • systematic analysis of primary and secondary data to identify relationships between patterns, trends, errors and anomalies.	The student work has the following characteristics: • formulation of justified questions/hypotheses which inform design and management of investigations • assessment of risk, safe selection of equipment, and appropriate application of technology to gather, record and process data • analysis of primary and secondary data to identify patterns, trends, errors and anomalies.	The student work has the following characteristics: • formulation of questions and hypotheses to select and manage investigations • assessment of risk, safe selection of equipment, and appropriate application of technology to gather and record data • analysis of primary and secondary data to identify obvious patterns, trends, errors and anomalies.	The student work has the following characteristics: • implementation of given investigations • safe use of equipment and technology to gather and record data • identification of obvious patterns and errors.	The student work has the following characteristics: • guided use of given procedures • safe directed use of equipment to gather data • recording of data.
Evaluating and concluding	The student work has the following characteristics: • analysis and evaluation of complex scientific interrelationships • exploration of scenarios and possible outcomes with justification of conclusions/ recommendations • discriminating selection, use and presentation of scientific data and ideas to make meaning accessible to intended audiences through innovative use of range of formats.	The student work has the following characteristics: • analysis of complex scientific interrelationships • explanation of scenarios and possible outcomes with discussion of conclusions/ recommendations • selection, use and presentation of scientific data and ideas to make meaning accessible to intended audiences in range of formats.	The student work has the following characteristics: • description of scientific interrelationships • description of scenarios and possible outcomes with statements of conclusion/ recommendation • selection, use and presentation of scientific data and ideas to make meaning accessible in range of formats.	The student work has the following characteristics: • identification of simple scientific interrelationshi ps • identification of scenarios or possible outcomes • presentation of scientific data or ideas in range of formats.	The student work has the following characteristics: • identification of obvious scientific interrelationships • statements about outcomes • presentation of scientific data or ideas.

Australian Curriculum Physics

Achievement Standard: Units 3 and 4

Physics concepts, models and applications

A	B	C	D	E
For the physical systems studied, the student: • analyses physical phenomena in complex scenarios at a range of scales qualitatively and quantitatively • analyses the relationships between mass, energy and properties of physical systems qualitatively and quantitatively • explains the theories and model/s used to explain the system, the supporting evidence, and their limitations and assumptions • applies theories and models of systems and processes to explain phenomena, critically analyse complex problems, and make reasoned, plausible predictions in unfamiliar contexts	*For the physical systems studied, the student:* • explains physical phenomena at a range of scales qualitatively and quantitatively • explains the relationships between mass, energy and properties of physical systems qualitatively and quantitatively • describes the theories and model/s used to explain the system, some supporting evidence, and their limitations • applies theories and models of systems and processes to explain phenomena, analyse problems, and make plausible predictions in unfamiliar contexts	*For the physical systems studied, the student:* • explains physical phenomena qualitatively and quantitatively • explains the relationships between mass, energy and properties of physical systems qualitatively • describes key aspects of a theory or model used to explain system processes, and the phenomena to which they can be applied • applies theories or models of systems and processes to explain phenomena, interpret problems, and make plausible predictions in some unfamiliar contexts	*For the physical systems studied, the student:* • describes physical phenomena qualitatively • describes how components and properties of physical systems are related • describes key aspects of a theory or model used to explain a system process • describes phenomena, interprets simple problems, and makes predictions in familiar contexts	*For the physical systems studied, the student:* • describes properties of physical phenomena • describes components of physical systems • identifies aspects of a theory or model related to a system process • describes phenomena and makes simple predictions in familiar contexts
For the physical science contexts studied, the student: • analyses the roles of collaboration, debate and review, and technologies, in the development of physical science theories and models • evaluates how physical science has been used in concert with other sciences to meet diverse needs and to inform decision making; and how these applications are influenced by interacting social, economic and ethical factors	*For the physical science contexts studied, the student:* • explains the roles of collaboration, debate and review, and technologies, in the development of physical science theories and models • explains how physical science has been used to meet diverse needs and to inform decision making; and how these applications are influenced by social, economic and ethical factors	*For the physical science contexts studied, the student:* • describes the roles of collaboration and review, and technologies, in the development of physical science theories or models • discusses how physical science has been used to meet needs and to inform decision making, and some social, economic or ethical implications of these applications	*For the physical science contexts studied, the student:* • describes the roles of communication and new evidence in developing physical science knowledge • describes ways in which physical science has been used in society to meet needs, and identifies some implications of these applications	*For the physical science contexts studied, the student:* • identifies that physical science knowledge has changed over time • identifies ways in which physical science has been used in society to meet needs

Physics inquiry skills

A	B	C	D	E
For the physical science contexts studied, the student: • designs, conducts and improves safe, ethical investigations that efficiently collect valid, reliable data in response to a complex question or problem • analyses data sets to explain causal and correlational relationships, the reliability of the data, and sources of error • justifies their selection of data as evidence, analyses evidence with reference to models and/or theories, and develops evidence-based conclusions that identify limitations • evaluates processes and claims, and provides an evidence-based critique and discussion of improvements or alternatives • selects, constructs and uses appropriate representations to describe complex relationships and solve complex and unfamiliar problems • communicates effectively and accurately in a range of modes, styles and genres for specific audiences and purposes	*For the physical science contexts studied, the student:* • designs, conducts and improves safe, ethical investigations that collect valid, reliable data in response to a question or problem • analyses data sets to identify causal and correlational relationships, anomalies, and sources of error • selects appropriate data as evidence, interprets evidence with reference to models and/or theories, and provides evidence for conclusions • evaluates processes and claims, provides a critique with reference to evidence, and identifies possi alterr • select appro descr and s • comm accur styles audie	*For the physical science contexts studied, the student:* • designs and conducts safe, ethical investigations that collect valid data in response to a question or problem • analyses data to identify relationships, anomalies, and sources of error • selects data to demonstrate relationships linked to physical science knowledge, and provides conclusions based on data • evaluates processes and claims, and suggests improvements or alternatives	*For the physical science contexts studied, the student:* • plans and conducts safe, ethical investigations to collect data in response to a question or problem • analyses data to identify trends and anomalies • selects data to demonstrate trends, and presents simple conclusions based on data • considers processes and claims from a personal perspective • constructs and uses simple representations to describe relationships and solve simple problems	*For the physical science contexts studied, the student:* • follows a procedure to conduct safe, ethical investigations to collect data • identifies trends in data • selects data to demonstrate trends • considers claims from a personal perspective • constructs and uses simple representations to describe phenomena • communicates in a range of modes

Key:

- Interpreting, analysing and evaluating relationships, concepts and phenomena
- Using physics understandings to explain phenomena/theories/models and solve complex problems
- Designing and conducting investigations
- Analysing and explaining data
- Drawing conclusions and making recommendations
- Communication

Queensland Mathematics A Syllabus

Criterion	Standard *A*	Standard *B*	Standard *C*	Standard *D*	Standard *E*
Knowledge and procedures	The student's work has the following characteristics: • accurate use of rules and formulas in simple through to complex situations	The student's work has the following characteristics: • accurate use of rules and formulas in simple situations or use of rules and formulas in complex situations	The student's work has the following characteristics: • use of rules and formulas in simple routine situations	The student's work has the following characteristics: • use of given rules and formulas in simple rehearsed situations	The student's work has the following characteristics: • attempted use of given rules and formulas in simple rehearsed situations
	• application of simple through to complex sequences of mathematical procedures in routine and non-routine situations	• application of simple sequences of mathematical procedures in non-routine situations or complex sequences in routine situations	• application of simple sequences of mathematical procedures in routine situations	• application of simple mathematical procedures in simple rehearsed situations	• attempted use of simple mathematical procedures in simple rehearsed situations
	• appropriate selection and accurate use of technology	• appropriate selection and accurate use of technology	• selection and use of technology	• use of technology	• attempted use of technology
Modelling and problem solving	The student's work has the following characteristics: • use of strategies to model and solve problems in complex routine through to simple non-routine situations	The student's work has the following characteristics: • use of strategies to model and solve problems in routine through to simple non-routine situations	The student's work has the following characteristics: • use of familiar strategies for problem solving in simple routine situations	The student's work has the following characteristics: • use of given strategies for problem solving in simple rehearsed situations	The student's work has the following characteristics: • attempted use of given strategies for problem solving in well-rehearsed situations
	• investigation of alternative solutions and/or procedures to complex routine through to simple non-routine problems	• investigation of alternative solutions and/or procedures to routine problems			
	• informed decisions based on mathematical reasoning in complex routine through to simple non-routine situations	• informed decisions based on mathematical reasoning in routine situations	• informed decisions based on mathematical reasoning in simple routine situations		
	• reflection on the effectiveness of mathematical models including recognition of the strengths and limitations of the model	• recognition of the strengths and limitations of the model in simple situations			

Communication and justification	The student's work has the following characteristics: • accurate and appropriate use of mathematical terminology and conventions in simple non-routine through to complex routine situations	The student's work has the following characteristics: • accurate and appropriate use of mathematical terminology and conventions in simple non-routine and/or complex routine situations	The student's work has the following characteristics: • appropriate use of mathematical terminology and conventions in simple routine situations	The student's work has the following characteristics: • use of mathematical terminology and conventions in simple rehearsed situations	The student's work has the following characteristics: • use of mathematical terminology or conventions in simple rehearsed situations
	• organisation and presentation of information in a variety of representations in simple non-routine through to complex routine situations	• organisation and presentation of information in a variety of representations in simple non-routine and/or complex routine situations	• organisation and presentation of information in a variety of representations in simple routine situations	• presentation of information in simple rehearsed situations	
	• analysis and translation of information displayed from one representation to another in complex routine situations	• analysis and translation of information displayed from one representation to another in simple routine situations	• translation of information displayed from one representation to another in simple routine situations		
	• use of mathematical reasoning to develop logical sequences in simple non-routine through to complex routine situations using everyday and/or mathematical language	• use of mathematical reasoning to develop logical sequences in simple non-routine and/or complex routine situations using everyday and/or mathematical language	• development of logical sequences in simple routine situations using everyday and/or mathematical language		
	• justification of the reasonableness of results obtained through technology or other means				

Australian Curriculum General Mathematics

Concepts and Techniques

A	B	C	D	E
• demonstrates knowledge of concepts of statistics, growth and decay in sequences, graphs and networks, and financial mathematics in routine and non-routine problems in a variety of contexts	• demonstrates knowledge of concepts of statistics, growth and decay in sequences, graphs and networks, and financial mathematics in routine and non-routine problems	• demonstrates knowledge of concepts of statistics, growth and decay in sequences, graphs and networks, and financial mathematics that apply to routine problems	• demonstrates knowledge of concepts of statistics, growth and decay in sequences, graphs and networks, and financial mathematics.	• demonstrates limited familiarity with simple concepts of statistics, growth and decay in sequences, graphs and networks, and financial mathematics .
• selects and applies techniques in mathematics and statistics to solve routine and non-routine problems in a variety of contexts	• selects and applies techniques in mathematics and statistics to solve routine and non-routine problems	• selects and applies techniques in mathematics and statistics to solve routine problems	• uses simple techniques in mathematics and statistics in routine problems	• uses simple techniques in a structured context
• develops, selects and applies mathematical and statistical models to routine and non-routine problems in a variety of contexts	• selects and applies mathematical and statistical models to routine and non-routine problems	• applies mathematical and statistical models to routine problems	• demonstrates familiarity with mathematical and statistical models	• demonstrates limited familiarity with mathematical or statistical models
• uses digital technologies effectively to graph, display and organise mathematical and statistical information to solve a range of routine and non-routine problems in a variety of contexts	• uses digital technologies appropriately to graph, display and organise mathematical and statistical information to solve a range of routine and non-routine problems	• uses digital technologies to graph, display and organise mathematical and statistical information to solve routine problems	• uses digital technologies to display some mathematical and statistical information in routine problems	• uses digital technologies for arithmetic calculations and to display limited mathematical and statistical information

Reasoning and Communication

A	B	C	D	E
• represents mathematical and statistical information in numerical, graphical and symbolic form in routine and non-routine problems in a variety of contexts	• represents mathematical and statistical information in numerical, graphical and symbolic form in routine and non-routine problems	• represents mathematical and statistical information in numerical, graphical and symbolic form in routine problems	• represents simple mathematical and statistical information in numerical, graphical or symbolic form in routine problems	• represents simple mathematical or statistical information in a structured context
• communicates mathematical and statistical judgments and arguments which are succinct and reasoned using appropriate language	• communicates mathematical and statistical judgments and arguments which are clear and reasoned using appropriate language	• communicates mathematical and statistical arguments using appropriate language	• communicates simple mathematical and statistical information using appropriate language	• communicates simple mathematical or statistical information
• interprets the solutions to routine and non-routine problems in a variety of contexts	• interprets the solutions to routine and non-routine problems	• interprets the solutions to routine problems	• describes solutions to routine problems	• identifies solutions to routine problems
• explains the reasonableness of the results and solutions to routine and non-routine problems in a variety of contexts	• explains the reasonableness of the results and solutions to routine and non-routine problems	• describes the reasonableness of the results and solutions to routine problems	• describes the appropriateness of the results of calculations	• demonstrates limited familiarity with the appropriateness of the results of calculations
• identifies and explains the validity and limitations of models used when developing solutions to routine and non-routine problems	• identifies and explains limitations of models used when developing solutions to routine problems	• identifies limitations of models used when developing solutions to routine problems	• identifies limitations of simple models	• identifies simple models

Key:

- Difficulty/complexity/familiarity of the problem/situation/context
- Modelling, evaluating and applying strategies/techniques
- Use of technology and representation of mathematical information
- Mathematical terminology/language/reasoning/justification

Queensland Mathematics C Syllabus

Criterion	Standard A	Standard B	Standard C	Standard D	Standard E
Knowledge and procedures	The student work has the following characteristics:	The student work has the following characteristics:	The student work has the following characteristics:	The student work has the following characteristics:	The student work has the following characteristics:
	recall, access, selection of mathematical definitions, rules and procedures in routine and non-routine simple tasks through to routine complex tasks, in life-related and abstract situations	recall, access, selection of mathematical definitions, rules and procedures in routine and non-routine simple tasks through to routine complex tasks in life-related and abstract situations	recall, access, selection of mathematical definitions, rules and procedures in routine, simple life-related or abstract situations	use of stated rules and procedures in simple situations	statements of relevant mathematical facts
	application of mathematical definitions, rules and procedures in routine and non-routine simple tasks through to routine complex tasks, in life-related and abstract situations	application of mathematical definitions, rules and procedures in routine or non-routine simple tasks, through to routine complex tasks, in either life-related or abstract situations	application of mathematical definitions, rules and procedures in routine, simple life-related or abstract situations		
	numerical calculations, spatial sense and algebraic facility in routine and non-routine simple tasks through to routine complex tasks, in life-related and abstract situations	numerical calculations, spatial sense and algebraic facility in routine or non-routine simple tasks, through to routine complex tasks, in either life-related or abstract situations	numerical sense, spatial sense and algebraic facility in routine, simple life-related or abstract situations	numerical sense, spatial sense and/or algebraic facility in routine or simple tasks	
	appropriate selection and accurate use of technology	appropriate selection and accurate use of technology	selection and use of technology	use of technology	use of technology
	knowledge of the nature of and use of mathematical proof				

Criterion	Standard A	Standard B	Standard C	Standard D	Standard E
Modelling and problem solving	The student work has the following characteristics:	The student work has the following characteristics:	The student work has the following characteristics:	The student work has the following characteristics:	The student work has the following characteristic:
	use of problem-solving strategies to interpret, clarify and analyse problems to develop responses from routine simple tasks through to non-routine complex tasks in life-related and abstract situations	use of problem-solving strategies to interpret, clarify and analyse problems to develop responses to routine and non-routine simple tasks through to routine complex tasks in life-related or abstract situations	use of problem-solving strategies to interpret, clarify and develop responses to routine, simple problems in life-related or abstract situations	evidence of simple problem-solving strategies in the context of problems	evidence of simple mathematical procedures
	identification of assumptions and their associated effects, parameters and/or variables	identification of assumptions, parameters and/or variables			
	use of data to synthesise mathematical models and generation of data from mathematical models in simple through to complex situations	use of data to synthesise mathematical models in simple situations and generation of data from mathematical models in simple through to complex situations	use of mathematical models to represent routine, simple situations and generate data	use of given simple mathematical models to generate data	
	investigation and evaluation of the validity of mathematical arguments including the analysis of results in the context of problems, the strengths and limitations of models, both given and developed	interpretation of results in the context of simple through to complex problems and mathematical models	interpretation of results in the context of routine, simple problems		
	refinement of mathematical models				

Criterion	Standard A	Standard B	Standard C	Standard D	Standard E
Communication and justification	The student's work has the following characteristics:	The student's work has the following characteristics:	The student's work has the following characteristics:	The student's work has the following characteristics:	The student's work has the following characteristics:
	appropriate interpretation and use of mathematical terminology, symbols and conventions from simple through to complex and from routine through to non-routine, in life-related and abstract situations	appropriate interpretation and use of mathematical terminology, symbols and conventions in simple or complex and from routine through to non-routine, in life-related or abstract situations	appropriate interpretation and use of mathematical terminology, symbols and conventions in simple routine situations	use of mathematical terminology, symbols or conventions in simple or routine situations	use of mathematical terminology, symbols or conventions
	organisation and presentation of information in a variety of representations	organisation and presentation of information in a variety of representations	organisation and presentation of information	presentation of information	presentation of information
	analysis and translation of information from one representation to another in life-related and abstract situations from simple through to complex and from routine through to non-routine	analysis and translation of information from one representation to another in life-related or abstract situations, simple or complex, and from routine through to non-routine	translation of information from one representation to another in simple routine situations		
	use of mathematical reasoning to develop coherent, concise and logical sequences within a response from simple through to complex and in life-related and abstract situations using everyday and mathematical language	use of mathematical reasoning to develop coherent and logical sequences within a response in simple or complex and in life-related or abstract situations using everyday and/or mathematical language	use of mathematical reasoning to develop sequences within a response in simple routine situations using everyday or mathematical language		
	coherent, concise and logical justification of procedures, decisions and results	coherent and logical justification of procedures, decisions and results	justification of procedures, decisions or results		
	justification of the reasonableness of results				
	provision of supporting arguments in the form of proof				

Australian Curriculum Specialist Mathematics

Concepts and Techniques

A	B	C	D	E
• demonstrates knowledge and understanding of concepts of functions, calculus, vectors and statistics in routine and non-routine problems in a variety of contexts	• demonstrates knowledge of concepts of functions, calculus, vectors and statistics in routine and non-routine problems	• demonstrates knowledge of concepts of functions, calculus, vectors and statistics that apply to routine problems	• demonstrates knowledge of concepts of functions, calculus, vectors and statistics	• demonstrates limited familiarity with simple concepts of functions, calculus, vectors and statistics
• synthesises information to select and apply techniques in mathematics to solve routine and non-routine problems in a variety of contexts	• synthesises information to select and apply techniques in mathematics to solve routine and non-routine problems	• selects and applies techniques in mathematics to solve routine problems	• uses simple techniques in mathematics in routine problems	• uses simple techniques in a structured context
• develops, selects and applies mathematical models to routine and non-routine problems in a variety of contexts	• selects and applies mathematical models to routine and non-routine problems	• applies mathematical models to routine problems	• demonstrates familiarity with mathematical models	• demonstrates limited familiarity with mathematical models
• constructs mathematical proofs in a variety of contexts using a range of techniques	• constructs mathematical proofs in a variety of contexts and adapts previously seen mathematical proofs	• constructs simple mathematical proofs and adapts previously seen mathematical proofs	• reproduces previously seen mathematical proofs	• reproduces previously seen simple mathematical proofs
• uses digital technologies effectively to graph, display and organise mathematical information to solve a range of routine and non-routine problems in a variety of contexts	• uses digital technologies appropriately to graph, display and organise mathematical information to solve a range of routine and non-routine problems	• uses digital technologies to graph, display and organise mathematical information to solve routine problems	• uses digital technologies to display some mathematical information in routine problems	• uses digital technologies for arithmetic calculations and to display limited mathematical information

Reasoning and Communication

A	B	C	D	E
• represents mathematical and statistical information in numerical, graphical and symbolic form in routine and non-routine problems in a variety of contexts	• represents mathematical and statistical information in numerical, graphical and symbolic form in routine and non-routine problems	• represents mathematical and statistical information in numerical, graphical and symbolic form in routine problems	• represents mathematical and statistical information in numerical, graphical or symbolic form in routine problems	• represents simple mathematical and statistical information in a structured context
• communicates succinct and reasoned mathematical and statistical judgments and arguments, including proofs, using appropriate language	• communicates clear and reasoned mathematical and statistical judgments and arguments, including proofs, using appropriate language	• communicates mathematical and statistical arguments, including simple proofs, using appropriate language	• communicates mathematical and statistical arguments, including previously seen proofs, using appropriate language	• communicates simple mathematical and statistical information using appropriate language
• interprets the solutions to routine and non-routine problems in a variety of contexts	• interpret the solutions to routine and non-routine problems	• interprets the solutions to routine problems	• describes solutions to routine problems	• identifies solutions to routine problems
• explains the reasonableness of the results and solutions to routine and non-routine problems in a variety of contexts	• explains the reasonableness of the results and solutions to routine and non-routine problems	• describes the reasonableness of the results and solutions to routine problems	• describes the appropriateness of the results of calculations	• demonstrates limited familiarity with the appropriateness of the results of calculations
• identifies and explains the validity and limitations of models used when developing solutions to routine and non-routine problems	• identifies and explains limitations of models used when dev… solutions … problems…	• identifies limitations of models used when	• identifies limitations of simple models	• identifies simple models

Key:

- Difficulty/complexity/familiarity of the problem/situation/context
- Modelling, evaluating and applying strategies/techniques
- Use of technology and representation of mathematical information
- Mathematical terminology/language/reasoning/justification
- Mathematical proof

Queensland Mathematics B Syllabus

Criterion	Standard A	Standard B	Standard C	Standard D	Standard E
Knowledge and procedures	The student work has the following characteristics: • recall, access, selection of mathematical definitions, rules and procedures in routine and non-routine simple tasks through to routine complex tasks, in life-related and abstract situations	The student work has the following characteristics: • recall, access, selection of mathematical definitions, rules and procedures in routine and non-routine simple tasks through to routine complex tasks, in life-related and abstract situations	The student work has the following characteristics: • recall, access, selection of mathematical definitions, rules and procedures in routine, simple life-related or abstract situations	The student work has the following characteristics: • use of stated rules and procedures in simple situations	The student work has the following characteristics: • statements of relevant mathematical facts
	• application of mathematical definitions, rules and procedures in routine and non-routine simple tasks, through to routine complex tasks, in life-related and abstract situations	• application of mathematical definitions, rules and procedures in routine or non-routine simple tasks, through to routine complex tasks, in either life-related or abstract situations	• application of mathematical definitions, rules and procedures in routine, simple life-related or abstract situations		
	• numerical calculations, spatial sense and algebraic facility in routine and non-routine simple tasks through to routine complex tasks, in life-related and abstract situations	• numerical calculations, spatial sense and algebraic facility in routine or non-routine simple tasks, through to routine complex tasks, in either life-related or abstract situations	• numerical calculations, spatial sense and algebraic facility in routine, simple life-related or abstract situations	• numerical sense, spatial sense and/or algebraic facility in routine or simple tasks	
	• appropriate selection and accurate use of technology	• appropriate selection and accurate use of technology	• selection and use of technology	• use of technology	• use of technology

Criterion	Standard A	Standard B	Standard C	Standard D	Standard E
Modelling and problem solving	The student work has the following characteristics: • use of problem-solving strategies to interpret, clarify and analyse problems to develop responses from routine simple tasks through to non-routine complex tasks in life-related and abstract situations	The student work has the following characteristics: • use of problem-solving strategies to interpret, clarify and analyse problems to develop responses to routine and non-routine simple tasks through to routine complex tasks in life-related or abstract situations	The student work has the following characteristics: • use of problem-solving strategies to interpret, clarify and develop responses to routine, simple problems in life-related or abstract situations	The student work has the following characteristics: • evidence of simple problem-solving strategies in the context of problems	The student work has the following characteristic: • evidence of simple mathematical procedures
	• identification of assumptions and their associated effects, parameters and/or variables	• identification of assumptions, parameters and/or variables			
	• use of data to synthesise mathematical models and generation of data from mathematical models in simple through to complex situations	• use of data to synthesise mathematical models in simple situations and generation of data from mathematical models in simple through to complex situations	• use of mathematical models to represent routine, simple situations and generate data	• use of given simple mathematical models to generate data	
	• investigation and evaluation of the validity of mathematical arguments including the analysis of results in the context of problems; the strengths and limitations of models, both given and developed	• interpretation of results in the context of simple through to complex problems and mathematical models	• interpretation of results in the context of routine, simple problems		

Criterion	Standard A	Standard B	Standard C	Standard D	Standard E
Communication and justification	The student's work has the following characteristics: • appropriate interpretation and use of mathematical terminology, symbols and conventions from simple through to complex and from routine through to non-routine, in life-related and abstract situations	The student's work has the following characteristics: • appropriate interpretation and use of mathematical terminology, symbols and conventions in simple or complex and from routine through to non-routine, in life-related or abstract situations	The student's work has the following characteristics: • appropriate interpretation and use of mathematical terminology, symbols and conventions in simple routine situations	The student's work has the following characteristics: • use of mathematical terminology, symbols or conventions in simple or routine situations	The student's work has the following characteristics: • use of mathematical terminology, symbols or conventions
	• organisation and presentation of information in a variety of representations	• organisation and presentation of information in a variety of representations	• organisation and presentation of information	• presentation of information	• presentation of information
	• analysis and translation of information from one representation to another in life-related and abstract situations from simple through to complex and from routine through to non-routine	• analysis and translation of information from one representation to another in life-related or abstract situations, simple or complex, and from routine through to non-routine	• translation of information from one representation to another in simple routine situations		
	• use of mathematical reasoning to develop coherent, concise and logical sequences within a response from simple through to complex and in life-related and abstract situations using everyday and mathematical language	• use of mathematical reasoning to develop coherent and logical sequences within a response in simple or complex and in life-related or abstract situations using everyday and/or mathematical language	• use of mathematical reasoning to develop sequences within a response in simple routine situations using everyday or mathematical language		
	• coherent, concise and logical justification of procedures, decisions and results	• coherent and logical justification of procedures, decisions and results	• justification of procedures, decisions or results		
	• justification of the reasonableness of results				

Australian Curriculum Mathematical Methods

Concepts and techniques

A	B	C	D	E
• demonstrates knowledge of concepts of functions, integration and distributions in routine and non-routine problems in a variety of contexts	• demonstrates knowledge of concepts of functions, integration and distributions in routine and non-routine problems	• demonstrates knowledge of concepts of functions, integration and distributions that apply to routine problems	• demonstrates knowledge of concepts of simple functions, integration and distributions	• demonstrates limited familiarity with concepts of simple functions, integration and distributions
• selects and applies techniques in functions, integration and distributions to solve routine and non-routine problems in a variety of contexts	• selects and applies techniques in functions, integration and distributions to solve routine and non-routine problems	• selects and applies techniques in functions, integration and distributions to solve routine problems	• uses simple techniques in functions, integration and distributions in routine problems	• uses simple techniques in a structured context
• develops, selects and applies mathematical and statistical models in routine and non-routine problems in a variety of contexts	• selects and applies mathematical and statistical models in routine and non-routine problems	• applies mathematical and statistical models in routine problems	• demonstrates familiarity with mathematical and statistical models	• demonstrates limited familiarity with mathematical or statistical models
• uses digital technologies effectively to graph, display and organise mathematical and statistical information and to solve a range of routine and non-routine problems in a variety of contexts	• uses digital technologies appropriately to graph, display and organise mathematical and statistical information and to solve a range of routine and non-routine problems	• uses digital technologies to graph, display and organise mathematical and statistical information to solve routine problems	• uses digital technologies to display some mathematical and statistical information in routine problems	• uses digital technologies for arithmetic calculations and to display limited mathematical and statistical information

Reasoning and Communication

A	B	C	D	E
• represents functions, integration and distributions in numerical, graphical and symbolic form in routine and non-routine problems in a variety of contexts	• represents functions, integration and distributions in numerical, graphical and symbolic form in routine and non-routine problems	• represents functions, integration and distributions in numerical, graphical and symbolic form in routine problems	• represents simple functions and distributions in numerical, graphical or symbolic form in routine problems	• represents limited mathematical or statistical information in a structured context
• communicates mathematical and statistical judgments and arguments, which are succinct and reasoned, using appropriate language	• communicates mathematical and statistical judgments and arguments, which are clear and reasoned, using appropriate language	• communicates mathematical and statistical arguments using appropriate language	• communicates simple mathematical and statistical information using appropriate language	• communicates simple mathematical and statistical information
• interprets the solutions to routine and non-routine problems in a variety of contexts	• interprets the solutions to routine and non-routine problems	• interprets the solutions to routine problems	• describes solutions to routine problems	• identifies solutions to routine problems
• explains the reasonableness of the results and solutions to routine and non-routine problems in a variety of contexts	• explains the reasonableness of the results and solutions to routine and non-routine problems	• describes the reasonableness of results and solutions to routine problems	• describes the appropriateness of the result of calculations	• demonstrates limited familiarity with the appropriateness of the results of calculations
• identifies and explains the validity and limitations of models used when developing solutions to routine and non-routine problems	• identifies and explains the limitations of models used when developing solutions to routine problems	• identifies thelimitations of models used when	• identifies limitations of simple models used	• identifies simple models

Key:

- Difficulty/complexity/familiarity of the problem/situation/context
- Modelling, evaluating and applying strategies/techniques
- Use of technology and representation of mathematical information
- Mathematical terminology/language/reasoning/justification