Essential Mathematics 2019 v1.1

Applied Senior Syllabus

This syllabus is for implementation with Year 11 students in 2019.

Queensland Government | Queensland Curriculum & Assessment Authority

For all Queensland schools

170356

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1 Course overview

1.1 Introduction

1.1.1 Rationale

Mathematics is a unique and powerful intellectual discipline that is used to investigate patterns, order, generality and uncertainty. It is a way of thinking in which problems are explored and solved through observation, reflection and logical reasoning. It uses a concise system of communication, with written, symbolic, spoken and visual components. Mathematics is creative, requires initiative and promotes curiosity in an increasingly complex and data-driven world. It is the foundation of all quantitative disciplines.

To prepare students with the knowledge, skills and confidence to participate effectively in the community and the economy requires the development of skills that reflect the demands of the 21st century. Students undertaking Mathematics will develop their critical and creative thinking, oral and written communication, information & communication technologies (ICT) capability, ability to collaborate, and sense of personal and social responsibility — ultimately becoming lifelong learners who demonstrate initiative when facing a challenge. The use of technology to make connections between mathematical theory, practice and application has a positive effect on the development of conceptual understanding and student disposition towards mathematics.

Mathematics teaching and learning practices range from practising essential mathematical routines to develop procedural fluency, through to investigating scenarios, modelling the real world, solving problems and explaining reasoning. When students achieve procedural fluency, they carry out procedures flexibly, accurately and efficiently. When factual knowledge and concepts come to mind readily, students are able to make more complex use of knowledge to successfully formulate, represent and solve mathematical problems. Problem-solving helps to develop an ability to transfer mathematical skills and ideas between different contexts. This assists students to make connections between related concepts and adapt what they already know to new and unfamiliar situations. With appropriate effort and experience, through discussion, collaboration and reflection of ideas, students should develop confidence and experience success in their use of mathematics.

The major domains of mathematics in Essential Mathematics are Number, Data, Location and time, Measurement and Finance. Teaching and learning builds on the proficiency strands of the P–10 Australian Curriculum. Students develop their conceptual understanding when they undertake tasks that require them to connect mathematical concepts, operations and relations. They will learn to recognise definitions, rules and facts from everyday mathematics and data, and to calculate using appropriate mathematical processes.

Students will benefit from studies in Essential Mathematics because they will develop skills that go beyond the traditional ideas of numeracy. This is achieved through a greater emphasis on estimation, problem-solving and reasoning, which develops students into thinking citizens who interpret and use mathematics to make informed predictions and decisions about personal and financial priorities. Students will see mathematics as applicable to their employability and lifestyles, and develop leadership skills through self-direction and productive engagement in their learning. They will show curiosity and imagination, and appreciate the benefits of technology. Students will gain an appreciation that there is rarely one way of doing things and that real-world mathematics requires adaptability and flexibility.

Assumed knowledge, prior learning or experience

Assumed knowledge refers to the subject matter that teachers can expect students to know prior to beginning this subject. Emphasis is placed on the mastery of subject matter, ensuring key concepts or procedures are learnt fully so they will not need reteaching.

Developing mastery often involves multiple approaches to teaching and conceptualising the same mathematical concept. When students have a good understanding of a key concept or procedure, they are more easily able to make connections to related new subject matter and apply what they already know to new problems.

Subject matter from previous unit/s is assumed for subsequent unit/s.

The following is a non-exhaustive list of assumed knowledge from the P–10 Australian Curriculum that must be learnt or revised and maintained as required:

- recall concepts of number and its operations, percentages, money, rates and ratios
- read and use graphs and scales
- recall concepts of probability, data collection and statistical data representations
- use a scientific calculator and other technology, where appropriate
- substitute numbers into formulas
- translate word problems to mathematical form.

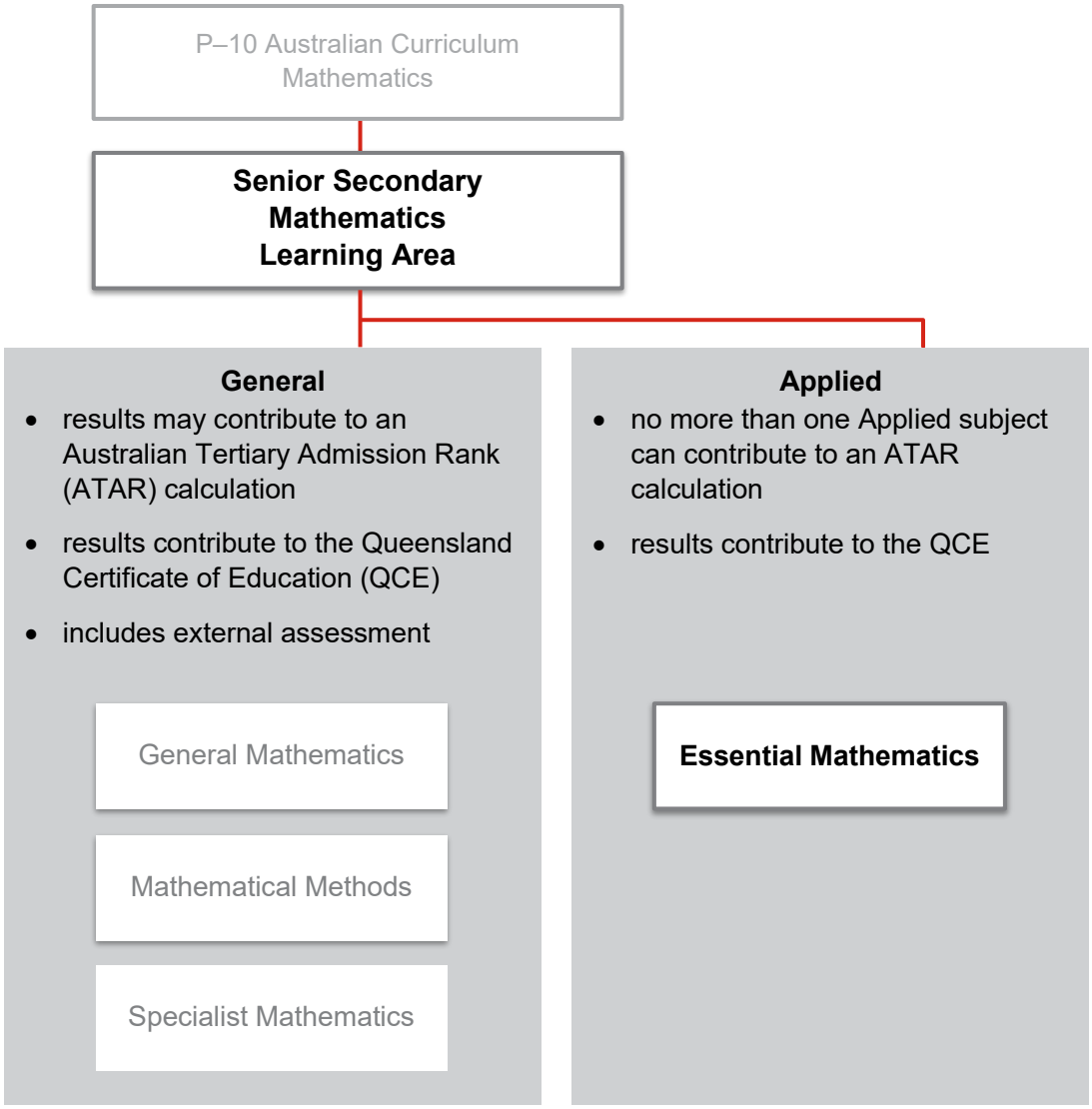
Pathways

Essential Mathematics is an Applied subject suited to students who are interested in pathways beyond Year 12 that lead to tertiary studies, vocational education or work. A course of study in Essential Mathematics can establish a basis for further education and employment in the fields of trade, industry, business and community services. Students will learn within a practical context related to general employment and successful participation in society, drawing on the mathematics used by various professional and industry groups.

1.1.2 Learning area structure

All learning areas build on the P–10 Australian Curriculum.

Figure 1: Learning area structure



1.1.3 Course structure

Essential Mathematics is a course of study consisting of four units. Subject matter, learning experiences and assessment increase in complexity from Units 1 and 2 to Units 3 and 4 as students develop greater independence as learners.

Units 1 and 2 provide foundational learning, which allows students to experience all syllabus objectives and begin engaging with the course subject matter. Students should complete Units 1 and 2 before beginning Unit 3. It is recommended that Unit 3 be completed before Unit 4.

Units 3 and 4 consolidate student learning. Only the results from Units 3 and 4 will contribute to ATAR calculations.

Students who complete this course of study with a grade of C or better will meet the numeracy requirement for QCE and should also be able to demonstrate numeracy competencies equivalent to the Australian Core Skills Framework (ACSF)[1] Level 3.

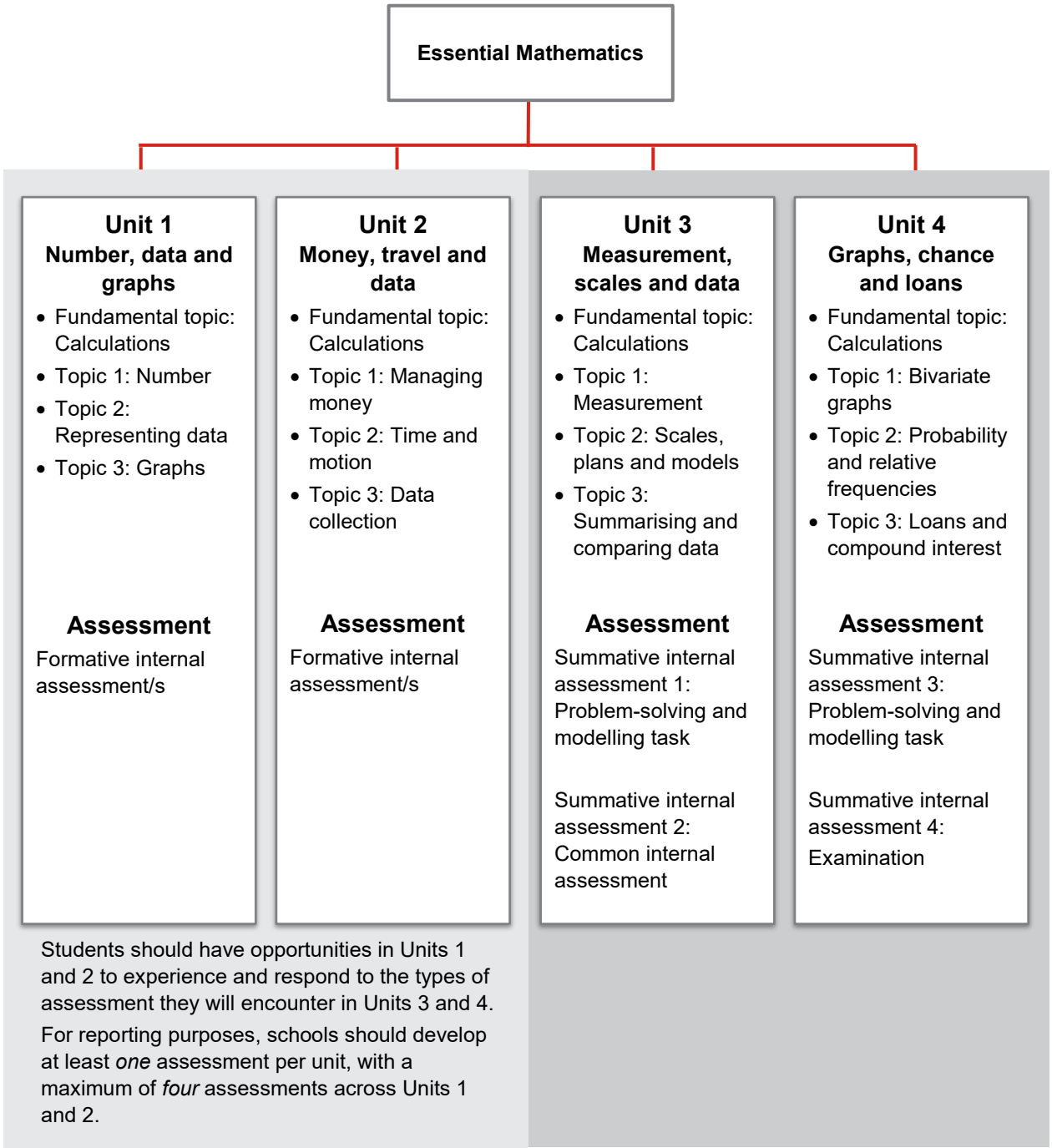
Subject matter that is denoted by '[complex]' is considered to be complex and indicates alignment to ACSF Level 4 or higher. All other subject matter is considered to be simple and indicates alignment to ACSF Level 3.

Students who demonstrate attainment of simple subject matter only will be able to achieve a maximum of a C grade overall. Figure 2 outlines the structure of this course of study.

Each unit has been developed with a notional time of 55 hours of teaching and learning, including assessment.

[1] https://www.education.gov.au/australian-core-skills-framework

Figure 2: Course structure



1.2 Teaching and learning

1.2.1 Syllabus objectives

The syllabus objectives outline what students have the opportunity to learn. Assessment provides evidence of how well students have achieved the objectives.

Syllabus objectives inform unit objectives, which are contextualised for the subject matter and requirements of the unit. Unit objectives, in turn, inform the assessment objectives, which are further contextualised for the requirements of the assessment instruments. The number of each objective remains constant at all levels, i.e. Syllabus objective 1 relates to Unit objective 1 and to Assessment objective 1 in each assessment instrument.

Syllabus objectives are described in terms of actions that operate on the subject matter. Students are required to use a range of cognitive processes in order to demonstrate and meet the syllabus objectives. These cognitive processes are described in the explanatory paragraph following each objective in terms of four levels: retrieval, comprehension, analytical processes (analysis), and knowledge utilisation, with each process building on the previous processes (see Marzano & Kendall 2007, 2008). That is, comprehension requires retrieval, and knowledge utilisation requires retrieval, comprehension and analytical processes (analysis).

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

Syllabus objective	Unit 1	Unit 2	Unit 3	Unit 4
1. select, recall and use facts, rules, definitions and procedures drawn from Number, Data, Location and time, Measurement and Finance	•	•	•	•
2. comprehend mathematical concepts and techniques drawn from Number, Data, Location and time, Measurement and Finance	•	•	•	•
3. communicate using mathematical, statistical and everyday language and conventions	•	•	•	•
4. evaluate the reasonableness of solutions	•	•	•	•
5. justify procedures and decisions by explaining mathematical reasoning	•	•	•	•
6. solve problems by applying mathematical concepts and techniques drawn from Number, Data, Location and time, Measurement and Finance.	•	•	•	•

1. select, recall and use facts, rules, definitions and procedures drawn from Number, Data, Location and time, Measurement and Finance

When students select, recall and use facts, rules, definitions and procedures, they recognise particular features of remembered information and consider its accuracy and relevance. They present facts, rules, definitions and procedures and put them into effect, performing calculations with and without the use of technology.

2. comprehend mathematical concepts and techniques drawn from Number, Data, Location and time, Measurement and Finance

When students comprehend, they understand the meaning, nature and purpose of the mathematics they are learning. They identify, articulate and symbolise the critical elements of the relevant concepts and techniques, making connections between topics and between the 'why' and the 'how' of mathematics.

3. **communicate using mathematical, statistical and everyday language and conventions**

   When students communicate, they use mathematical and statistical terminology, symbols, conventions and everyday language to organise and present information in graphical and symbolic form, and describe and represent mathematical and statistical models.

4. **evaluate the reasonableness of solutions**

   When students evaluate the reasonableness of solutions, they interpret their mathematical results in the context of the situation. They reflect on whether the problem has been solved by using estimation skills and checking calculations, using their knowledge of relevant facts, rules, definitions and procedures. They make an appraisal by assessing strengths, implications and limitations of solutions and/or models with and without technology, and use this to consider if alternative methods or refinements are required.

5. **justify procedures and decisions by explaining mathematical reasoning**

   When students justify procedures and decisions by explaining mathematical reasoning, they describe their mathematical thinking in detail, identifying causes and making relationships evident, constructing mathematical arguments and providing reasons for choices made and conclusions reached. Students use their conceptual understanding to connect what they already know to new information. Mathematical reasoning is rigorous and requires clarity, precision, completeness and due regard to the order of statements.

6. **solve problems by applying mathematical concepts and techniques drawn from Number, Data, Location and time, Measurement and Finance**

   When students solve problems by applying mathematical concepts and techniques, they analyse the context of the problem and make decisions about the concepts, techniques and technology that must be used to develop a solution. They analyse, generalise and translate information into a mathematically workable format, synthesise and refine models, and generate and test hypotheses with primary or secondary data and information.

1.2.2 Underpinning factors

There are three skill sets that underpin senior syllabuses and are essential for defining the distinctive nature of subjects:

- literacy — the set of knowledge and skills about language and texts essential for understanding and conveying Essential Mathematics content
- numeracy — the knowledge, skills, behaviours and dispositions that students need to use mathematics in a wide range of situations, to recognise and understand the role of mathematics in the world, and to develop the dispositions and capacities to use mathematical knowledge and skills purposefully
- 21st century skills — the attributes and skills students need to prepare them for higher education, work and engagement in a complex and rapidly changing world.

These skill sets, which overlap and interact, are derived from current education, industry and community expectations. They encompass the knowledge, skills, capabilities, behaviours and dispositions that will help students live and work successfully in the 21st century.

Together these three skill sets shape the development of senior subject syllabuses. Although coverage of each skill set may vary from syllabus to syllabus, students should be provided with opportunities to learn through and about these skills over the course of study. Each skill set contains identifiable knowledge and skills that can be directly assessed.

Literacy in Essential Mathematics

Literacy skills and strategies enable students to express, interpret and communicate complex mathematical information, ideas and processes. Mathematics provides a specific and rich context for students to develop their abilities to read, write, visualise and talk about complex situations involving a range of mathematical ideas.

Students can apply and further develop their literacy skills and strategies by shifting between verbal, graphic, numerical and symbolic forms of representing problems in order to formulate, understand and solve problems and communicate results. This process of translation across different systems of representation is essential for complex mathematical reasoning and expression. Students learn to communicate their findings in different ways, using multiple systems of representation and data displays to illustrate the relationships they have observed or constructed.

To understand and use Essential Mathematics content, teaching and learning strategies include:

- breaking the language code to make meaning of Essential Mathematics language and texts
- comprehending language and texts to make literal and inferred meanings about Essential Mathematics content
- using Essential Mathematics ideas and information in classroom, real-world and/or lifelike contexts to progress students' learning.

To analyse and evaluate Essential Mathematics content, teaching and learning strategies include:

- making conclusions about the purpose and audience of Essential Mathematics language and texts
- analysing the ways language is used to convey ideas and information in Essential Mathematics texts
- transforming language and texts to convey Essential Mathematics ideas and information in particular ways to suit audience and purpose.

These aspects of literacy knowledge and skills are embedded in the syllabus objectives, unit objectives and subject matter, and instrument-specific standards for Essential Mathematics.

Numeracy in Essential Mathematics

Numeracy relates to the capacity to deal with quantitative aspects of life (Goos, Geiger & Dole 2012). It involves accessing, using, interpreting and communicating mathematical information and ideas when engaging with and managing the mathematical demands of real contexts — everyday and civic life, the world of work, and opportunities for further learning (OECD 2012). Numerate citizens who are constructive, engaged and reflective are able to use mathematics to help make credible judgments and reasoned decisions (OECD 2015).

Unlike mathematics, numeracy must be understood as inseparable from context:

> Mathematics climbs the ladder of abstraction to see, from sufficient height, common patterns in seemingly different things. Abstraction is what gives mathematics its power; it is what enables methods derived in one context to be applied in others. But abstraction is not the focus of numeracy. Instead, numeracy clings to specifics, marshalling all relevant aspects of setting and context to reach conclusions.
>
> To enable students to become numerate, teachers must encourage them to see and use mathematics in everything they do. Numeracy is driven by issues that are important to people in their lives and work, not by future needs of the few who may make professional use of mathematics or statistics (Steen 2001, pp. 17–18).

The students who undertake Essential Mathematics will continue to develop their numeracy skills at a more sophisticated level than in P–10. For example, this subject contains financial

applications of mathematics that will assist students to become literate consumers of investment, loan and superannuation products. It also contains statistics topics that will equip students for the ever-increasing demands of the information age. Students will also learn about the probability of certain events occurring and will therefore be well equipped to make informed decisions about gambling.

These aspects of numeracy knowledge and skills are embedded in the syllabus objectives, unit objectives and subject matter, and instrument-specific standards for Essential Mathematics.

21st century skills

The 21st century skills identified in the following table reflect a common agreement, both in Australia and internationally, on the skills and attributes students need to prepare them for higher education, work and engagement in a complex and rapidly changing world.

21st century skills	Associated skills	21st century skills	Associated skills
critical thinking	• analytical thinking • problem-solving • decision-making • reasoning • reflecting and evaluating • intellectual flexibility	creative thinking	• innovation • initiative and enterprise • curiosity and imagination • creativity • generating and applying new ideas • identifying alternatives • seeing or making new links
communication	• effective oral and written communication • using language, symbols and texts • communicating ideas effectively with diverse audiences	collaboration and teamwork	• relating to others (interacting with others) • recognising and using diverse perspectives • participating and contributing • community connections
personal and social skills	• adaptability/flexibility • management (self, career, time, planning and organising) • character (resilience, mindfulness, open- and fair-mindedness, self-awareness) • leadership • citizenship • cultural awareness • ethical (and moral) understanding	information & communication technologies (ICT) skills	• operations and concepts • accessing and analysing information • being productive users of technology • digital citizenship (being safe, positive and responsible online)

Essential Mathematics helps develop the following 21st century skills:

- critical thinking
- creative thinking
- communication
- information & communication technologies (ICT) skills.

These elements of 21st century skills are embedded in the syllabus objectives, unit objectives and subject matter, and instrument-specific standards for Essential Mathematics.

Use of digital technology

An important aspect of teaching and learning in the 21st century is to embed digital technologies so that they are not seen as optional tools. Digital technologies allow new approaches to explaining and presenting mathematics, and can assist in connecting representations and deepening understanding. They can make previously inaccessible mathematics accessible and increase the opportunities for teachers to make mathematics interesting to a wider range of students. The computational and graphing capabilities of digital technologies enable students to engage in active learning through exploratory work and experiments using realistic data. The ability to visualise solutions can give problems more meaning. Digital technologies can support the development of conceptual understanding that can lead to enhanced procedural fluency.

To meet the requirements of this syllabus, students must make use of a range of digital technologies, such as:

- general-purpose computer software that can be used for mathematics teaching and learning, e.g. spreadsheet software, applications
- computer software designed for mathematics teaching and learning, e.g. dynamic graphing software, dynamic geometry software
- hand-held (calculator) technologies designed for mathematics teaching and learning, e.g. scientific, graphics (non-CAS or CAS) calculators, smartphone and tablet apps.

Students must make choices about various forms of technology and develop the ability to work with these flexibly. Technology use must go beyond simple computation or word processing.

Access to a handheld scientific calculator is a requirement for all assessments.

1.2.3 Aboriginal perspectives and Torres Strait Islander perspectives

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

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

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

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

In Mathematics, students have the opportunity to gain an awareness of the contributions of Aboriginal peoples and Torres Strait Islander peoples at local, regional, national and global levels through contextualisation of the subject matter.

To understand and use mathematics content, teaching and learning strategies may include:

- using pedagogies such Maths as Storytelling (MAST)[2]
- using mathematics subject matter in real-world Aboriginal contexts and Torres Strait Islander contexts
- identifying the specific Aboriginal issues and Torres Strait Islander issues relevant to the mathematics topics being covered
- providing learning experiences and opportunities that support the application of students' general mathematical knowledge and problem-solving processes in an Aboriginal context and Torres Strait Islander context.

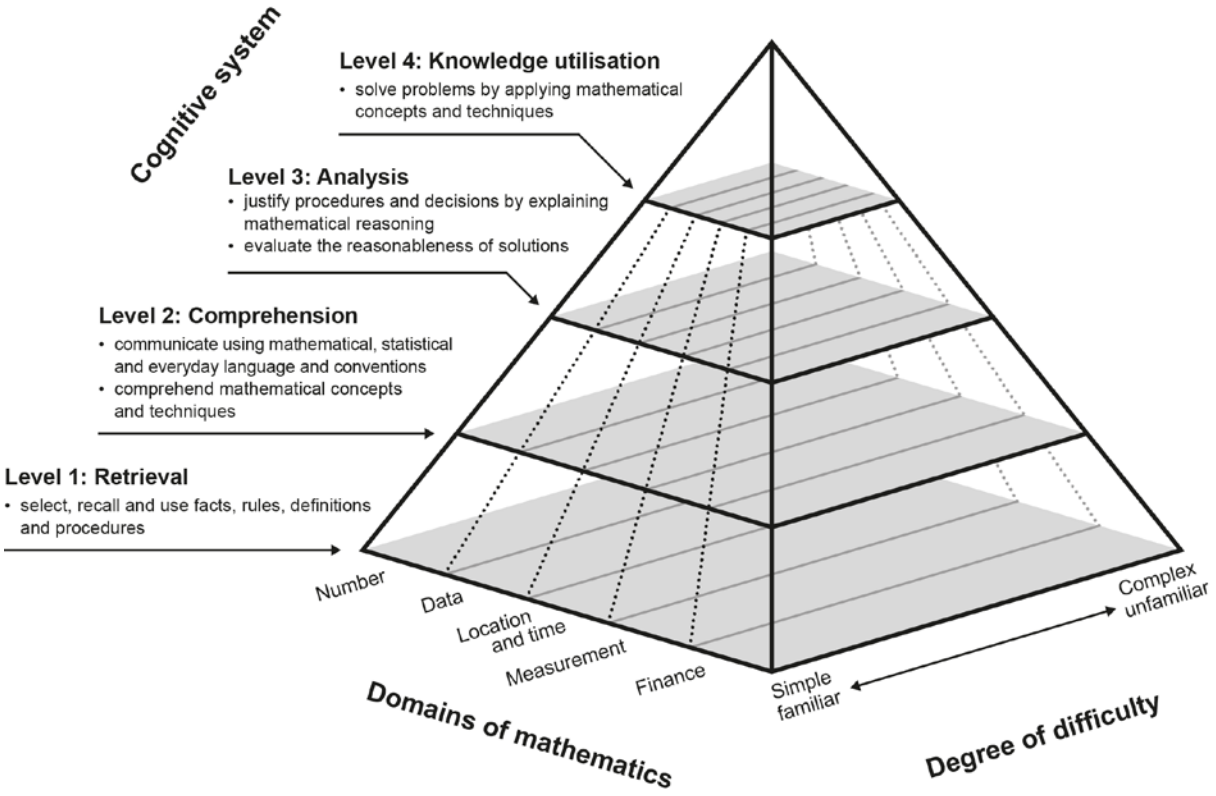
1.2.4 Pedagogical and conceptual frameworks

The relationship between foundational knowledge and problem-solving

To succeed in mathematics assessment, students must understand the subject matter (organised in domains of mathematics), draw on a range of cognitive skills, and apply these to problems of varying degrees of difficulty, from simple and routine, through to unfamiliar situations, complex contexts, and multi-step solutions (Grønmo et al. 2015).The relationship between the domains of mathematics in Essential Mathematics, level of cognitive skill required (syllabus objective) and degree of difficulty is represented in three dimensions for mathematics problems in the following diagram.

[2] https://www.qcaa.qld.edu.au/downloads/approach2/indigenous_res_culture_and_maths.pdf

Figure 3: Assessment pyramid



Adapted from Verhage & de Lange (1997) and Marzano & Kendall (2007).

Principles of developing mathematics problems

This representation, known as the 'assessment pyramid', shows the relative distribution of thinking and range of difficulty of mathematics problems.[3] It places an emphasis on building up from the basics. Success in mathematics is built on knowledge of basic facts and proficiency with foundational processes (Norton & O'Connor 2016). With a solid foundation, students can then be asked to apply higher level cognitive processes in more complex and unfamiliar situations that require the application of a wider range of concepts and skills.

The degree of difficulty

The difficulty of a problem is defined by its complexity and a student's familiarity with it, not the level of cognitive process required to solve it. The complexity of a particular type of problem doesn't change, but familiarity does. With practice, students become more familiar with a process and can execute it more quickly and easily (Marzano & Kendall 2007).

The cognitive system

To solve a full range of mathematics problems, students are required to engage the cognitive system at all four levels of processing knowledge: retrieval, comprehension, analysis and knowledge utilisation (Marzano & Kendall 2007). The syllabus objectives are represented in the pyramid model through their alignment to these levels.

[3] In an assessment instrument for Mathematics, a 'problem' is synonymous with 'assessment item' (a question, task or command that forms part of an assessment technique).

Using a full range of questions

The pyramid model shows that problems requiring Level 1 processes to solve them can be hard and relatively complex, even though they are based on 'retrieval' and therefore might seem easy and straightforward (Shafer & Foster 1997). Problems requiring higher level processes to solve them are not necessarily more difficult than those in Level 1. There are some students who find Level 1 processes more challenging and have more success in solving problems requiring Levels 2, 3 and 4 (Webb 2009).

The distance along the domains of mathematics dimension and the degree of difficulty dimension decreases for higher levels. Problems requiring Level 1 processes can more easily be based on distinct subject matter and the difference between easy and hard can be great. Problems that require students to use more levels of cognition tend to also involve making connections with subject matter within and across the domains of mathematics. They are often placed in contexts that require strategic mathematical decisions and making representations according to situation and purpose. At higher levels the difference between easy and hard is smaller (Shafer & Foster 1997; Webb 2009). Students should master basic facts and processes through practising simple familiar problems, before moving on to those that are more complex and unfamiliar, at any level.[4]

The assessment pyramid helps visualise what is necessary for a complete assessment program. Problems in a complete mathematics program need to assess a student's growth and achievement in all areas of subject matter and across the full range of objectives. Over time, through a teaching and learning period, students will be exposed to problems that 'fill the pyramid'. Each assessment instrument will reflect this for the relevant subject matter, providing students with the opportunity to demonstrate what they know and can do at all levels of thinking and at varying degrees of difficulty (Shafer & Foster 1997).

Problem-solving and mathematical modelling

A key aspect of learning mathematics is to develop strategic competence; that is, to formulate, represent and solve mathematical problems (Kilpatrick, Swafford & Bradford 2001). As such, problem-solving is a focus of mathematics education research, curriculum and teaching (Sullivan 2011). This focus is not to the exclusion of routine exercises, which are necessary for practising, attaining mastery and being able to respond automatically. But mathematics education in the 21st century goes beyond this to include innovative problems that are complex, unfamiliar and non-routine (Mevarech & Kramarski 2014).

Problem-solving in mathematics can be set in purely mathematical contexts or real-world contexts. When set in the real world, problem-solving in mathematics involves mathematical modelling.

Problem-solving

Problem-solving is required when a task or goal has limiting conditions placed upon it or an obstacle blocking the path to a solution (Marzano & Kendall 2007). It involves:

- knowledge of the relevant details
- using generalisations and principles to identify, define and interpret the problem
- mental computation and estimation

[4] Complex unfamiliar questions that require more levels of cognitive skills should not be equated with elaborate problem-solving tasks and modelling questions only. A single-answer, conventional question, such as: 'Find the equation of the line passing through the points (2,1) and (1,3)' can be adapted to a more open-ended question, such as: 'Write the equations of at least five lines passing through the point (2,1)' (Goos 2014). This revised question targets the identical subject matter but provides the possibility of easily identifying diverse student understanding and skills by moving it towards complex unfamiliar questions and assessing more cognitive skills. For further examples, see White et al. (2000).

- critical, creative and lateral thinking
- creating or choosing a strategy
- making decisions
- testing, monitoring and evaluating solutions.

Problem-solving requires students to explain their mathematical thinking and develop strong conceptual foundations. They must do more than follow set procedures and mimic examples without understanding. Through problem-solving, students will make connections between mathematics topics, across the curriculum and with the real world, and see the value and usefulness of mathematics. Problems may be real world or abstract, and presented to students as issues, statements or questions that may require them to use primary or secondary data.

Mathematical modelling

Mathematical modelling begins from an assumption that mathematics is everywhere in the world around us — a challenge is to identify where it is present, access it and apply it productively. Models are developed in order to better understand real-world phenomena, to make predictions and answer questions. A mathematical model depicts a situation by expressing relationships using mathematical concepts and language. It refers to the set of simplifying assumptions (such as the relevant variables or the shape of something); the set of assumed relationships between variables; and the resulting representation (such as a formula) that can be used to generate an answer (Stacey 2015).

Mathematical modelling involves:

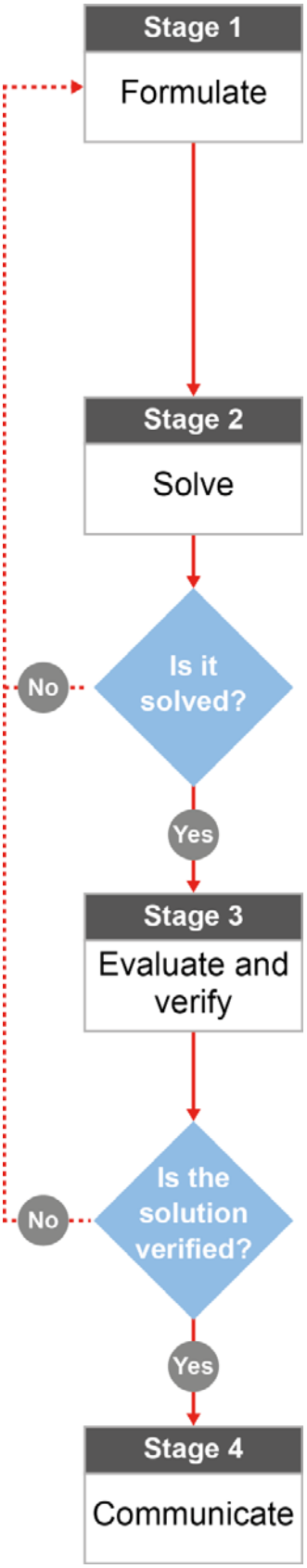
- formulating a mathematical representation of a problem derived from within a real-world context
- using mathematics concepts and techniques to obtain results
- interpreting the results by referring back to the original problem context
- revising the model (where necessary) (Geiger, Faragher & Goos 2010).

Through developing and applying mathematical models, students cumulatively become real-world problem-solvers. Ultimately, this means that not only can they productively address problems set by others, but also that they develop the ability to identify and address problems and answer questions that matter to them.

The following section outlines an approach to problem-solving and mathematical modelling.[5] Problems must be real-world, and can be presented to students as issues, statements or questions that may require them to use primary or secondary data.

[5] A wide variety of frameworks for problem-solving and modelling exist in mathematics education literature. The approach outlined here aligns with and is informed by other approaches, such as Polya in *How to Solve It: A new aspect of mathematical method* (1957), the Australian Curriculum (2015a) *Statistical investigation process*, the OECD/PISA Mathematics framework (OECD 2003, 2015) and *A framework for success in implementing mathematical modelling in the secondary classroom* (Stillman et al. 2007). For further reading see Blum et al. (2007), Kaiser et al. (2011) and Stillman et al. (2013).

Figure 4: An approach to problem-solving and mathematical modelling



Once students understand what the problem is asking, they must design a plan to solve the problem. Students translate the problem into a mathematically purposeful representation by first determining the applicable mathematical and/or statistical principles, concepts, techniques and technology that are required to make progress with the problem. Appropriate assumptions, variables and observations are identified and documented, based on the logic of a proposed solution and/or model.

In mathematical modelling, formulating a model involves the process of mathematisation — moving from the real world to the mathematical world.

Students select and apply mathematical and/or statistical procedures, concepts and techniques previously learnt to solve the mathematical problem to be addressed through their model. Possible approaches are wide-ranging and include synthesising and refining existing models, and generating and testing hypotheses with primary or secondary data and information, as well as using standard mathematical techniques to produce a valid solution.

Solutions can be found using algebraic, graphic, arithmetic and/or numeric methods, with and/or without technology.

Once a possible solution has been achieved, students need to consider the reasonableness of the solution and/or the utility of the model in terms of the problem. They evaluate their results and make a judgment about the solution/s to the problem in relation to the original issue, statement or question.

This involves exploring the strengths and limitations of the solution and/or model. Where necessary, this will require going back through the process to further refine the solution and/or model. In mathematical modelling, students must check that the output of their model provides a valid solution to the real-world problem it has been designed to address.

This stage emphasises the importance of methodological rigour and the fact that problem-solving and mathematical modelling is not usually linear and involves an iterative process.

The development of solutions and models to abstract and real-world problems must be capable of being evaluated and used by others and so need to be communicated clearly and fully. Students communicate findings systematically and concisely using mathematical, statistical and everyday language. They draw conclusions, discussing the key results and the strengths and limitations of the solution and/or model. Students could offer further explanation, justification and/or recommendations, framed in the context of the initial problem.

Approaches to problem-solving and mathematical modelling in the classroom

When teaching problem-solving and mathematical modelling, teachers should consider *teaching for* and *learning through* problem-solving and mathematical modelling. When *teaching for*, students are taught the specific mathematical rules, definitions, procedures, problem-solving strategies and critical elements of the model that are needed to solve a given problem. When *learning through*, students are presented with problems to solve, but must apply the knowledge and skills they have previously been taught to solve it. By solving these problems, students are able to develop new mathematical understanding and skills. This requires an explicit and connected approach to teaching problem-solving and mathematical modelling that necessitates fluency of critical facts and processes at each step.

The following describes three different approaches to teaching problem-solving and mathematical modelling along the continua between *teaching for* and *learning through*:[6]

Approach	Description	*Teaching for* or *learning through*
Dependent	The teacher explicitly demonstrates and teaches the concepts and techniques required to solve the problem and/or develop a mathematical model. This usually involves students solving (stage 2), and evaluating and verifying (stage 3).	*Teaching for*
Guided	The teacher influences the choice of concepts and techniques, and/or model that students use to solve the problem. Guidance is provided and all stages of the approach are used.	Moving towards *learning through*
Independent	The teacher cedes control and students work independently, choosing their own solution and/or model, and working at their own level of mathematics. The independent approach is the most challenging.	*Learning through*

These approaches are not mutually exclusive. An independent approach (*learning through*) might be undertaken as an extension of a dependent or guided activity that students have previously undertaken (*teaching for*). Students need to have attained the relevant foundational understanding and skills before working independently during the problem-solving and modelling task (internal assessment). This capacity needs to be built over time through the course of study with teachers closely monitoring student progress.

1.2.5 Subject matter

Subject matter is the body of information, mental procedures and psychomotor procedures (see Marzano & Kendall 2007, 2008) that are necessary for students' learning and engagement with Essential Mathematics. It is particular to each unit in the course of study and provides the basis for student learning experiences.

Subject matter has a direct relationship to the unit objectives, but is of a finer granularity and is more specific. These statements of learning are constructed in a similar way to objectives. Each statement:

- describes an action (or combination of actions) — what the student is expected to do
- describes the element — expressed as information, mental procedures and/or psychomotor procedures
- is contextualised for the topic or circumstance particular to the unit.

[6] Based on Galbraith (1989).

Subject matter in Essential Mathematics is organised into topics and sub-topics. Notional time allocations have been provided for each sub-topic. Subject matter that is accompanied by '[complex]' is considered to be complex. All other subject matter is considered to be simple. Students who demonstrate attainment of simple subject matter only will be able to achieve a maximum of a C grade overall.

1.3 Assessment — general information

Assessments are formative in Units 1 and 2, and summative in Units 3 and 4.

Assessment	Unit 1	Unit 2	Unit 3	Unit 4
Formative assessments	•	•		
Summative internal assessment 1			•	
Summative internal assessment 2			•	
Summative internal assessment 3				•
Summative internal assessment 4				•

1.3.1 Formative assessments — Units 1 and 2

Formative assessments provide feedback to both students and teachers about each student's progress in the course of study.

Schools develop internal assessments for each senior subject, based on the learning described in Units 1 and 2 of the subject syllabus. Each unit objective must be assessed at least once.

For reporting purposes, schools should devise at least *two* but no more than *four* assessments for Units 1 and 2 of this subject. At least *one* assessment must be completed for *each* unit.

The sequencing, scope and scale of assessments for Units 1 and 2 are matters for each school to decide and should reflect the local context.

Teachers are encouraged to use the A–E descriptors in the reporting standards (Section 1.5) to provide formative feedback to students and to report on progress.

1.3.2 Summative assessments — Units 3 and 4

Students will complete a total of four summative internal assessments that count towards their overall subject result. Schools develop three of the summative internal assessments and the other is a common internal assessment (CIA) developed by the QCAA.

These assessments are based on the learning described in Units 3 and 4 of the syllabus and provide the evidence of student work included in exit folios.

Common internal assessment

The common internal assessment (CIA) is based on the learning described in Unit 3 of the syllabus. The CIA is:

- developed by the QCAA
- common to all schools
- delivered to schools by the QCAA

- administered under supervised conditions flexibly in Unit 3
- marked by the school according to a common marking scheme developed by the QCAA.

The CIA is not privileged over the school-developed assessment.

Summative internal assessment — Instrument-specific standards

This syllabus provides instrument-specific standards for the three summative internal assessments in Units 3 and 4.

The instrument-specific standards describe the characteristics evident in student responses and align with the identified assessment objectives. Assessment objectives are drawn from the unit objectives and are contextualised for the requirements of the assessment instrument.

Criteria

Each instrument-specific standard groups assessment objectives into criteria. An assessment objective may appear in multiple criteria or in a single criterion of an assessment.

Using instrument-specific standards

The instrument-specific standards identify the evidence at each level (A–E) for each of the criteria. Teachers use the instrument-specific standards to:

- judge student performance on individual assessments by directly matching the evidence in responses to fixed reference points that describe the expected qualities of student work
- discuss student responses within a common frame using a shared language
- guide feedback to students through evidence-based discussions, focusing on how they can critique their own responses and identify goals for improvement and future learning.

Authentication

Schools and teachers must have strategies in place for ensuring that work submitted for internal summative assessment is the student's own. Authentication strategies outlined in the QCAA guidelines, which include guidance for drafting, scaffolding and teacher feedback, must be adhered to.

1.4 Exiting a course of study

1.4.1 Exit folios

The exit folio is the collection of evidence of student work from Units 3 and 4 that is used to determine the student's exit result. Each folio must include:

- three school-developed assessment instruments, and the student responses
- the common internal assessment (CIA), and the student response
- a completed student profile.

1.4.2 Determining an exit result

When each student exits the course of study, the school is required to determine an A–E exit result for them.

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

For students who exit before completing four units, judgments are made based on the evidence of achievement to that stage of the course of study.

Awarding an exit result

The result awarded at exit is an on-balance judgment about the quality of learning demonstrated by students. An on-balance judgment involves teachers making professional decisions about how the pattern of evidence across the four summative assessments in the folio best matches the characteristics of the reporting standards at one of the five levels (A–E). This means that it is not necessary for student responses to have been matched to every characteristic for a particular standard.

Teachers consider all the evidence in the folio with reference to the reporting standards. If there is an easy fit or match to one of the five levels (A–E), the on-balance judgment will be obvious. If there is uneven performance across four assessments, teachers consider the contribution of each of the assessments and the judgments made on the associated instrument-specific standards, and decide whether the pattern of evidence of learning is more like an A, B, C, D or E.

1.5 Reporting standards

Reporting standards are summary statements that succinctly describe typical performance at each of the five levels (A–E). They reflect the cognitive taxonomy and objectives of the course of study.

The primary purpose of reporting standards is for twice-yearly reporting on student progress and for determining exit results. These descriptors can also be used to help teachers provide formative feedback to students and to align instrument-specific standards.

Reporting standards

A
The student demonstrates a comprehensive knowledge and understanding of the simple and complex subject matter; recognises, recalls and uses facts, rules, definitions and procedures; and comprehends and applies mathematical concepts and techniques to solve problems drawn from Number, Data, Location and time, Measurement and Finance. The student explains mathematical reasoning to justify procedures and decisions; evaluates the reasonableness of solutions; communicates using mathematical, statistical and everyday language and conventions; and makes decisions about the choice of technology and uses the technology to solve simple and complex situations.

B
The student demonstrates a thorough knowledge and understanding of the simple and complex subject matter; recognises, recalls and uses facts, rules, definitions and procedures; and comprehends and applies mathematical concepts and techniques to solve problems drawn from Number, Data, Location and time, Measurement and Finance. The student explains mathematical reasoning to justify simple and complex procedures and decisions; evaluates the reasonableness of solutions; communicates using mathematical, statistical and everyday language and conventions; and makes decisions about the choice of technology and uses the technology to solve simple and complex situations.
C
The student demonstrates knowledge and understanding of the simple subject matter; recognises, recalls and uses facts, rules, definitions and procedures; and comprehends and applies mathematical concepts and techniques to solve problems drawn from Number, Data, Location and time, Measurement and Finance. The student explains mathematical reasoning to justify simple procedures and decisions; evaluates the reasonableness of solutions; communicates using mathematical, statistical and everyday language and conventions; and uses technology to solve simple situations.
D
The student demonstrates partial knowledge and understanding of the subject matter; recognises, recalls and uses some facts, rules, definitions and procedures; and comprehends and applies aspects of mathematical concepts and techniques to solve some problems drawn from Number, Data, Location and time, Measurement and Finance. The student explains some mathematical reasoning to justify procedures and decisions; sometimes evaluates the reasonableness of solutions; communicates using some mathematical, statistical and everyday language and conventions; and uses technology to solve situations.
E
The student: demonstrates isolated knowledge and understanding of the subject matter; infrequently recognises, recalls and uses some facts, rules, definitions and procedures; and infrequently comprehends and applies aspects of mathematical concepts and techniques drawn from Number, Data, Location and time, Measurement and Finance. The student: infrequently describes aspects of mathematical reasoning relevant to procedures and decisions; rarely evaluates the reasonableness of solutions; infrequently communicates using some aspects of mathematical, statistical and everyday language and conventions; and uses aspects of technology to solve situations.

2 Unit 1: Number, data and graphs

2.1 Unit description

In Unit 1, students will develop the mathematical understanding and skills to solve problems relating to the topics:

- Fundamental topic: Calculations
- Topic 1: Number
- Topic 2: Representing data
- Topic 3: Graphs.

The subject matter of the topics in this unit should be applied in contexts that are meaningful and of interest to students. A variety of approaches can be used to achieve this purpose. Two possible contexts that may be used are ‘Mathematics of foods’ and ‘Mathematics of sports’. However, these contexts may not be relevant to all students. Suitable contexts relevant to the particular student cohort should be chosen.

Unit requirements

Subject matter describes the concepts, ideas, knowledge, understanding and skills that students are to learn in Unit 1. It is organised into topics and sub-topics. Notional time allocations have been provided for each sub-topic.

2.2 Unit objectives

Unit objectives are drawn from the syllabus objectives and are contextualised for the subject matter and requirements of the unit. Each unit objective is assessed at least once.

Students will:

1. select, recall and use facts, rules, definitions and procedures drawn from all Unit 1 topics
2. comprehend mathematical concepts and techniques drawn from all Unit 1 topics
3. communicate using mathematical, statistical and everyday language and conventions
4. evaluate the reasonableness of solutions
5. justify procedures and decisions by explaining mathematical reasoning
6. solve problems by applying mathematical concepts and techniques drawn from all Unit 1 topics.

2.3 Fundamental topic: Calculations

Calculations should be integrated throughout Unit 1.

Subject matter
Calculations In this sub-topic, students will: • solve practical problems requiring basic number operations • apply arithmetic operations according to their correct order • ascertain the reasonableness of answers to arithmetic calculations • use leading-digit approximation to obtain estimates of calculations • use a calculator for multi-step calculations • check results of calculations for accuracy • recognise the significance of place value after the decimal point • evaluate decimal fractions to the required number of decimal places • round up or round down numbers to the required number of decimal places • apply approximation strategies for calculations.

2.4 Topic 1: Number

Subject matter
Ratios (7 hours) In this sub-topic, students will: • demonstrate an understanding of the fundamental ideas and notation of ratio • understand the relationship between fractions and ratio • express a ratio in simplest form using whole numbers • find the ratio of two quantities in its simplest form • divide a quantity in a given ratio [complex] • use ratio to describe simple scales [complex].
Rates (6 hours) In this sub-topic, students will: • review identifying common usage of rates, including km/h • convert between units for rates • complete calculations with rates, including solving problems involving direct proportion in terms of rate [complex] • use rates to make comparisons • use rates to determine costs.
Percentages (7 hours) In this sub-topic, students will: • calculate a percentage of a given amount • determine one amount expressed as a percentage of another for same units • determine one amount expressed as a percentage of another for different units [complex] • apply percentage increases and decreases in situations, including mark-ups, discounts and GST [complex] • determine the overall change in a quantity following repeated percentage changes [complex] • calculate simple interest for different rates and time periods [complex].

2.5 Topic 2: Representing data

Subject matter
Classifying data (3 hours) In this sub-topic, students will: • identify examples of categorical data • identify examples of numerical data.
Data presentation and interpretation (8 hours) In this sub-topic, students will: • display categorical data in tables and column graphs • display numerical data as frequency distribution tables, dot plots, stem-and-leaf plots and histograms • recognise and identify outliers from a dataset • compare the suitability of different methods of data presentation in real-world contexts [complex].

2.6 Topic 3: Graphs

Subject matter
Reading and interpreting graphs (8 hours) In this sub-topic, students will: • interpret information presented in graphs, such as step graphs, column graphs, pie graphs, picture graphs, conversion graphs of calories ↔ kilojoules, line graphs using units of energy to describe consumption of electricity, including kilowatt hours • interpret information presented in two-way tables • discuss and interpret tables and graphs, including misleading graphs found in the media and in factual texts [complex].
Drawing graphs (9 hours) In this sub-topic, students will: • determine which type of graph is best used to display a dataset • use spreadsheets to tabulate and graph data [complex] • draw a line graph to represent any data that demonstrates a continuous change, such as hourly temperature [complex].
Using graphs (7 hours) In this sub-topic, students will: • use graphs in practical situations • interpret graphs in practical situations [complex] • draw graphs from given data to represent practical situations [complex] • interpret the point of intersection and other important features (x- and y-intercepts) of given graphs of two linear functions drawn from practical contexts [complex].

2.7 Assessment guidance

In constructing assessment instruments for Unit 1, schools should ensure that the objectives cover, or are chosen from, the unit objectives. If one assessment instrument is developed for a unit, it must assess all the unit objectives; if more than one assessment instrument is developed, the unit objectives must be covered across those instruments.

It is suggested that schools develop:

- a ‘dependent’ problem-solving and modelling task that assesses Unit 1 Topic 2, and
- an internal examination that representatively samples subject matter from Unit 1 not assessed in the problem-solving and modelling task.

3 Unit 2: Money, travel and data

3.1 Unit description

In Unit 2, students will develop the mathematical understanding and skills to solve problems relating to:

- Fundamental topic: Calculations
- Topic 1: Managing money
- Topic 2: Time and motion
- Topic 3: Data collection.

The subject matter of the topics in this unit should be applied in contexts that are meaningful and of interest to students. A variety of approaches can be used to achieve this purpose. Two possible contexts that may be used are 'Mathematics of independent living' and 'Mathematics of travel'. However, these contexts may not be relevant to all students. Suitable contexts relevant to the particular student cohort should be chosen.

Unit requirements

Subject matter describes the concepts, ideas, knowledge, understanding and skills that students are to learn in Unit 2. It is organised in topics and sub-topics. Notional time allocations have been provided for each sub-topic.

3.2 Unit objectives

Unit objectives are drawn from the syllabus objectives and are contextualised for the subject matter and requirements of the unit. Each unit objective is assessed at least once.

Students will:

1. select, recall and use facts, rules, definitions and procedures drawn from all Unit 2 topics
2. comprehend mathematical concepts and techniques drawn from all Unit 2 topics
3. communicate using mathematical, statistical and everyday language and conventions
4. evaluate the reasonableness of solutions
5. justify procedures and decisions by explaining mathematical reasoning
6. solve problems by applying mathematical concepts and techniques drawn from all Unit 2 topics.

3.3 Fundamental topic: Calculations

Calculations should be integrated throughout Unit 2.

Subject matter
Calculations In this sub-topic, students will: • solve practical problems requiring basic number operations • apply arithmetic operations according to their correct order • ascertain the reasonableness of answers to arithmetic calculations • use leading-digit approximation to obtain estimates of calculations • use a calculator for multi-step calculations • check results of calculations for accuracy • recognise the significance of place value after the decimal point • evaluate decimal fractions to the required number of decimal places • round up or round down numbers to the required number of decimal places • apply approximation strategies for calculations.

3.4 Topic 1: Managing money

Subject matter
Earning money (14 hours) In this sub-topic, students will: • find earnings, including salary, wages, overtime, piece-work and commission • convert between annual, monthly, fortnightly, weekly and hourly rates of earning [complex] • understand the purpose of superannuation • interpret entries on a selection of wage or salary pay slips and timesheets • understand the purpose of taxation and the use of tax file numbers • use tax tables to determine PAYG tax for periodic (weekly/fortnightly/monthly) earnings [complex] • interpret entries on a simple PAYG summary • apply the concepts of taxable income, gross income, allowable deductions and levies in simple contexts [complex] • calculate a simple income tax return and net income using current income tax rates [complex].
Budgeting (6 hours) In this sub-topic, students will: • investigate the costs involved in independent living [complex] • prepare a personal budget plan [complex].

3.5 Topic 2: Time and motion

Subject matter
Time (7 hours) In this sub-topic, students will: • use units of time and convert between fractional, decimal and digital representations • represent time using 12-hour and 24-hour clocks • calculate time intervals, including time between, time ahead, time behind • interpret timetables for buses, trains and/or ferries

- use several timetables and/or electronic technologies to plan the most time-efficient routes
- interpret complex timetables, such as tide charts, sunrise charts and moon phases [complex]
- compare the time taken to travel a specific distance with various modes of transport.

Distance (5 hours)

In this sub-topic, students will:

- use scales to find distances, e.g. on maps
- investigate distances through trial and error or systematic methods [complex]
- apply directions to distances calculated on maps including the eight compass points in relation to the rising and setting of the sun: N, NE, E, SE, S, SW, W, NW [complex].

Speed (8 hours)

In this sub-topic, students will:

- identify the appropriate units for different activities, e.g. walking, running, swimming, driving and flying
- use units of energy used for foods, including calories
- use units of energy to describe the amount of energy in activity, including kilojoules.
- calculate speed, distance or time using the formula, $\text{speed} = \frac{\text{distance}}{\text{time}}$
- calculate the time and costs for a journey from distances estimated from maps, given a travelling speed [complex]
- calculate average speed
- interpret distance-versus-time graphs, including reference to the steepness of the slope (or average speed) [complex].

3.6 Topic 3: Data collection

Subject matter

Census (3 hours)

In this sub-topic, students will:

- investigate the procedure for conducting a census
- investigate the advantages and disadvantages of conducting a census [complex].

Surveys (5 hours)

In this sub-topic, students will:

- understand the purpose of sampling to provide an estimate of population values when a census is not used
- investigate the different kinds of samples [complex]
- investigate the advantages and disadvantages of these kinds of samples [complex].

Simple survey procedure (4 hours)

In this sub-topic, students will:

- identify the target population to be surveyed
- investigate questionnaire design principles, including simple language, unambiguous questions, consideration of number of choices, issues of privacy and ethics, and freedom from bias [complex].

Sources of bias (3 hours)

In this sub-topic, students will:

- describe the faults in the process of collecting data
- describe sources of error in surveys, including sampling error and measurement error
- investigate the possible misrepresentation of the results of a survey due to misunderstanding the procedure or the reliability of generalising the survey findings to the entire population [complex]
- investigate errors and misrepresentation in surveys, including examples of media misrepresentations of surveys [complex].

3.7 Assessment guidance

In constructing assessment instruments for Unit 2, schools should ensure that the objectives cover, or are chosen from, the unit objectives. If one assessment instrument is developed for a unit, it must assess all the unit objectives; if more than one assessment instrument is developed, the unit objectives must be covered across those instruments.

It is suggested that schools develop:

- a 'dependent and/or guided' problem-solving and modelling task that assesses Unit 2 Topic 2, and
- an internal examination that representatively samples subject matter from Unit 2 not assessed in the problem-solving and modelling task.

4 Unit 3: Measurement, scales and data

4.1 Unit description

In Unit 3, students will develop the mathematical understanding and skills to solve problems relating to:

- Fundamental topic: Calculations
- Topic 1: Measurement
- Topic 2: Scales, plans and models
- Topic 3: Summarising and comparing data.

The subject matter of the topics in this unit should be applied in a context that is meaningful and of interest to students. A variety of approaches can be used to achieve this purpose. Two possible contexts that may be used in this unit are 'Mathematics of designs' and 'Mathematics of the media'. However, these contexts may not be relevant to all students. Suitable contexts relevant to the particular student cohort should be chosen.

Unit requirements

Subject matter describes the concepts, ideas, knowledge, understanding and skills that students are to learn in Unit 3. It is organised in topics and sub-topics. Notional time allocations have been provided for each sub-topic.

4.2 Unit objectives

Unit objectives are drawn from the syllabus objectives and are contextualised for the subject matter and requirements of the unit. Each unit objective is assessed at least once. The objectives will be evident in the instrument-specific standards.

Students will:

Unit objective	IA1	IA2
1. select, recall and use facts, rules, definitions and procedures drawn from all Unit 3 topics	•	•
2. comprehend mathematical concepts and techniques drawn from all Unit 3 topics	•	•
3. communicate using mathematical, statistical and everyday language and conventions	•	•
4. evaluate the reasonableness of solutions	•	•
5. justify procedures and decisions by explaining mathematical reasoning	•	•
6. solve problems by applying mathematical concepts and techniques drawn from all Unit 3 topics.	•	•

4.3 Fundamental topic: Calculations

Calculations should be integrated throughout Unit 3.

Subject matter
Calculations In this sub-topic, students will: • solve practical problems requiring basic number operations • apply arithmetic operations according to their correct order • ascertain the reasonableness of answers to arithmetic calculations • use leading-digit approximation to obtain estimates of calculations • use a calculator for multi-step calculations • check results of calculations for accuracy • recognise the significance of place value after the decimal point • evaluate decimal fractions to the required number of decimal places • round up or round down numbers to the required number of decimal places • apply approximation strategies for calculations.

4.4 Topic 1: Measurement

Subject matter
Geometry (3 hours) In this sub-topic, students will: • recognise the properties of common two-dimensional geometric shapes, including squares, rectangles and triangles, and three-dimensional solids, including cubes, rectangular-based prisms and triangular-based prisms • interpret different forms of two-dimensional representations of three-dimensional objects, including nets of cubes, rectangular-based prisms and triangular-based prisms [complex].
Linear measure (5 hours) In this sub-topic, students will: • use metric units of length (millimetres, centimetres, metres, kilometres), their abbreviations (mm, cm, m, km), conversions between them, and appropriate levels of accuracy and choice of units • estimate lengths • calculate perimeters of familiar shapes, including triangles, squares, rectangles, polygons, circles and arc lengths • calculate perimeters of familiar composite shapes [complex].
Area measure (9 hours) In this sub-topic, students will: • use metric units of area (square millimetres, square centimetres, square metres, square kilometres, hectares), their abbreviations (mm^2, cm^2, m^2, km^2, ha), conversions between them and appropriate choices of units • estimate the areas of different shapes • calculate areas of regular shapes, including triangles, squares, rectangles, parallelograms and circles • calculate areas of regular shapes, including trapeziums and sectors [complex] • calculate areas of composite figures by decomposing them into regular shapes [complex] • calculate surface areas of familiar prisms, including cubes, rectangular and triangular prisms, spheres and cylinders [complex] • calculate surface areas of familiar pyramids, including rectangular-based and triangular-based pyramids [complex] • calculate surface areas of irregular solids [complex].

Volume and capacity (6 hours)

In this sub-topic, students will:

- use metric units of volume (cubic millimetres, cubic centimetres, cubic metres), their abbreviations (mm^3, cm^3, m^3), conversions between them and appropriate choices of units
- understand and use the relationship between volume and capacity, recognising that 1 cm^3 = 1 mL (millilitre), 1000 cm^3 = 1 L (litre), 1 m^3 = 1 kL (kilolitre), 1000 kL = 1ML (megalitre)
- estimate volume and capacity of various objects
- calculate the volume and capacity of regular objects, including cubes, rectangular and triangular prisms, and cylinders
- calculate the volume and capacity of right pyramids, including square-based and rectangular-based pyramids, and spheres.

Mass (4 hours)

In this sub-topic, students will:

- use metric units of mass (milligrams, grams, kilograms, metric tonnes), their abbreviations (mg, g, kg, t), conversions between them and appropriate choices of units
- estimate the mass of different objects
- recognise the need for milligrams.

4.5 Topic 2: Scales, plans and models

Subject matter
Interpret scale drawings (6 hours) In this sub-topic, students will: • interpret commonly used symbols and abbreviations in scale drawings • find actual measurements from scale drawings, including lengths, perimeters and areas • estimate and compare quantities, materials and costs using actual measurements from scale drawings [complex].
Creating scale drawings (4 hours) In this sub-topic, students will: • understand and apply drawing conventions of scale drawings, including scales in ratio, clear indications of dimensions and clear labelling [complex] • construct scale drawings by hand and by using software packages [complex].
Right-angled triangles (5 hours) In this sub-topic, students will: • apply Pythagoras' theorem to solve problems for all side lengths using $a^2 + b^2 = c^2$ • apply the tangent, sine and cosine ratios to find unknown angles and sides [complex] • use the concepts of angle of elevation and angle of depression to solve practical problems [complex].

4.6 Topic 3: Summarising and comparing data

Subject matter
Summarising and interpreting data (8 hours) In this sub-topic, students will: • identify the mode from a dataset • calculate measures of central tendency, the mean and the median from a dataset • investigate the suitability of measures of central tendency in various real-world contexts [complex] • investigate the effect of outliers on the mean and the median [complex] • calculate quartiles from a dataset [complex] • interpret quartiles, deciles and percentiles from a graph [complex] • use everyday language to describe spread, including spread out, dispersed, tightly packed, clusters, gaps, more/less dense regions, outliers • calculate and interpret statistical measures of spread, such as the range, interquartile range and standard deviation [complex] • investigate real-world examples from the media illustrating inappropriate uses of measures of central tendency and spread [complex].
Comparing datasets (5 hours) In this sub-topic, students will: • complete a five-number summary for different datasets • construct box plots using a five-number summary • compare parallel box plots and back-to-back stem plots for different datasets [complex] • compare the characteristics of the shape of histograms using symmetry, skewness and bimodality, where applicable [complex].

4.7 Assessment

4.7.1 Summative internal assessment 1: Problem-solving and modelling task

Description

This assessment focuses on the interpretation, analysis and evaluation of ideas and information. It is an independent task responding to a particular situation or stimuli. While students may undertake some research in the writing of the problem-solving and modelling task, it is not the focus of this technique. This assessment occurs over an extended and defined period of time. Students will use class time and their own time to develop a response.

The problem-solving and modelling task must use subject matter from Fundamental topic: Calculations, and at least one of the following topics in Unit 3:

- Topic 1: Measurement
- Topic 2: Scales, plans and models
- Topic 3: Summarising and comparing data.

Assessment objectives

This assessment technique is used to determine student achievement in the following objectives:

1. select, recall and use facts, rules, definitions and procedures drawn from Fundamental topic: Calculations and Unit 3 Topics 1, 2 and/or 3
2. comprehend mathematical concepts and techniques drawn from Fundamental topic: Calculations and Unit 3 Topics 1, 2 and/or 3
3. communicate using mathematical, statistical and everyday language and conventions
4. evaluate the reasonableness of solutions
5. justify procedures and decisions by explaining mathematical reasoning
6. solve problems by applying mathematical concepts and techniques drawn from Fundamental topic: Calculations and Unit 3 Topics 1, 2 and/or 3.

Specifications

Description

A problem-solving and modelling task is an assessment instrument developed in response to a mathematical investigative scenario or context. It requires students to respond with a range of understanding and skills, such as using mathematical language, appropriate calculations, tables of data, graphs and diagrams.

Students must provide a response to a specific task or issue that must be set in a context that highlights a real-life application of mathematics. The task requires students to use relevant stimulus material involving the selected subject matter and must have sufficient scope to allow students to address all the stages of the problem-solving and modelling approach (see Section 1.2.4). Technology must be used.

Conditions

- Written:
  - up to 8 pages (including tables, figures and diagrams)
  - maximum of 1000 words
  - appendixes can include raw data, repeated calculations, evidence of authentication and student notes (appendixes are not to be marked).
- Duration: 5 weeks (including 10 hours of class time).
- Other:
  - opportunity may be provided for group work, but unique responses must be developed by each student
  - use of technology is required; schools must specify the technology used, e.g. scientific calculator, graphics calculator, spreadsheet program and/or other mathematical software; use of technology must go beyond simple computation or word processing
  - the teacher provides the mathematical investigative scenario or context for the problem-solving and modelling task.

Task examples

Examples of problem-solving and modelling tasks include:

- a magazine article laying out the different types of rainwater tanks for particular house dimensions: Consider the amount of collectable rainfall and water usage at home and make a recommendation of the most appropriate water tank; make a recommendation for the type of solar hot water heater (from a choice of four) a house should get based on exposure to sunlight and hot water use.
- a written persuasive argument/proposal to a manager: Use scales, plans and models to find the required amount of different materials (such as paint and lighting) and other equipment when designing the layout of a stage for a particular performance; calculate the ideal placement of a projector and other lights for a different performance.
- a report on students' internet use (time, activity, device) compared to the national data provided by the Australian Bureau of Statistics (ABS), and comparing children's participation in different activities (e.g. sport and music) in different countries over a period of time.

Summary of the instrument-specific standards

The following table summarises the criteria and assessment objectives for the problem-solving and modelling task.

Criterion	Objectives
Formulate	1, 2 and 5
Solve	1 and 6
Evaluate and verify	4 and 5
Communicate	3

Instrument-specific standards — IA1

Formulate	Solve	Evaluate and verify	Communicate	Grade
The student work has the following characteristics:				
• documentation of appropriate assumptions • accurate documentation of relevant observations • accurate translation of all simple and complex aspects of the problem by identifying mathematical concepts and techniques.	• accurate use of complex procedures to reach a valid solution • discerning application of simple and complex mathematical concepts and techniques relevant to the task • accurate and appropriate use of technology.	• evaluation of the reasonableness of solutions by considering the results, assumptions and observations • documentation of relevant strengths and limitations of the solution and/or model • justification of decisions made using mathematical reasoning.	• correct use of appropriate technical vocabulary, procedural vocabulary and conventions to develop the response. • coherent and concise organisation of the response, appropriate to the genre, including a suitable introduction, body and conclusion.	**A**
• statements of appropriate assumptions • statements of relevant observations • translation of simple and complex aspects of the problem by identifying mathematical concepts and techniques.	• use of complex procedures to reach a reasonable solution • application of simple and complex mathematical concepts and techniques relevant to the task • appropriate use of technology.	• statements about the reasonableness of solutions by considering the context of the task • statements about relevant strengths and limitations of the solution and/or model • statements about decisions made relevant to the context of the task.	• use of technical vocabulary, procedural vocabulary and conventions to develop the response • organisation of the response, including a suitable introduction, body and conclusion.	**B**
• statement of assumptions • statement of observations • translation of simple aspects of the problem by identifying mathematical concepts and techniques.	• use of simple procedures to make some progress towards a solution • application of simple mathematical concepts and techniques relevant to the task • use of technology.	• statement about the reasonableness of solutions • statement about strengths and/or limitations of the solution and/or model • statement about decisions made.	• use of some appropriate language and conventions to develop the response • adequate organisation of the response.	**C**
• statement of an assumption or an observation • translation of some simple aspects of the problem by identifying mathematical concepts and techniques.	• application of some simple procedures, mathematical concepts or techniques • superficial use of technology.	• statement about a decision and/or the reasonableness of a solution.	• use of everyday language to develop a response • basic organisation of the response.	**D**
• statement of an assumption, observation or translation of an aspect of the problem.	• inappropriate use of technology or procedures.	• inappropriate statement about a decision or the reasonableness of a solution.	• unclear and disjointed organisation of the response.	**E**

4.7.2 Summative internal assessment 2: Common internal assessment

Description

This assessment is developed by the QCAA and marked internally by the school.

The common internal assessment (CIA) in Essential Mathematics is common to all schools and administered under controlled conditions, appropriate to the context of the school.

The CIA assists in strengthening reliability and validity in Essential Mathematics. The CIA models best assessment practice, which teachers can apply to other internal assessments, including the:

- application of assessment standards
- depth of treatment of subject matter.

Schools are able to deliver this assessment with some flexibility in Unit 3 once it has been provided by the QCAA.

Assessment objectives

This assessment technique is used to determine student achievement in the following objectives:

1. select, recall and use facts, rules, definitions and procedures drawn from all Unit 3 Topics
2. comprehend mathematical concepts and techniques drawn from all Unit 3 Topics
3. communicate using mathematical, statistical and everyday language and conventions
4. evaluate the reasonableness of solutions
5. justify procedures and decisions by explaining mathematical reasoning
6. solve problems by applying mathematical concepts and techniques drawn from all Unit 3 Topics.

Specifications

Description

The CIA for Essential Mathematics will representatively sample subject matter from all topics in Unit 3 only.

The CIA has two parts: simple (Part A) and complex (Part B). It assesses the application of a range of cognitions to a number of items drawn from all Unit 3 Topics. Student responses must be completed individually, under supervised conditions, and in a set timeframe.

Conditions

- Time: 60 minutes plus 5 minutes perusal
  - Part A: simple
    - short response
  - Part B: complex
    - short response.
- Length: the number of short-response items should allow students to complete the responses in the set time.
- Short-response format, consisting of a number of items that ask students to respond to the following activities:
  - calculating using algorithms
  - drawing, labelling or interpreting graphs, tables or diagrams
  - short items requiring single-word, term, sentence or short paragraph responses
  - justifying solutions using appropriate mathematical language where applicable
  - responding to seen or unseen stimulus materials
  - interpreting ideas and information.
- Other:
  - only the QCAA formula sheet must be provided
  - notes are not permitted.
  - use of technology is required; schools must specify the technology used, e.g. scientific calculator, graphics calculator, spreadsheet program and/or other mathematical software.

Instrument-specific standards

No instrument-specific standards are provided for this assessment.

A marking guide will be provided with the CIA. Once the CIA has been administered, student responses are internally marked by the teacher/s using this guide.

5 Unit 4: Graphs, chance and loans

5.1 Unit description

In Unit 4, students will develop the mathematical understanding and skills to solve problems relating to:

- Fundamental topic: Calculations
- Topic 1: Bivariate graphs
- Topic 2: Probability and relative frequencies
- Topic 3: Loans and compound interest.

The subject matter of the topics in this unit should be applied in a context that is meaningful and of interest to students. Two possible contexts that may be used in this unit are 'Mathematics of health' and 'Mathematics of home loans'. However, these contexts may not be relevant to all students. Suitable contexts relevant to the particular student cohort should be chosen.

Unit requirements

Subject matter describes the concepts, ideas, knowledge, understanding and skills that students are to learn in Unit 4. It is organised in topics and sub-topics. Notional time allocations have been provided for each sub-topic.

5.2 Unit objectives

Unit objectives are drawn from the syllabus objectives and are contextualised for the subject matter and requirements of the unit. Each unit objective is assessed at least once. The objectives will be evident in the instrument-specific standards.

Students will:

Unit objective	IA3	IA4
1. select, recall and use facts, rules, definitions and procedures drawn from all Unit 4 topics	•	•
2. comprehend mathematical concepts and techniques drawn from all Unit 4 topics	•	•
3. communicate using mathematical, statistical and everyday language and conventions	•	•
4. evaluate the reasonableness of solutions	•	•
5. justify procedures and decisions by explaining mathematical reasoning	•	•
6. solve problems by applying mathematical concepts and techniques drawn from all Unit 4 topics.	•	•

5.3 Fundamental topic: Calculations

Calculations should be integrated throughout Unit 4.

Subject matter
Calculations In this sub-topic, students will: • solve practical problems requiring basic number operations • apply arithmetic operations according to their correct order • ascertain the reasonableness of answers to arithmetic calculations • use leading-digit approximation to obtain estimates of calculations • use a calculator for multi-step calculations • check results of calculations for accuracy • recognise the significance of place value after the decimal point • evaluate decimal fractions to the required number of decimal places • round up or round down numbers to the required number of decimal places • apply approximation strategies for calculations.

5.4 Topic 1: Bivariate graphs

Subject matter
Cartesian plane (6 hours) In this sub-topic, students will: • demonstrate familiarity with Cartesian coordinates in two dimensions by plotting points on the Cartesian plane • generate tables of values for linear functions, including for negative values of x • graph linear functions for all values of x with pencil and paper and with graphing software.
Bivariate scatterplots (4 hours) In this sub-topic, students will: • describe the patterns and features of bivariate data • describe the association between two numerical variables in terms of direction (positive/negative), form (linear/non-linear) and strength (strong/moderate/weak).
Line of best fit (10 hours) In this sub-topic, students will: • identify the dependent and independent variable • find the line of best fit by eye • use technology to find the line of best fit [complex] • interpret relationships in terms of the variables [complex] • use technology to find the correlation coefficient (an indicator of the strength of linear association) [complex] • use the line of best fit to make predictions, both by interpolation and extrapolation [complex] • recognise the dangers of extrapolation [complex] • distinguish between causality and correlation through examples [complex].

5.5 Topic 2: Probability and relative frequencies

Subject matter
Simulations (9 hours) In this sub-topic, students will: • perform simulations of probability experiments using technology • recognise that the repetition of chance events is likely to produce different results • identify relative frequency as probability • identify factors that could complicate the simulation of real-world events [complex].
Simple probabilities (6 hours) In this sub-topic, students will: • construct a sample space for an experiment • use a sample space to determine the probability of outcomes for an experiment • use arrays or tree diagrams to determine the outcomes and the probabilities for experiments.

5.6 Topic 3: Loans and compound interest

Subject matter
Compound interest (12 hours) In this sub-topic, students will: • review the principles of simple interest through substitution of given values for other pronumerals into a mathematical formula to find the value of the subject of the formula • understand the concept of compound interest as a recurrence relation • consider similar problems involving compounding [complex] • use technology (online calculator) to calculate the future value of a compound interest loan or investment and the total interest paid or earned • use technology (spreadsheet) to calculate the future value of a compound interest loan or investment and the total interest paid or earned [complex] • use technology (online calculator) to compare, numerically and graphically, the growth of simple interest and compound interest loans and investments • use technology (spreadsheet) to compare, numerically and graphically, the growth of simple interest and compound interest loans and investments [complex] • use technology (online calculator) to investigate the effect of the interest rate and the number of compounding periods on the future value of a loan or investment • use technology (spreadsheet) to investigate the effect of the interest rate and the number of compounding periods on the future value of a loan or investment [complex].
Reducing balance loans (8 hours) In this sub-topic, students will: • understand that reducing balance loans are compound interest loans with periodic repayments • use technology (online calculator) to model a reducing balance loan • use technology (spreadsheet) to model a reducing balance loan [complex] • use technology (online calculator) to investigate the effect of the interest rate and repayment amount on the time taken to repay a loan • use technology (spreadsheet) to investigate the effect of the interest rate and repayment amount on the time taken to repay a loan [complex].

5.7 Assessment

5.7.1 Summative internal assessment 3: Problem-solving and modelling task

Description

This assessment focuses on the interpretation, analysis and evaluation of ideas and information. It is an independent task responding to a particular situation or stimuli. While students may undertake some research in the writing of the problem-solving and modelling task, it is not the focus of this technique. This assessment occurs over an extended and defined period of time. Students will use class time and their own time to develop a response.

The problem-solving and modelling task must use subject matter from Fundamental topic: Calculations and at least one of the following topics in Unit 4:

- Topic 1: Bivariate graphs
- Topic 2: Probability and relative frequencies
- Topic 3: Loans and compound interest.

Assessment objectives

This assessment technique is used to determine student achievement in the following objectives:

1. select, recall and use facts, rules, definitions and procedures drawn from Fundamental topic: Calculations and Unit 4 Topic 1, 2 and/or 3
2. comprehend mathematical concepts and techniques drawn from Fundamental topic: Calculations and Unit 4 Topic 1, 2 and/or 3
3. communicate using mathematical, statistical and everyday language and conventions
4. evaluate the reasonableness of solutions
5. justify procedures and decisions by explaining mathematical reasoning
6. solve problems by applying mathematical concepts and techniques drawn from Fundamental topic: Calculations and Unit 4 Topic 1, 2 and/or 3.

Specifications

Description

A problem-solving and modelling task is an assessment instrument developed in response to a mathematical investigative scenario or context. It requires students to respond with a range of understanding and skills, such as using mathematical language, appropriate calculations, tables of data, graphs and diagrams.

Students must provide a response to a specific task or issue that must be set in a context that highlights a real-life application of mathematics. The task requires students to use relevant stimulus material involving the selected subject matter and must have sufficient scope to allow students to address all the stages of the problem-solving and modelling approach (see Section 1.2.4). Technology must be used.

Conditions

- Written:

  - up to 8 pages (including tables, figures and diagrams)
  - maximum of 1000 words
  - appendixes can include raw data, repeated calculations, evidence of authentication and student notes (appendixes are not to be marked).
- Duration: 5 weeks (including 10 hours of class time).
- Other:
  - opportunity may be provided for group work, but unique responses must be developed by each student
  - use of technology is required; schools must specify the technology used, e.g. graphics calculator, spreadsheet program, scientific calculator
  - the teacher provides the mathematical investigative scenario or context for the problem-solving and modelling task.

Task examples

Examples of problem-solving and modelling tasks include:

- a report using scatterplots to make predictions about a long-term trend in running world records such as the 100 m, 200 m, 400 m and 1500 m; use provided data about the men's 1500 m freestyle world records since 1980 and predict the approximate year when someone will swim it in under 14 minutes.
- a brochure that analyses different mobile phone rates used by students across different year levels and explores future costings/break-even points; compare and contrast buying the same model of mobile phone on contract vs. outright and prepaid.
- the creation of a game that involves chance and choice and presentation of your findings to a prospective investor in a report, justifying your mathematical and statistical calculations, strategies and decisions.
- a written persuasive argument of your proposed plan and budget to your parents/caregivers for going on a 'schoolies' trip or purchasing a car by either borrowing with a bank loan, a payday loan or saving money from a part-time job worked since the end of Year 10, ensuring that concepts of compound interest and/or reducing balance loans are investigated, and compare the overall savings.

Summary of the instrument-specific standards

The following table summarises the criteria and assessment objectives for the problem-solving and modelling task.

Criterion	Objectives
Formulate	1, 2 and 5
Solve	1 and 6
Evaluate and verify	4 and 5
Communicate	3

Instrument-specific standards — IA3

Formulate	Solve	Evaluate and verify	Communicate	Grade
The student work has the following characteristics:				
• documentation of appropriate assumptions • accurate documentation of relevant observations • accurate translation of all simple and complex aspects of the problem by identifying mathematical concepts and techniques.	• accurate use of complex procedures to reach a valid solution • discerning application of simple and complex mathematical concepts and techniques relevant to the task • accurate and appropriate use of technology.	• evaluation of the reasonableness of solutions by considering the results, assumptions and observations • documentation of relevant strengths and limitations of the solution and/or model • justification of decisions made using mathematical reasoning.	• correct use of appropriate technical vocabulary, procedural vocabulary and conventions to develop the response • coherent and concise organisation of the response, appropriate to the genre, including a suitable introduction, body and conclusion.	**A**
• statements of appropriate assumptions • statements of relevant observations • translation of simple and complex aspects of the problem by identifying mathematical concepts and techniques.	• use of complex procedures to reach a reasonable solution • application of simple and complex mathematical concepts and techniques relevant to the task • appropriate use of technology.	• statements about the reasonableness of solutions by considering the context of the task • statements about relevant strengths and limitations of the solution and/or model • statements about decisions made relevant to the context of the task.	• use of technical vocabulary, procedural vocabulary and conventions to develop the response • organisation of the response, including a suitable introduction, body and conclusion.	**B**
• statement of assumptions • statement of observations • translation of simple aspects of the problem by identifying mathematical concepts and techniques.	• use of simple procedures to make some progress towards a solution • application of simple mathematical concepts and techniques relevant to the task • use of technology.	• statement about the reasonableness of solutions • statement about strengths and/or limitations of the solution and/or model • statement about decisions made.	• use of some appropriate language and conventions to develop the response • adequate organisation of the response.	**C**
• statement of an assumption or an observation • translation of some simple aspects of the problem by identifying mathematical concepts and techniques.	• application of some simple procedures, mathematical concepts or techniques • superficial use of technology.	• statement about a decision and/or the reasonableness of a solution.	• use of everyday language to develop a response • basic organisation of the response.	**D**
• statement of an assumption, observation or translation of an aspect of the problem.	• inappropriate use of technology or procedures.	• inappropriate statement about a decision or the reasonableness of a solution.	• unclear and disjointed organisation of the response.	**E**

5.7.2 Summative internal assessment 4: Examination

Description

This assessment is a supervised examination in two parts: simple (Part A) and complex (Part B). This examination assesses the application of a range of cognitions to a number of items, drawn from all Unit 4 topics. Student responses must be completed individually, under supervised conditions and in a set timeframe.

Assessment objectives

This assessment technique is used to determine student achievement in the following objectives:

1. select, recall and use facts, rules, definitions and procedures drawn from all Unit 4 topics
2. comprehend mathematical concepts and techniques drawn from all Unit 4 topics
3. communicate using mathematical, statistical and everyday language and conventions
4. evaluate the reasonableness of solutions
5. justify procedures and decisions by explaining mathematical reasoning
6. solve problems by applying mathematical concepts and techniques drawn from all Unit 4 topics.

Specifications

Description

The examination will representatively sample subject matter from all Unit 4 topics. Where relevant, the focus of this assessment should be on subject matter not assessed in the problem-solving and modelling task.

The examination must ensure that all assessment objectives are assessed. The examination should be designed using the principles of developing mathematics problems in Section 1.2.4. The total number of marks used in an examination marking scheme is a school decision. However, in order to correctly apply the instrument-specific standards, the percentage allocation of marks must match the specifications below.

Mark allocations

Percentage of marks	Degree of difficulty
Part B ~10%	**Complex unfamiliar** Problems of this degree of difficulty require students to demonstrate knowledge and understanding of the subject matter and application of skills in a situation where: • knowledge of [complex] subject matter is required to solve the problem; and • all the information to solve the problem is not immediately identifiable, that is – the required procedure is not clear from the way the problem is posed; and – in a context in which students have had limited prior experience. Students interpret, clarify and analyse problems to develop responses. Typically, these problems focus on objectives 4, 5 and 6.
Part B ~10%	**Complex familiar** Problems of this degree of difficulty require students to demonstrate knowledge and understanding of the subject matter and application of skills in a situation where: • knowledge of [complex] subject matter is required to solve the problem; and • all of the information to solve the problem is identifiable, that is – the required procedure is clear from the way the problem is posed, *or* – in a context that has been a focus of prior learning. Some interpretation, clarification and analysis will be required to develop responses. These problems can focus on any of the objectives.
Part A ~80%	**Simple familiar** Problems of this degree of difficulty require students to demonstrate knowledge and understanding of the subject matter and application of skills in a situation where: • knowledge of simple subject matter is required to solve the problem; and • all of the information to solve the problem is identifiable, that is – the required procedure is clear from the way the problem is posed, *or* – is in a context that has been a focus of prior learning. Students are *not* required to interpret, clarify and analyse problems to develop responses. Typically, these problems focus on objectives 1, 2 and 3.

Conditions

- Time: 60 minutes plus 5 minutes perusal
  - Part A: simple
    - short response
  - Part B: complex
    - short response.
- Length: the number of short-response items should allow students to complete the responses in the set time.
- Short response format, consisting of a number of items that ask students to respond to the following activities:
  - calculating using algorithms
  - drawing, labelling or interpreting graphs, tables or diagrams
  - short items requiring single-word, term, sentence or short paragraph responses

  - justifying solutions using appropriate mathematical language where applicable
  - responding to seen or unseen stimulus materials
  - interpreting ideas and information.
- Other:
  - seen stimulus — teachers must ensure the purpose of the technique is not compromised
  - unseen stimulus — materials or questions must not be copied from information or texts that students have previously been exposed to or have directly used in class
  - when stimulus materials are used, they will be succinct enough to allow students sufficient time to engage with them; for stimulus materials that are lengthy, complex or large in number, they will be shared with students prior to the administration of the assessment instrument
  - only the QCAA formula sheet must be provided
  - notes are not permitted
  - use of technology is required; schools must specify the technology used, e.g. scientific calculator, graphics calculator, spreadsheet program and/or other mathematical software.

Summary of the instrument-specific standards

The following table summarises the criteria and assessment objectives for the examination.

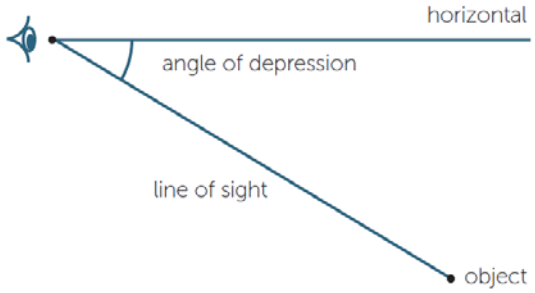
Criterion	Objectives
Foundational knowledge and problem-solving	1, 2, 3, 4, 5 and 6

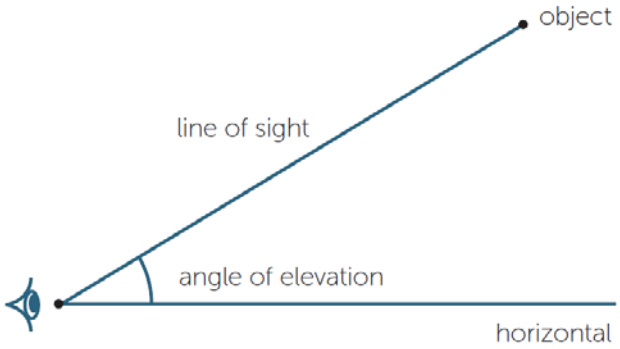
Instrument-specific standards — IA4

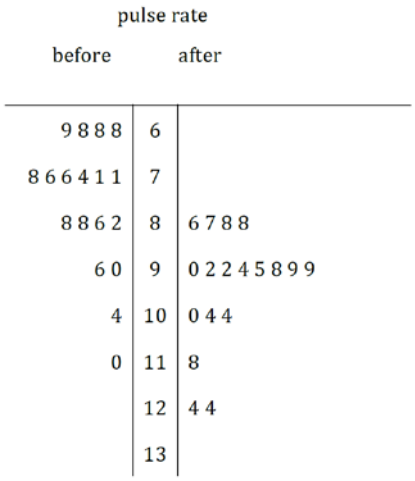
Foundational knowledge and problem-solving	Cut-off	Grade
The student work has the following characteristics:		
• comprehensive selection, recall and use of simple and complex facts, rules, definitions and procedures; comprehension and clear communication of simple and complex mathematical concepts and techniques; evaluation of the reasonableness of solutions and use of mathematical reasoning to justify procedures and decisions; and proficient application of simple and complex mathematical concepts and techniques to solve problems.	> 80%	**A**
• selection, recall and use of simple and some complex facts, rules, definitions and procedures; comprehension and communication of simple and some complex mathematical concepts and techniques; evaluation of the reasonableness of some solutions using mathematical reasoning; and application of simple and some complex mathematical concepts and techniques to solve problems.	> 60%	**B**
• selection, recall and use of simple facts, rules, definitions and procedures; comprehension and communication of simple mathematical concepts and techniques; discussion of the reasonableness of solutions using mathematical reasoning; and application of simple mathematical concepts and techniques to solve problems.	> 40%	**C***
• some selection, recall and use of facts, rules, definitions and procedures; basic comprehension and communication of mathematical concepts and techniques; some discussion of the reasonableness of solutions; and inconsistent application of mathematical concepts and techniques.	> 20%	**D**
• isolated and inaccurate selection, recall and use of facts, rules, definitions and procedures; disjointed and unclear communication of mathematical concepts and techniques; superficial discussion of the reasonableness of solutions.	≥ 0%	**E**

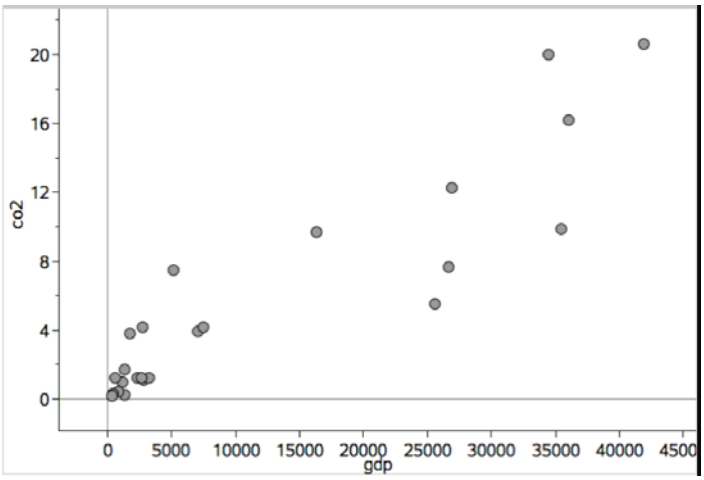
* Equivalent to > 50% for Part A simple questions only

6 Glossary

Term	Explanation
A	
accomplished	highly trained or skilled in a particular activity; perfected in knowledge or training; expert
accuracy	the condition or quality of being true, correct or exact; freedom from error or defect; precision or exactness; correctness; in science, the extent to which a measurement result represents the quantity it purports to measure; an accurate measurement result includes an estimate of the true value and an estimate of the uncertainty
accurate	precise and exact; to the point; consistent with or exactly conforming to a truth, standard, rule, model, convention or known fact; free from error or defect; meticulous; correct in all details
adept	very/highly skilled or proficient at something; expert
adequate	satisfactory or acceptable in quality or quantity equal to the requirement or occasion
algorithm	a precisely defined procedure that can be applied and systematically followed through to a conclusion
analyse	dissect to ascertain and examine constituent parts and/or their relationships; break down or examine in order to identify the essential elements, features, components or structure; determine the logic and reasonableness of information; examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences
angle of depression	when an observer looks at an object that is lower than 'the eye of the observer', the angle between the line of sight and the horizontal is called the angle of depression 

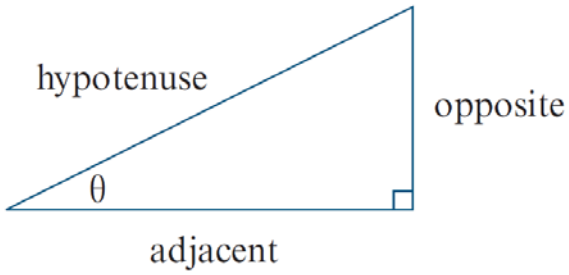
Term	Explanation
angle of elevation	when an observer looks at an object that is higher than 'the eye of the observer', the angle between the line of sight and the horizontal is called the angle of elevation 
applied learning	the acquisition and application of knowledge, understanding and skills in real-world or lifelike contexts that may encompass workplace, industry and community situations; it emphasises learning through doing and includes both theory and the application of theory, connecting subject knowledge and understanding with the development of practical skills
Applied subject	a subject whose primary pathway is work and vocational education; it emphasises applied learning and community connections; a subject for which a syllabus has been developed by the QCAA with the following characteristics: results from courses developed from Applied syllabuses contribute to the QCE; results may contribute to ATAR calculations
apply	use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation
appraise	evaluate the worth, significance or status of something; judge or consider a text or piece of work
appreciate	recognise or make a judgment about the value or worth of something; understand fully; grasp the full implications of
appropriate	acceptable; suitable or fitting for a particular purpose, circumstance, context, etc.
apt	suitable to the purpose or occasion; fitting, appropriate
area of study	a division of or a section within a unit
argue	give reasons for or against something; challenge or debate an issue or idea; persuade, prove or try to prove by giving reasons
array	an ordered collection of objects or numbers
aspect	a particular part of a feature of something; a facet, phase or part of a whole
assess	measure, determine, evaluate, estimate or make a judgment about the value, quality, outcomes, results, size, significance, nature or extent of something
assessment	purposeful and systematic collection of information about students' achievements
assessment instrument	a tool or device used to gather information about student achievement

Term	Explanation
assessment objectives	drawn from the unit objectives and contextualised for the requirements of the assessment instrument (see also 'syllabus objectives', 'unit objectives')
assessment technique	the method used to gather evidence about student achievement, e.g. examination, project, investigation
assumptions	conditions that are stated to be true when beginning to solve a problem
astute	showing an ability to accurately assess situations or people; of keen discernment
ATAR	Australian Tertiary Admission Rank
authoritative	able to be trusted as being accurate or true; reliable; commanding and self-confident; likely to be respected and obeyed
average speed	the total distance travelled divided by the total time taken
B	
back-to-back stem plot	a method for comparing two data distributions by attaching two sets of 'leaves' to the same 'stem' in a stem-and-leaf plot; for example, the stem-and-leaf plot below displays the distribution of pulse rates of 18 students before and after gentle exercise 
balanced	keeping or showing a balance; not biased; fairly judged or presented; taking everything into account in a fair, well-judged way
basic	fundamental
bimodality	a dataset is bimodal if it has two modes; this means that there is not a single data value that occurs with the highest frequency, but two data values have the same and highest frequency

Term	Explanation
bivariate scatterplot	a two-dimensional data plot using Cartesian coordinates to display the values of two variables in a bivariate dataset; for example, the scatterplot below displays the CO_2 emissions in tonnes per person (CO_2) plotted against Gross Domestic Product per person in $US (GDP) for a sample of 24 countries in 2004; in constructing this scatterplot, GDP has been used as the explanatory variable 
C	
calculate	determine or find (e.g. a number, answer) by using mathematical processes; obtain a numerical answer showing the relevant stages in the working; ascertain/determine from given facts, figures or information
calorie (Cal)	a measure of energy related to food and exercise; one calorie is equivalent to 4.184 kilojoules; the energy required to increase the temperature of 1 kg of water by 1 °C
capacity	the quantity of fluid a container can hold
Cartesian plane	two intersecting number lines are taken intersecting at right angles at their origins to form the axes of the coordinate system; the plane is divided into four quadrants by these perpendicular axes, called the x-axis (horizontal line) and the y-axis (vertical line); the position of any point in the plane can be represented by an ordered pair of numbers (x, y); these ordered pairs are called the coordinates of the point; this is called the Cartesian coordinate system; the plane is called the Cartesian plane
categorical data	data associated with a categorical variable
categorise	place in or assign to a particular class or group; arrange or order by classes or categories; classify, sort out, sort, separate
census	an attempt to collect information about the whole population; a population is the complete set of individuals, objects, places etc. that we want information about
challenging	difficult but interesting; testing one's abilities; demanding and thought-provoking; usually involving unfamiliar or less familiar elements
characteristic	a typical feature or quality

Term	Explanation
clarify	make clear or intelligible; explain; make a statement or situation less confused and more comprehensible
clarity	clearness of thought or expression; the quality of being coherent and intelligible; free from obscurity of sense; without ambiguity; explicit; easy to perceive, understand or interpret
classify	arrange, distribute or order in classes or categories according to shared qualities or characteristics
clear	free from confusion, uncertainty, or doubt; easily seen, heard or understood
clearly	in a clear manner; plainly and openly, without ambiguity
coherent	having a natural or due agreement of parts; connected; consistent; logical, orderly; well-structured and makes sense; rational, with parts that are harmonious; having an internally consistent relation of parts
cohesive	characterised by being united, bound together or having integrated meaning; forming a united whole
comment	express an opinion, observation or reaction in speech or writing; give a judgment based on a given statement or result of a calculation
communicate	convey knowledge and/or understandings to others; make known; transmit
compare	display recognition of similarities and differences and recognise the significance of these similarities and differences
competent	having suitable or sufficient skills, knowledge, experience, etc. for some purpose; adequate but not exceptional; capable; suitable or sufficient for the purpose; having the necessary ability, knowledge or skill to do something successfully; efficient and capable (of a person); acceptable and satisfactory, though not outstanding
competently	in an efficient and capable way; in an acceptable and satisfactory, though not outstanding, way
complex	composed or consisting of many different and interconnected parts or factors; compound; composite; characterised by an involved combination of parts; complicated; intricate; a complex whole or system; a complicated assembly of particulars
complex familiar	problems of this degree of difficulty require students to demonstrate knowledge and understanding of the subject matter and application of skills in a situation where: • knowledge of [complex] subject matter is required to solve the problem; and • all of the information to solve the problem is identifiable, that is – the required procedure is clear from the way the problem is posed, *or* – in a context that has been a focus of prior learning. Some interpretation, clarification and analysis will be required to develop responses. These problems can focus on any of the objectives.

Term	Explanation
complex unfamiliar	problems of this degree of difficulty require students to demonstrate knowledge and understanding of the subject matter and application of skills in a situation where: • knowledge of [complex] subject matter is required to solve the problem; and • all the information to solve the problem is not immediately identifiable, that is – the required procedure is not clear from the way the problem is posed; and – in a context in which students have had limited prior experience. Students interpret, clarify and analyse problems to develop responses. Typically, these problems focus on objectives 4, 5 and 6.
compound interest	the interest earned by investing a sum of money (the principal) is compound interest if each successive interest payment is added to the principal for the purpose of calculating the next interest payment; for example, if the principal P earns compound interest at the rate of $i\%$ per period, then after n periods the total amount accrued is: $$A = P\left(1 + \frac{i}{100}\right)^n$$
comprehend	understand the meaning or nature of; grasp mentally
comprehensive	inclusive; of large content or scope; including or dealing with all or nearly all elements or aspects of something; wide-ranging; detailed and thorough, including all that is relevant
concise	expressing much in few words; giving a lot of information clearly and in a few words; brief, comprehensive and to the point; succinct, clear, without repetition of information
concisely	in a way that is brief but comprehensive; expressing much in few words; clearly and succinctly
conclusion	final result or summing up; inference deduced from previous information; reasoned judgment
conduct	direct in action or course; manage; organise; carry out
consider	think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect on
considerable	fairly large or great; thought about deliberately and with a purpose
considered	formed after careful and deliberate thought
consistent	agreeing or accordant; compatible; not self-opposed or self-contradictory, constantly adhering to the same principles; acting in the same way over time, especially so as to be fair or accurate; unchanging in nature, standard, or effect over time; not containing any logical contradictions (of an argument); constant in achievement or effect over a period of time
construct	create or put together (e.g. an argument) by arranging ideas or items; display information in a diagrammatic or logical form; make; build

Term	Explanation
context	a framework for linking concepts and learning experiences that enables students to identify and understand the applications of mathematics to their world; a group of related situations, phenomena, technical applications and social issues likely to be encountered by students; can provide a meaningful application of concepts in real-world situations
contrast	display recognition of differences by deliberate juxtaposition of contrary elements; show how things are different or opposite; give an account of the differences between two or more items or situations, referring to both or all of them throughout
controlled	shows the exercise of restraint or direction over; held in check; restrained, managed or kept within certain bounds
convention	the generally agreed upon way in which something is done; in a mathematical context this refers to notation, symbols, abbreviations, usage and setting out
conversion	a change in the form or units of an expression
convert	change into a different form
convincing	persuaded by argument or proof; leaving no margin of doubt; clear; capable of causing someone to believe that something is true or real; persuading or assuring by argument or evidence; appearing worthy of belief; credible or plausible
correlation	a measure of the strength of the linear relationship between two variables
cosine ratio	in any right-angled triangle, $\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$ 
course	a defined amount of learning developed from a subject syllabus
create	bring something into being or existence; produce or evolve from one's own thought or imagination; reorganise or put elements together into a new pattern or structure or to form a coherent or functional whole
creative	resulting from originality of thought or expression; relating to or involving the use of the imagination or original ideas to create something; having good imagination or original ideas
credible	capable or worthy of being believed; believable; convincing
criterion	the property or characteristic by which something is judged or appraised

Term	Explanation
critical	involving skilful judgment as to truth, merit, etc.; involving the objective analysis and evaluation of an issue in order to form a judgment; expressing or involving an analysis of the merits and faults of a work of literature, music or art; incorporating a detailed and scholarly analysis and commentary (of a text); rationally appraising for logical consistency and merit
critique	review (e.g. a theory, practice, performance) in a detailed, analytical and critical way
cursory	hasty, and therefore not thorough or detailed; performed with little attention to detail; going rapidly over something, without noticing details; hasty; superficial
D	
dataset	a collection of related sets of information
decide	reach a resolution as a result of consideration; make a choice from a number of alternatives
decile	any of the nine values that divide a ranked dataset into ten equal parts
deduce	reach a conclusion that is necessarily true, provided a given set of assumptions is true; arrive at, reach or draw a logical conclusion from reasoning and the information given
defensible	justifiable by argument; capable of being defended in argument
define	give the meaning of a word, phrase, concept or physical quantity; state meaning and identify or describe qualities
demonstrate	prove or make clear by argument, reasoning or evidence, illustrating with practical example; show by example; give a practical exhibition
derive	arrive at by reasoning; manipulate a mathematical relationship to give a new equation or relationship; in mathematics, obtain the derivative of a function
describe	give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something
design	produce a plan, simulation, model or similar; plan, form or conceive in the mind; in English, select, organise and use particular elements in the process of text construction for particular purposes; these elements may be linguistic (words), visual (images), audio (sounds), gestural (body language), spatial (arrangement on the page or screen) and multimodal (a combination of more than one)
detailed	executed with great attention to the fine points; meticulous; including many of the parts or facts
determine	establish, conclude or ascertain after consideration, observation, investigation or calculation; decide or come to a resolution
develop	elaborate, expand or enlarge in detail; add detail and fullness to; cause to become more complex or intricate
devise	think out; plan; contrive; invent

Term	Explanation
differentiate	identify the difference/s in or between two or more things; distinguish, discriminate; recognise or ascertain what makes something distinct from similar things; in mathematics, obtain the derivative of a function
discerning	discriminating; showing intellectual perception; showing good judgment; making thoughtful and astute choices; selected for value or relevance
discriminate	note, observe or recognise a difference; make or constitute a distinction in or between; differentiate; note or distinguish as different
discriminating	differentiating; distinctive; perceiving differences or distinctions with nicety; possessing discrimination; perceptive and judicious; making judgments about quality; having or showing refined taste or good judgment
discuss	examine by argument; sift the considerations for and against; debate; talk or write about a topic, including a range of arguments, factors or hypotheses; consider, taking into account different issues and ideas, points for and/or against, and supporting opinions or conclusions with evidence
disjointed	disconnected; incoherent; lacking a coherent order/sequence or connection
distinguish	recognise as distinct or different; note points of difference between; discriminate; discern; make clear a difference/s between two or more concepts or items
diverse	of various kinds or forms; different from each other
document	support (e.g. an assertion, claim, statement) with evidence (e.g. decisive information, written references, citations)
domains of mathematics	a particular taxonomic classification used to group similar mathematics concepts, ideas, knowledge, understandings and skills; the scope and range of mathematics subject matter
draw conclusions	make a judgment based on reasoning and evidence
E	
effective	successful in producing the intended, desired or expected result; meeting the assigned purpose
efficient	working in a well-organised and competent way; maximum productivity with minimal expenditure of effort; acting or producing effectively with a minimum of waste, expense or unnecessary effort
element	a component or constituent part of a complex whole; a fundamental, essential or irreducible part of a composite entity
elementary	simple or uncompounded; relating to or dealing with elements, rudiments or first principles (of a subject); of the most basic kind; straightforward and uncomplicated
erroneous	based on or containing error; mistaken; incorrect
essential	absolutely necessary; indispensable; of critical importance for achieving something

Term	Explanation
evaluate	make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria
examination	a supervised test that assesses the application of a range of cognitions to one or more provided items such as questions, scenarios and/or problems; student responses are completed individually, under supervised conditions, and in a set timeframe
examine	investigate, inspect or scrutinise; inquire or search into; consider or discuss an argument or concept in a way that uncovers the assumptions and interrelationships of the issue
experiment	try out or test new ideas or methods, especially in order to discover or prove something; undertake or perform a scientific procedure to test a hypothesis, make a discovery or demonstrate a known fact
explain	make an idea or situation plain or clear by describing it in more detail or revealing relevant facts; give an account; provide additional information
explicit	clearly and distinctly expressing all that is meant; unequivocal; clearly developed or formulated; leaving nothing merely implied or suggested
explore	look into both closely and broadly; scrutinise; inquire into or discuss something in detail
express	convey, show or communicate (e.g. a thought, opinion, feeling, emotion, idea or viewpoint); in words, art, music or movement, convey or suggest a representation of; depict
extended response	an open-ended assessment technique that focuses on the interpretation, analysis, examination and/or evaluation of ideas and information in response to a particular situation or stimulus; while students may undertake some research when writing of the extended response, it is not the focus of this technique; an extended response occurs over an extended and defined period of time
Extension subject	a two-unit subject (Units 3 and 4), for which a syllabus has been developed by the QCAA, that is an extension of one or more General subject/s, studied concurrently with, or after completion of, Units 3 and 4 of that subject
extensive	of great extent; wide; broad; far-reaching; comprehensive; lengthy; detailed; large in amount or scale
external assessment	summative assessment that occurs towards the end of a course of study and is common to all schools; developed and marked by the QCAA according to a commonly applied marking scheme
external examination	a supervised test, developed and marked by the QCAA, that assesses the application of a range of cognitions to multiple provided items such as questions, scenarios and/or problems; student responses are completed individually, under supervised conditions, and in a set timeframe
extrapolate	infer or estimate by extending or projecting known information; conjecture; infer from what is known; extend the application of something (e.g. a method or conclusion) to an unknown situation by assuming that existing trends will continue or similar methods will be applicable

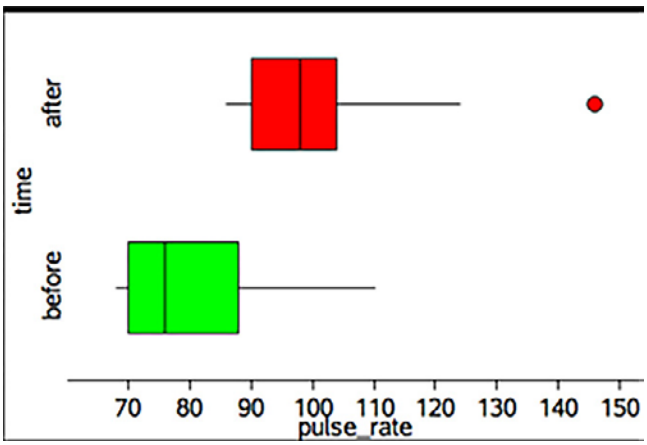
Term	Explanation
extrapolation	in the context of fitting a linear relationship between two variables, extrapolation occurs when the fitted model is used to make predictions using values of the explanatory variable that are outside the range of the original data; extrapolation is a dangerous process as it can sometimes lead to quite erroneous predictions
F	
factual	relating to or based on facts; concerned with what is actually the case; actually occurring; having verified existence
familiar	well-acquainted; thoroughly conversant with; well known from long or close association; often encountered or experienced; common; of materials, texts, skills or circumstances, having been the focus of learning experiences or previously encountered in prior learning activities
feasible	capable of being achieved, accomplished or put into effect; reasonable enough to be believed or accepted; probable; likely
five-number summary	a method of summarising a set of data using the minimum value, the lower or first quartile (Q_1), the median (Q_2), the upper or third quartile (Q_3) and the maximum value; forms the basis for a box plot
fluent	spoken or written with ease; able to speak or write smoothly, easily or readily; articulate; eloquent; in artistic performance, characteristic of a highly developed and excellently controlled technique; flowing; polished; flowing smoothly, easily and effortlessly
fluently	in a graceful and seemingly effortless manner; in a way that progresses smoothly and readily
formative assessment	assessment whose major purpose is to improve teaching and student achievement
formula	a special type of equation that shows the relationship between different variables; for example, the formula for the volume of a rectangular box is $V = l \times w \times h$, 'V' is called the subject of the formula
fragmented	disorganised; broken down; disjointed or isolated
frequent	happening or occurring often at short intervals; constant, habitual or regular
fundamental	forming a necessary base or core; of central importance; affecting or relating to the essential nature of something; part of a foundation or basis
G	
General subject	a subject for which a syllabus has been developed by the QCAA with the following characteristics: results from courses developed from General syllabuses contribute to the QCE; General subjects have an external assessment component; results may contribute to ATAR calculations
generate	produce; create; bring into existence
GST	the GST (Goods and Services Tax) is a broad sales tax of 10% on most goods and services transactions in Australia

Term	Explanation
H	
hypothesise	formulate a supposition to account for known facts or observed occurrences; conjecture, theorise, speculate; especially on uncertain or tentative grounds
I	
identify	distinguish; locate, recognise and name; establish or indicate who or what someone or something is; provide an answer from a number of possibilities; recognise and state a distinguishing factor or feature
illogical	lacking sense or sound reasoning; contrary to or disregardful of the rules of logic; unreasonable
implement	put something into effect, e.g. a plan or proposal
implicit	implied, rather than expressly stated; not plainly expressed; capable of being inferred from something else
improbable	not probable; unlikely to be true or to happen; not easy to believe
inaccurate	not accurate
inappropriate	not suitable or proper in the circumstances
inconsistent	lacking agreement, as one thing with another, or two or more things in relation to each other; at variance; not consistent; not in keeping; not in accordance; incompatible, incongruous
independent	thinking or acting for oneself, not influenced by others
in-depth	comprehensive and with thorough coverage; extensive or profound; well-balanced or fully developed
infer	derive or conclude something from evidence and reasoning, rather than from explicit statements; listen or read beyond what has been literally expressed; imply or hint at
informed	knowledgeable; learned; having relevant knowledge; being conversant with the topic; based on an understanding of the facts of the situation (of a decision or judgment)
infrequent	happening or occurring at long intervals or not often
innovative	new and original; introducing new ideas; original and creative in thinking
insightful	showing understanding of a situation or process; understanding relationships in complex situations; informed by observation and deduction
instrument-specific standards	a tool for marking that describes the characteristics evident in student responses and aligns with the identified objectives for the assessment (see 'assessment objectives')
integral	*adjective* necessary for the completeness of the whole; essential or fundamental; *noun* in mathematics, the result of integration; an expression from which a given function, equation, or system of equations is derived by differentiation

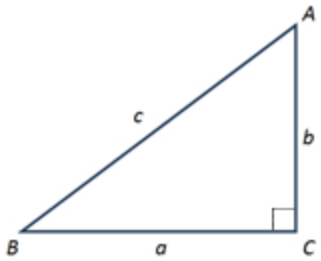
Term	Explanation
intended	designed; meant; done on purpose; intentional
internal assessment	assessments that are developed by schools; summative internal assessments are endorsed by the QCAA before use in schools and results externally confirmed contribute towards a student's final result
interpret	use knowledge and understanding to recognise trends and draw conclusions from given information; make clear or explicit; elucidate or understand in a particular way; bring out the meaning of, e.g. a dramatic or musical work, by performance or execution; bring out the meaning of an artwork by artistic representation or performance; give one's own interpretation of; identify or draw meaning from, or give meaning to, information presented in various forms, such as words, symbols, pictures or graphs
interquartile range	a measure of the spread within a numerical dataset; it is equal to the upper quartile (Q_3) minus the lower quartile (Q_1), that is, $IQR = Q_3 - Q_1$ • Q_1 is the median of the lower half of the data (excluding the median, Q_2, of the dataset) • Q_3 is the median of the upper half of the data (excluding the median, Q_2, of the dataset) hence IQR is the width of an interval that contains the middle 50% (approximately) of the data values; to be exactly 50%, the sample size must be a multiple of four
investigate	carry out an examination or formal inquiry in order to establish or obtain facts and reach new conclusions; search, inquire into, interpret and draw conclusions about data and information
investigation	an assessment technique that requires students to research a specific problem, question, issue, design challenge or hypothesis through the collection, analysis and synthesis of primary and/or secondary data; it uses research or investigative practices to assess a range of cognitions in a particular context; an investigation occurs over an extended and defined period of time
irregular solids	without symmetry, even shape or formal arrangement
irrelevant	not relevant; not applicable or pertinent; not connected with or relevant to something
ISMG	instrument-specific marking guide; a tool for marking that describes the characteristics evident in student responses and aligns with the identified objectives for the assessment (see 'assessment objectives')
isolated	detached, separate, or unconnected with other things; one-off; something set apart or characterised as different in some way
J	
judge	form an opinion or conclusion about; apply both procedural and deliberative operations to make a determination
justified	sound reasons or evidence are provided to support an argument, statement or conclusion

Term	Explanation
justify	give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable
K	
kilojoules (kJ)	a measure of energy related to food or exercise; equivalent to 1000 joules and 0.2390 calories
kilowatt hour (kWh)	the kilowatt hour, or kilowatt-hour, is a unit of energy equal to 1000 watt hours or 3.6 megajoules; the kilowatt hour is most commonly known as a billing unit for energy delivered to consumers by electric utilities
L	
leading-digit approximation	the leading digit is the first digit in the number; consider the second digit; if it is less than 5, leave the first digit unchanged and replace all other digits with zeros, but if the second digit is 5 or greater, increase the leading digit by one and replace all other digits with zeros; complete the operation to provide an estimate of the solution
learning area	a grouping of subjects, with related characteristics, within a broad field of learning, e.g. the Arts, sciences, languages
logical	rational and valid; internally consistent; reasonable; reasoning in accordance with the principles/rules of logic or formal argument; characterised by or capable of clear, sound reasoning; (of an action, decision, etc.) expected or sensible under the circumstances
logically	according to the rules of logic or formal argument; in a way that shows clear, sound reasoning; in a way that is expected or sensible
M	
make decisions	select from available options; weigh up positives and negatives of each option and consider all the alternatives to arrive at a position
manipulate	adapt or change to suit one's purpose
mass	a body of coherent matter, usually of indefinite shape and often of considerable size
mathematical model	a depiction of a situation that expresses relationships using mathematical concepts and language, usually as an algebraic, diagrammatic, graphical or tabular representation
mathematical modelling	involves: • formulating a mathematical representation of a problem derived from within a real-world context • using mathematics concepts and techniques to obtain results • interpreting the results by referring back to the original problem context • revising the model (where necessary)
mean	the mean of a list of numbers is the sum of the data values divided by the number of values in the list; in everyday language, the mean is commonly called the average; for example, for the following list of five numbers: 2, 3, 3, 6, 8, the mean equals $\frac{2+3+3+6+8}{5} = \frac{22}{5} = 4.4$

Term	Explanation
median	the value in a set of ordered set of data values that divides the data into two parts of equal size; when there are an odd number of data values, the median is the middle value; when there are an even number of data values, the median is the average of the two central values
mental procedures	a domain of knowledge in Marzano's taxonomy, and acted upon by the cognitive, metacognitive and self-systems; sometimes referred to as 'procedural knowledge' there are three distinct phases to the acquisition of mental procedures — the cognitive stage, the associative stage, and the autonomous stage; the two categories of mental procedures are skills (single rules, algorithms and tactics) and processes (macroprocedures)
methodical	performed, disposed or acting in a systematic way; orderly; characterised by method or order; performed or carried out systematically
minimal	least possible; small; the least amount; negligible
misleading graph	a graph drawn to give a false impression, for example, only showing part of the vertical scale
mode	the mode is the most frequently occurring value in a dataset
model	any depiction of a situation expressing a relationship between ideas in mathematical terms
modify	change the form or qualities of; make partial or minor changes to something
multimodal	uses a combination of at least two modes (e.g. spoken, written), delivered at the same time, to communicate ideas and information to a live or virtual audience, for a particular purpose; the selected modes are integrated so that each mode contributes significantly to the response
N	
narrow	limited in range or scope; lacking breadth of view; limited in amount; barely sufficient or adequate; restricted
nuanced	showing a subtle difference or distinction in expression, meaning, response, etc.; finely differentiated; characterised by subtle shades of meaning or expression; a subtle distinction, variation or quality; sensibility to, awareness of, or ability to express delicate shadings, as of meaning, feeling, or value
numerical data	data involving numbers, for example, the number of siblings, height of students
O	
objectives	see 'syllabus objectives', 'unit objectives', 'assessment objectives'
observation	data or information required to solve a mathematical problem and/or develop a mathematical model; empirical evidence
obvious	clearly perceptible or evident; easily seen, recognised or understood
optimal	best, most favourable, under a particular set of circumstances

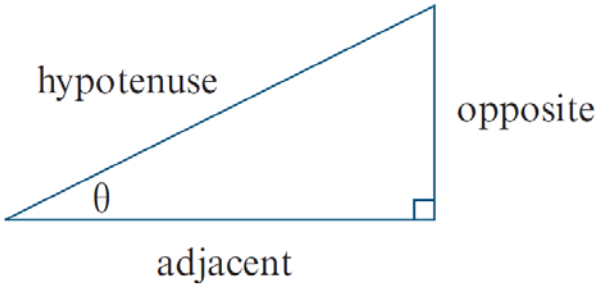
Term	Explanation
order of operations	the order of performing mathematical operations: 1. evaluate brackets or grouping symbols first 2. evaluate any powers and roots 3. working left to right, evaluate any multiplication and division 4. working left to right, evaluate any addition or subtraction (may also be known as BODMAS, BIDMAS, BEDMAS, etc.)
organise	arrange, order; form as or into a whole consisting of interdependent or coordinated parts, especially for harmonious or united action
organised	systematically ordered and arranged; having a formal organisational structure to arrange, coordinate and carry out activities
outlier	an observation that appears to be inconsistent with the remainder of that set of data; a surprising observation
outstanding	exceptionally good; clearly noticeable; prominent; conspicuous; striking
P	
parallel box plot	parallel box plots are used to visually compare the five-number summaries of two or more datasets; for example, the box-and-whisker plot below can be used to compare the five-number summaries for the pulse rates of 19 students before and after gentle exercise:  Note that the box plot for pulse rates after exercise shows the pulse rate of 146 as a possible outlier (•); this is because the distance of this data point above the upper quartile (42; 146 – 104) is more than 1.5 times the IQR (21; 1.5 × (104 – 90)); it is not expected that students will calculate outliers the term *parallel box plot* is a common abbreviation of *parallel box-and-whisker plot*
partial	not total or general; existing only in part; attempted, but incomplete
particular	distinguished or different from others or from the ordinary; noteworthy
percentile	the values that divide a ranked set of data into 100 equal parts
perceptive	having or showing insight and the ability to perceive or understand; discerning (see also ‘discriminating’)

Term	Explanation
performance	an assessment technique that requires students to demonstrate a range of cognitive, technical, creative and/or expressive skills and to apply theoretical and conceptual understandings, through the psychomotor domain; it involves student application of identified skills when responding to a task that involves solving a problem, providing a solution or conveying meaning or intent; a performance is developed over an extended and defined period of time
persuasive	capable of changing someone's ideas, opinions or beliefs; appearing worthy of approval or acceptance; (of an argument or statement) communicating reasonably or credibly (see also 'convincing')
perusal time	time allocated in an assessment to reading items and tasks and associated assessment materials; no writing is allowed; students may not make notes and may not commence responding to the assessment in the response space/book
planning time	time allocated in an assessment to planning how to respond to items and tasks and associated assessment materials; students may make notes but may not commence responding to the assessment in the response space/book; notes made during planning are not collected, nor are they graded or used as evidence of achievement
polished	flawless or excellent; performed with skilful ease
precise	definite or exact; definitely or strictly stated, defined or fixed; characterised by definite or exact expression or execution
precision	accuracy; exactness; exact observance of forms in conduct or actions
predict	give an expected result of an upcoming action or event; suggest what may happen based on available information
probability	the likelihood or chance of something; the relative frequency of the occurrence of an event as measured by the ratio of the number of cases or alternatives favourable to the event to the total number of cases or alternatives
procedural vocabulary	instructional terms used in a mathematical context (e.g. calculate, convert, determine, identify, justify, show, sketch, solve, state)
product	an assessment technique that focuses on the output or result of a process requiring the application of a range of cognitive, physical, technical, creative and/or expressive skills, and theoretical and conceptual understandings; a product is developed over an extended and defined period of time
proficient	well advanced or expert in any art, science or subject; competent, skilled or adept in doing or using something
project	an assessment technique that focuses on a problem-solving process requiring the application of a range of cognitive, technical and creative skills and theoretical understandings; the response is a coherent work that documents the iterative process undertaken to develop a solution and includes written paragraphs and annotations, diagrams, sketches, drawings, photographs, video, spoken presentations, physical prototypes and/or models; a project is developed over an extended and defined period of time
pronumeral	a letter that is used to represent a number (or numeral) in a problem
propose	put forward (e.g. a point of view, idea, argument, suggestion) for consideration or action

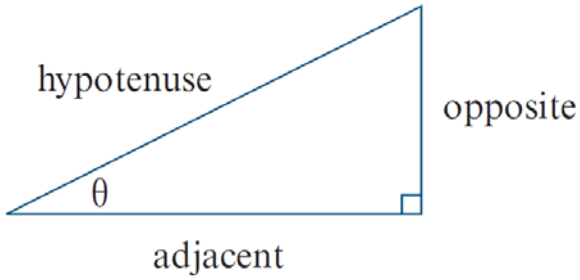
Term	Explanation
prove	use a sequence of steps to obtain the required result in a formal way
psychomotor procedures	a domain of knowledge in Marzano's taxonomy, and acted upon by the cognitive, metacognitive and self-systems; these are physical procedures used to negotiate daily life and to engage in complex physical activities; the two categories of psychomotor procedures are skills (foundational procedures and simple combination procedures) and processes (complex combination procedures)
purposeful	having an intended or desired result; having a useful purpose; determined; resolute; full of meaning; significant; intentional
Pythagoras' theorem	the square of the hypotenuse of a right-angled triangle equals the sum of the squares of the lengths of the other two sides; in symbols, $a^2 + b^2 = c^2$ 
Q	
QCE	Queensland Certificate of Education
qualitative statements	statements relating to a quality or qualities; of a non-numerical nature
quantitative analysis	use of mathematical measurements and calculations, including statistics, to analyse the relationships between variables; may include use of the correlation coefficient, coefficient of determination, simple residual analysis or outlier analysis
quartile	the quartiles of a ranked set of data values are the three points that divide the dataset into four equal groups
R	
range	the difference between the largest and smallest observations in a dataset; the range can be used as a measure of spread in a dataset, but it is extremely sensitive to the presence of outliers and should only be used with care
rarely	infrequently; in few instances
rate	a particular kind of ratio in which the two quantities are measured in different units; for example, the ratio of distance to time, known as speed, is a rate because distance and time are measured in different units (such as kilometres and hours); the value of the rate depends on the units in which the quantities are expressed
ratio	a comparison of two quantities of the same kind; for example, if a recipe uses 2 cups of milk and 3 cups of flour, the ratio of milk to flour is 2 is to 3. This can also be written with a colon, 2:3, or as a fraction, $\frac{2}{3}$

Term	Explanation
realise	create or make (e.g. a musical, artistic or dramatic work); actualise; make real or concrete; give reality or substance to
reasonable	endowed with reason; having sound judgment; fair and sensible; based on good sense; average; appropriate, moderate
reasonableness of solutions	to justify solutions obtained with or without technology using everyday language, mathematical language or a combination of both; may be applied to calculations to check working or to questions that require a relationship back to the context
reasoned	logical and sound; based on logic or good sense; logically thought out and presented with justification; guided by reason; well-grounded; considered
recall	remember; present remembered ideas, facts or experiences; bring something back into thought, attention or into one's mind
recognise	identify or recall particular features of information from knowledge; identify that an item, characteristic or quality exists; perceive as existing or true; be aware of or acknowledge
refined	developed or improved so as to be precise, exact or subtle
reflect on	think about deeply and carefully
rehearsed	practised; previously experienced; practised extensively
related	associated with or linked to
relative frequency	the number of items of a certain type divided by the number of all the items considered
relevance	being related to the matter at hand
relevant	bearing upon or connected with the matter in hand; to the purpose; applicable and pertinent; having a direct bearing on
repetitive	containing or characterised by repetition, especially when unnecessary or tiresome
reporting	providing information that succinctly describes student performance at different junctures throughout a course of study
representatively sample	in this syllabus, a selection of subject matter that accurately reflects the intended learning of a topic
resolve	in the Arts, consolidate and communicate intent through a synthesis of ideas and application of media to express meaning
routine	often encountered; previously experienced; commonplace; customary and regular; well-practised; performed as part of a regular procedure, rather than for a special reason
rudimentary	relating to rudiments or first principles; elementary; undeveloped; involving or limited to basic principles; relating to an immature, undeveloped or basic form

Term	Explanation
S	
safe	secure; not risky
sample	part of a population; a subset of the population, often randomly selected for the purpose of estimating the value of a characteristic of the population as a whole
scale	a graduated line, as on a map, representing proportionate size
secure	sure; certain; able to be counted on; self-confident; poised; dependable; confident; assured; not liable to fail
select	choose in preference to another or others; pick out
sensitive	capable of perceiving with a sense or senses; aware of the attitudes, feelings or circumstances of others; having acute mental or emotional sensibility; relating to or connected with the senses or sensation
sequence	place in a continuous or connected series; arrange in a particular order
show	provide the relevant reasoning to support a response
significant	important; of consequence; expressing a meaning; indicative; includes all that is important; sufficiently great or important to be worthy of attention; noteworthy; having a particular meaning; indicative of something
simple	easy to understand, deal with and use; not complex or complicated; plain; not elaborate or artificial; may concern a single or basic aspect; involving few elements, components or steps
simple familiar	problems of this degree of difficulty require students to demonstrate knowledge and understanding of the subject matter and application of skills in a situation where: • knowledge of simple subject matter is required to solve the problem; and • all of the information to solve the problem is identifiable, that is – the required procedure is clear from the way the problem is posed, *or* – is in a context that has been a focus of prior learning. Students are *not* required to interpret, clarify and analyse problems to develop responses. Typically, these problems focus on objectives 1, 2 and 3.
simple interest	simple interest is the interest accumulated when the interest payment in each period is a fixed fraction of the principal, e.g. if the principle P earns simple interest at the rate of $i\%$ per period, then after n periods the accumulated simple interest is: $$I = Pin$$
simplistic	characterised by extreme simplification, especially if misleading; oversimplified

Term	Explanation
sine ratio	in any right-angled triangle, $\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$ 
sketch	execute a drawing or painting in simple form, giving essential features but not necessarily with detail or accuracy; in mathematics, represent by means of a diagram or graph; the sketch should give a general idea of the required shape or relationship and should include features
skilful	having technical facility or practical ability; possessing, showing, involving or requiring skill; expert, dexterous; demonstrating the knowledge, ability or training to perform a certain activity or task well; trained, practised or experienced
skilled	having or showing the knowledge, ability or training to perform a certain activity or task well; having skill; trained or experienced; showing, involving or requiring skill
slope	steepness, incline or grade; normally described by the ratio of the 'rise' divided by the 'run' between two points on a line
solid	having three dimensions (length, breadth and thickness) as a geometrical body or figure
solution	the result of a mathematical process undertaken to answer or resolve a problem
solve	find an answer to, explanation for, or means of dealing with (e.g. a problem); work out the answer or solution to (e.g. a mathematical problem); obtain the answer/s using algebraic, numerical and/or graphical methods
sometimes	at times; now and then
sophisticated	of intellectual complexity; reflecting a high degree of skill, intelligence, etc.; employing advanced or refined methods or concepts; highly developed or complicated
specific	clearly defined or identified; precise and clear in making statements or issuing instructions; having a special application or reference; explicit, or definite; peculiar or proper to something, as qualities, characteristics, effects, etc.
sporadic	happening now and again or at intervals; irregular or occasional; appearing in scattered or isolated instances
statement	a sentence or assertion

Term	Explanation
stem-and-leaf plot	a method of organising and displaying numerical data in which each data value is split in to two parts: a 'stem' and a 'leaf'; for example, the stem-and-leaf plot below displays the resting pulse rates of 19 students: **pulse rate** 6 | 8 8 8 9 7 | 0 1 1 4 6 6 8 8 | 2 6 8 8 9 | 0 6 10 | 4 11 | 0 in this plot, the stem unit is 10 and the leaf unit is 1; thus, the top row in the plot, 6 **|** 8 8 8 9, displays pulse rates of 68, 68, 68 and 69; stem plot is a synonym for stem-and-leaf plot
straightforward	without difficulty; uncomplicated; direct; easy to do or understand
structure	*verb* give a pattern, organisation or arrangement to; construct or arrange according to a plan; *noun* in languages, arrangement of words into larger units, e.g. phrases, clauses, sentences, paragraphs and whole texts, in line with cultural, intercultural and textual conventions
structured	organised or arranged so as to produce a desired result
subject	a branch or area of knowledge or learning defined by a syllabus; school subjects are usually based in a discipline or field of study (see also 'course')
subject matter	the subject-specific body of information, mental procedures and psychomotor procedures that are necessary for students' learning and engagement within that subject
substantial	of ample or considerable amount, quantity, size, etc.; of real worth or value; firmly or solidly established; of real significance; reliable; important, worthwhile
substantiated	established by proof or competent evidence
subtle	fine or delicate in meaning or intent; making use of indirect methods; not straightforward or obvious
successful	achieving or having achieved success; accomplishing a desired aim or result
succinct	expressed in few words; concise; terse; characterised by conciseness or brevity; brief and clear
sufficient	enough or adequate for the purpose
suitable	appropriate; fitting; conforming or agreeing in nature, condition, or action
summarise	give a brief statement of a general theme or major point/s; present ideas and information in fewer words and in sequence
summative assessment	assessment whose major purpose is to indicate student achievement; summative assessments contribute towards a student's subject result

Term	Explanation
superficial	concerned with or comprehending only what is on the surface or obvious; shallow; not profound, thorough, deep or complete; existing or occurring at or on the surface; cursory; lacking depth of character or understanding; apparent and sometimes trivial
supported	corroborated; given greater credibility by providing evidence
sustained	carried on continuously, without interruption, or without any diminishing of intensity or extent
syllabus	a document that prescribes the curriculum for a course of study
syllabus objectives	outline what the school is required to teach and what students have the opportunity to learn; described in terms of actions that operate on the subject matter; the overarching objectives for a course of study (see also 'unit objectives', 'assessment objectives')
symbolise	represent or identify by a symbol or symbols
synthesise	combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding
systematic	done or acting according to a fixed plan or system; methodical; organised and logical; having, showing, or involving a system, method, or plan; characterised by system or method; methodical; arranged in, or comprising an ordered system
T	
tangent ratio	in any right-angled triangle, $\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$ 
technical vocabulary	terms that have a precise mathematical meaning (e.g. categorical data, chain rule, decimal fraction, imaginary number, log laws, linear regression, sine rule, whole number); may include everyday words used in a mathematical context (e.g. capacity, differentiate, evaluate, integrate, order, property, sample, union)
test	take measures to check the quality, performance or reliability of something
thorough	carried out through, or applied to the whole of something; carried out completely and carefully; including all that is required; complete with attention to every detail; not superficial or partial; performed or written with care and completeness; taking pains to do something carefully and completely
thoughtful	occupied with, or given to thought; contemplative; meditative; reflective; characterised by or manifesting thought

Term	Explanation
topic	a division of, or sub-section within a unit; all topics/sub-topics within a unit are interrelated
two-way table	commonly used for displaying the two-way frequency distribution that arises when a group of individuals or objects are categorised according to two criteria
U	
unclear	not clear or distinct; not easy to understand; obscure
understand	perceive what is meant by something; grasp; be familiar with (e.g. an idea); construct meaning from messages, including oral, written and graphic communication
uneven	unequal; not properly corresponding or agreeing; irregular; varying; not uniform; not equally balanced
unfamiliar	not previously encountered; situations or materials that have not been the focus of prior learning experiences or activities
unit	a defined amount of subject matter delivered in a specific context or with a particular focus; it includes unit objectives particular to the unit, subject matter and assessment direction
unit objectives	drawn from the syllabus objectives and contextualised for the subject matter and requirements of a particular unit; they are assessed at least once in the unit (see also 'syllabus objectives', 'assessment objectives')
unrelated	having no relationship; unconnected
use	operate or put into effect; apply knowledge or rules to put theory into practice
V	
vague	not definite in statement or meaning; not explicit or precise; not definitely fixed, determined or known; of uncertain, indefinite or unclear character or meaning; not clear in thought or understanding; couched in general or indefinite terms; not definitely or precisely expressed; deficient in details or particulars; thinking or communicating in an unfocused or imprecise way
valid	sound, just or well-founded; authoritative; having a sound basis in logic or fact (of an argument or point); reasonable or cogent; able to be supported; legitimate and defensible; applicable
variable	*adjective* apt or liable to vary or change; changeable; inconsistent; (readily) susceptible or capable of variation; fluctuating, uncertain; *noun* in mathematics, a symbol, or the quantity it signifies, that may represent any one of a given set of number and other objects
variety	a number or range of things of different kinds, or the same general class, that are distinct in character or quality; (of sources) a number of different modes or references

Term	Explanation
verify	to ascertain the truth or correctness of, especially by examination or comparison
volume	the size, measure or amount of anything in three dimensions; the space occupied by a body or substance in cubic units; the SI unit of volume is the cubic metre (m^3)
W	
whole number	a non-negative integer that is one of the numbers 0, 1, 2, 3, …
wide	of great range or scope; embracing a great number or variety of subjects, cases, etc.; of full extent
with expression	in words, art, music or movement, conveying or indicating feeling, spirit, character, etc.; a way of expressing or representing something; vivid, effective or persuasive communication

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8 Version history

Version	Date of change	Update
1.1	July 2018	Minor amendment to syllabus objective 6 explanatory paragraph
		Minor amendments to pedagogical and conceptual frameworks
		Minor amendments to assessment guidance in Units 1 and 2
		Minor amendments to subject matter in Units 2 and 3
		Summative internal assessments 1 and 3 (IA1 & IA3) — minor amendments to: • description • conditions • ISMG
		Summative internal assessment 2 (IA2) conditions — minor amendments to: • conditions
		Summative internal assessment 4 (IA4)— minor amendments to: • description • degree of difficulty definitions • conditions
		Glossary updates

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