

# General Mathematics 2019 v1.2

## General Senior External Examination Syllabus

This syllabus is for implementation in 2019.

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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 candidates 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. Candidates 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 candidate 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 candidates achieve procedural fluency, they carry out procedures flexibly, accurately and efficiently. When factual knowledge and concepts come to mind readily, candidates 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 candidates 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, candidates should develop confidence and experience success in their use of mathematics.

The major domains of mathematics in General Mathematics are Number and algebra, Measurement and geometry, Statistics and Networks and matrices, building on the content of the P–10 Australian Curriculum. Learning reinforces prior knowledge and further develops key mathematical ideas, including rates and percentages, concepts from financial mathematics, linear and non-linear expressions, sequences, the use of matrices and networks to model and solve authentic problems, the use of trigonometry to find solutions to practical problems, and the exploration of real-world phenomena in statistics.

General Mathematics is designed for candidates who want to extend their mathematical skills beyond Year 10 but whose future studies or employment pathways do not require calculus. It incorporates a practical approach that equips learners for their needs as future citizens. Candidates will learn to ask appropriate questions, map out pathways, reason about complex solutions, set up models and communicate in different forms. They will experience the relevance of mathematics to their daily lives, communities and cultural backgrounds. They will develop the ability to understand, analyse and take action regarding social issues in their world. When candidates gain skill and self-assurance, when they understand the content and when they evaluate their success by using and transferring their knowledge, they develop a mathematical mindset.

## Assumed knowledge, prior learning or experience

Assumed knowledge refers to the subject matter that teachers can expect candidates to know prior to beginning each unit. Emphasis is placed on the mastery of content, 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 candidates 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:

- solve a range of problems using percentages, rates and ratios, surface area and volume, Pythagoras' theorem, simple algebraic fractions, linear and quadratic equations
- understand the connection between algebraic and graphical representations, using appropriate technology when necessary
- calculate and compare measures of central tendency (mean, median and mode) and measures of spread; determine quartiles, interquartile range (IQR) and range
- construct and interpret box plots and use them to compare datasets; compare shapes of box plots to corresponding histograms and dot plots
- use scatter plots to investigate and comment on relationships between two numerical variables
- understand bivariate numerical data where the independent variable is time
- solve right-angled triangle problems, using trigonometric ratios
- solve simultaneous equations
- construct back-to-back stem-and-leaf plots and histograms
- solve linear equations
- understand the difference between numerical and categorical variables
- solve basic problems involving simple and compound interest.

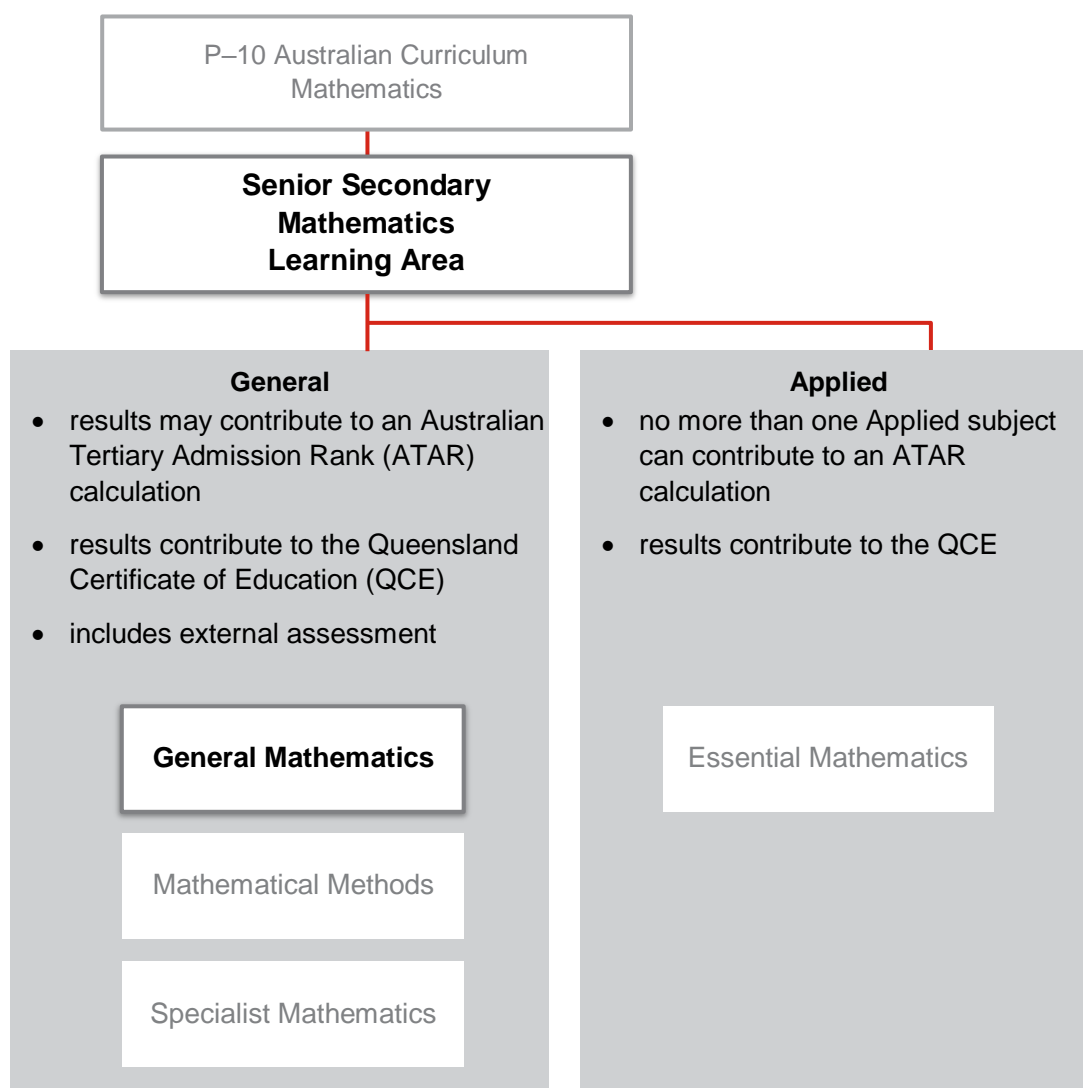
## Pathways

General Mathematics is a General subject suited to candidates who are interested in pathways beyond school that lead to tertiary studies, vocational education or work. A course of study in General Mathematics can establish a basis for further education and employment in the fields of business, commerce, education, finance, IT, social science and the arts.

## 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

General 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 candidates develop greater independence as learners.

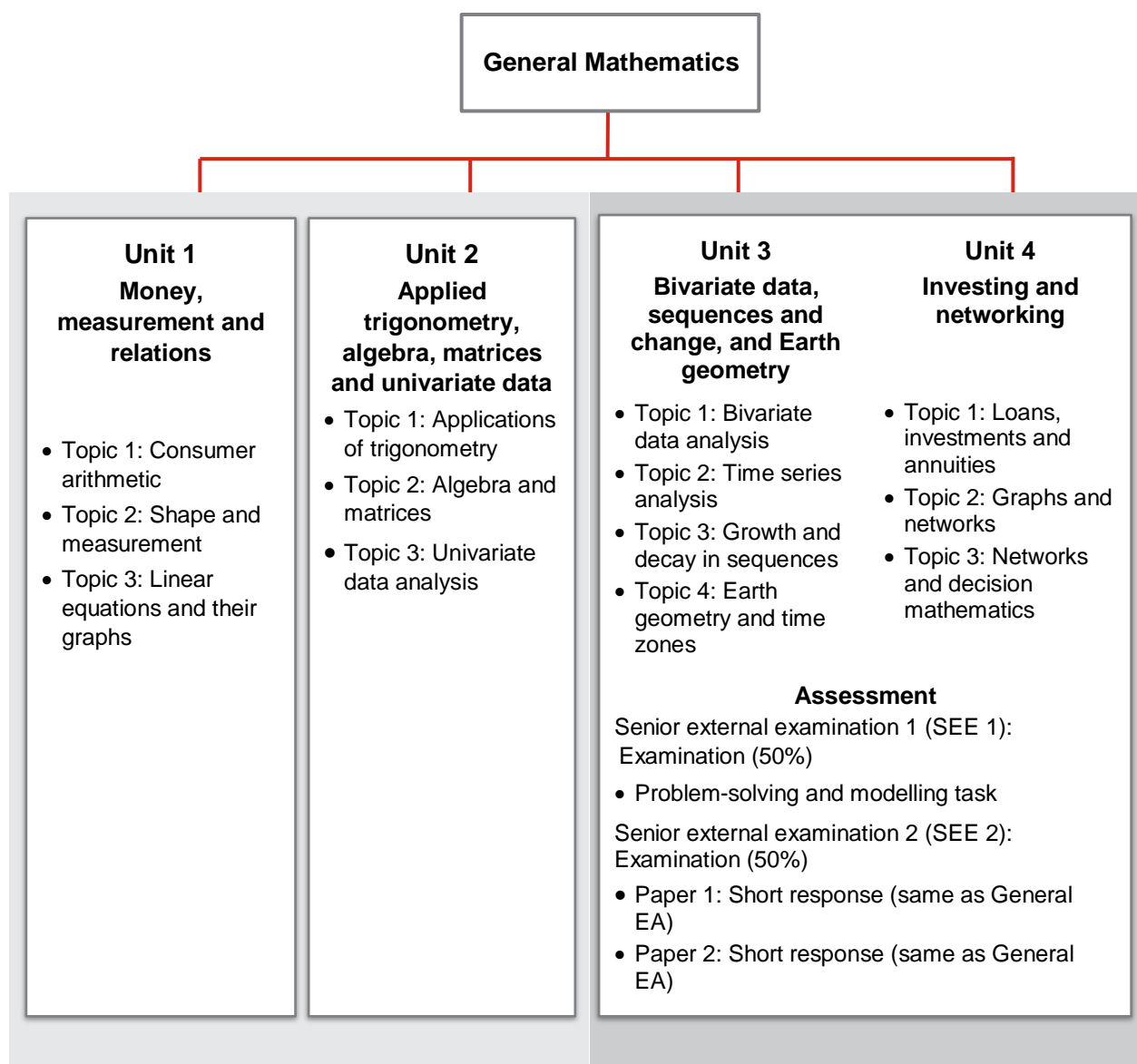
Units 1 and 2 provide foundational learning, which allows candidates to experience all syllabus objectives and begin engaging with the course subject matter. Candidates should complete Units 1 and 2 before beginning Unit 3. It is recommended that Unit 3 be completed before Unit 4.

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

Each unit has been developed with a notional time of 55 hours of teaching and learning, including assessment. Time allocation depends on the method of study. Candidates who elect to study without systematic tuition must organise their time according to syllabus requirements and individual circumstances.

Figure 2 outlines the structure of this course of study.

**Figure 2: Course structure**



## 1.2 Teaching and learning

### 1.2.1 Syllabus objectives

The syllabus objectives outline what candidates have the opportunity to learn. Assessment provides evidence of how well candidates 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. Candidates 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, candidates will:

Syllabus objective	Unit 1	Unit 2	Unit 3	Unit 4
1. <u>select</u> , <u>recall</u> and <u>use</u> facts, rules, definitions and procedures drawn from Number and algebra, Measurement and geometry, Statistics and Networks and matrices	•	•	•	•
2. <u>comprehend</u> mathematical concepts and techniques drawn from Number and algebra, Measurement and geometry, Statistics and Networks and matrices	•	•	•	•
3. <u>communicate</u> using mathematical, statistical and everyday language and conventions	•	•	•	•
4. <u>evaluate the reasonableness of solutions</u>	•	•	•	•
5. <u>justify</u> procedures and decisions by explaining mathematical reasoning	•	•	•	•
6. <u>solve</u> problems by applying mathematical concepts and techniques drawn from Number and algebra, Measurement and geometry, Statistics and Networks and matrices	•	•	•	•

#### 1. **select, recall and use facts, rules, definitions and procedures drawn from Number and algebra, Measurement and geometry, Statistics and Networks and matrices**

When candidates 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 technology.

#### 2. **comprehend mathematical concepts and techniques drawn from Number and algebra, Measurement and geometry, Statistics and Networks and matrices**

When candidates 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 candidates 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 candidates 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 are required.

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

When candidates 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. Candidates 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 and algebra, Measurement and geometry, Statistics and Networks and matrices

When candidates 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 General Mathematics content
- numeracy — the knowledge, skills, behaviours and dispositions that candidates 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 candidates 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 candidates 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, candidates 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 General Mathematics

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

Candidates 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. Candidates 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 General Mathematics content, teaching and learning strategies include:

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

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

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

## Numeracy in General 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 candidates 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 candidates who undertake General Mathematics will develop their numeracy skills at a more sophisticated level than in the P–10 years. For example, this subject contains financial applications of mathematics that will assist candidates to become literate consumers of investments, loans and superannuation products. It also contains statistics topics that will equip candidates for the ever-increasing demands of the information age.

These aspects of numeracy knowledge and skills are embedded in the syllabus objectives, unit objectives and subject matter for General 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 candidates 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	<ul style="list-style-type: none"> <li>• analytical thinking</li> <li>• problem-solving</li> <li>• decision-making</li> <li>• reasoning</li> <li>• reflecting and evaluating</li> <li>• intellectual flexibility</li> </ul>	creative thinking	<ul style="list-style-type: none"> <li>• innovation</li> <li>• initiative and enterprise</li> <li>• curiosity and imagination</li> <li>• creativity</li> <li>• generating and applying new ideas</li> <li>• identifying alternatives</li> <li>• seeing or making new links</li> </ul>
communication	<ul style="list-style-type: none"> <li>• effective oral and written communication</li> <li>• using language, symbols and texts</li> <li>• communicating ideas effectively with diverse audiences</li> </ul>	collaboration and teamwork	<ul style="list-style-type: none"> <li>• relating to others (interacting with others)</li> <li>• recognising and using diverse perspectives</li> <li>• participating and contributing</li> <li>• community connections</li> </ul>
personal and social skills	<ul style="list-style-type: none"> <li>• adaptability/flexibility</li> <li>• management (self, career, time, planning and organising)</li> <li>• character (resilience, mindfulness, open- and fair-mindedness, self-awareness)</li> <li>• leadership</li> <li>• citizenship</li> <li>• cultural awareness</li> <li>• ethical (and moral) understanding</li> </ul>	information & communication technologies (ICT) skills	<ul style="list-style-type: none"> <li>• operations and concepts</li> <li>• accessing and analysing information</li> <li>• being productive users of technology</li> <li>• digital citizenship (being safe, positive and responsible online)</li> </ul>

General 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 for General 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 candidates. The computational and graphing capabilities of digital technologies enable candidates 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, candidates 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
- handheld (calculator) technologies designed for mathematics teaching and learning, e.g. scientific, graphics (non-CAS or CAS) calculators, smartphone and tablet apps.

Candidates 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 scientific calculator is a requirement for the external examination. Graphics calculators and other technologies are not permitted in the external examination.

### 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 candidates to deepen their knowledge of Australia by engaging with the perspectives of Aboriginal peoples and Torres Strait Islander peoples
- positive outcomes for Aboriginal candidates and Torres Strait Islander candidates are supported by successfully embedding Aboriginal perspectives and Torres Strait Islander perspectives across planning, teaching and assessing candidate 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](http://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, candidates 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:

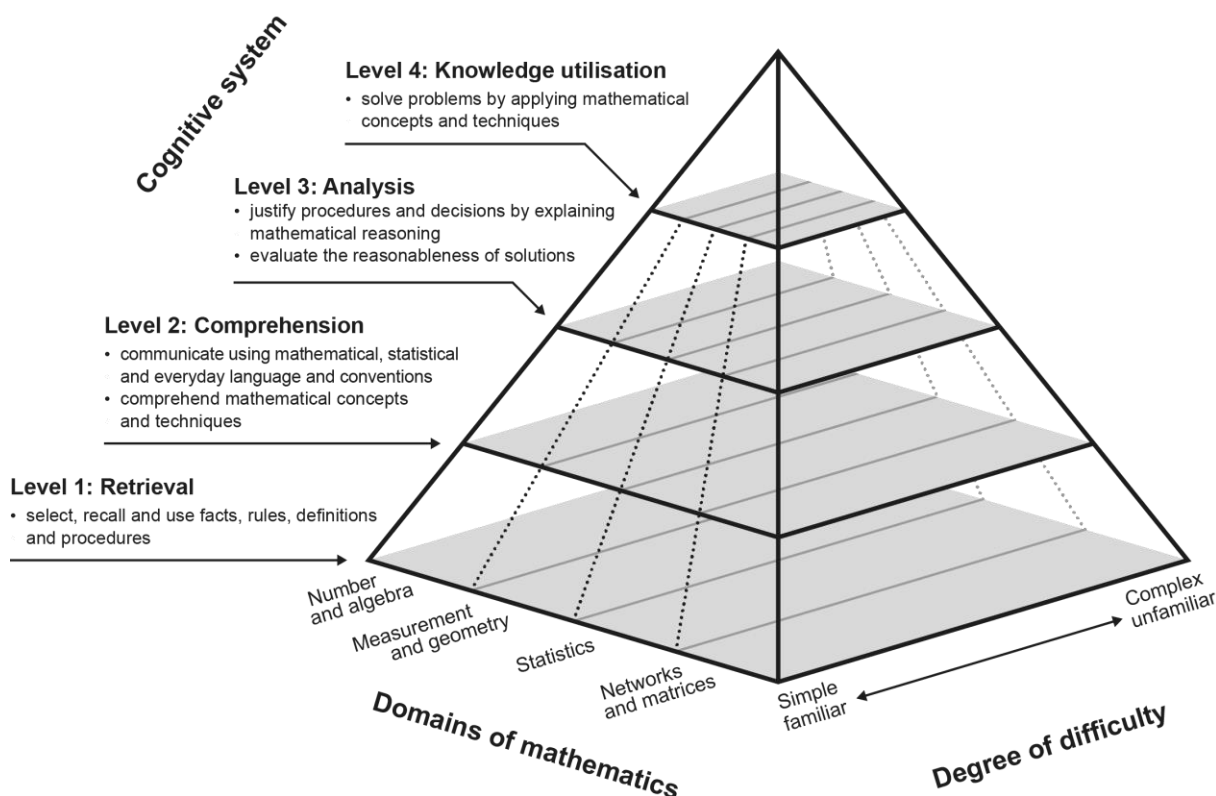
- using pedagogies such as Maths as Storytelling (MAST)
- using mathematics subject matter in real-world Aboriginal contexts and Torres Strait Islander contexts
- identifying the specific issues that may affect Aboriginal peoples and Torres Strait Islander peoples that are relevant to the mathematics topics being covered
- providing learning experiences and opportunities that support the application of candidates' general mathematical knowledge and problem-solving processes in an Aboriginal 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, candidates 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 General Mathematics, level of cognitive skill required (syllabus objective) and degree of difficulty is represented in three dimensions for mathematics problems in the following diagram.

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.<sup>1</sup> 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, candidates 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 candidate’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, candidates 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, candidates 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.

### 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 candidates 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 candidates 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). Candidates 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.<sup>2</sup>

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

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<sup>1</sup> 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).

<sup>2</sup> 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 candidate understanding and skills by moving it towards complex unfamiliar questions and assessing more cognitive skills. For further examples, see White et al. (2000).



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

Problem-solving requires candidates 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, candidates 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 candidates 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).

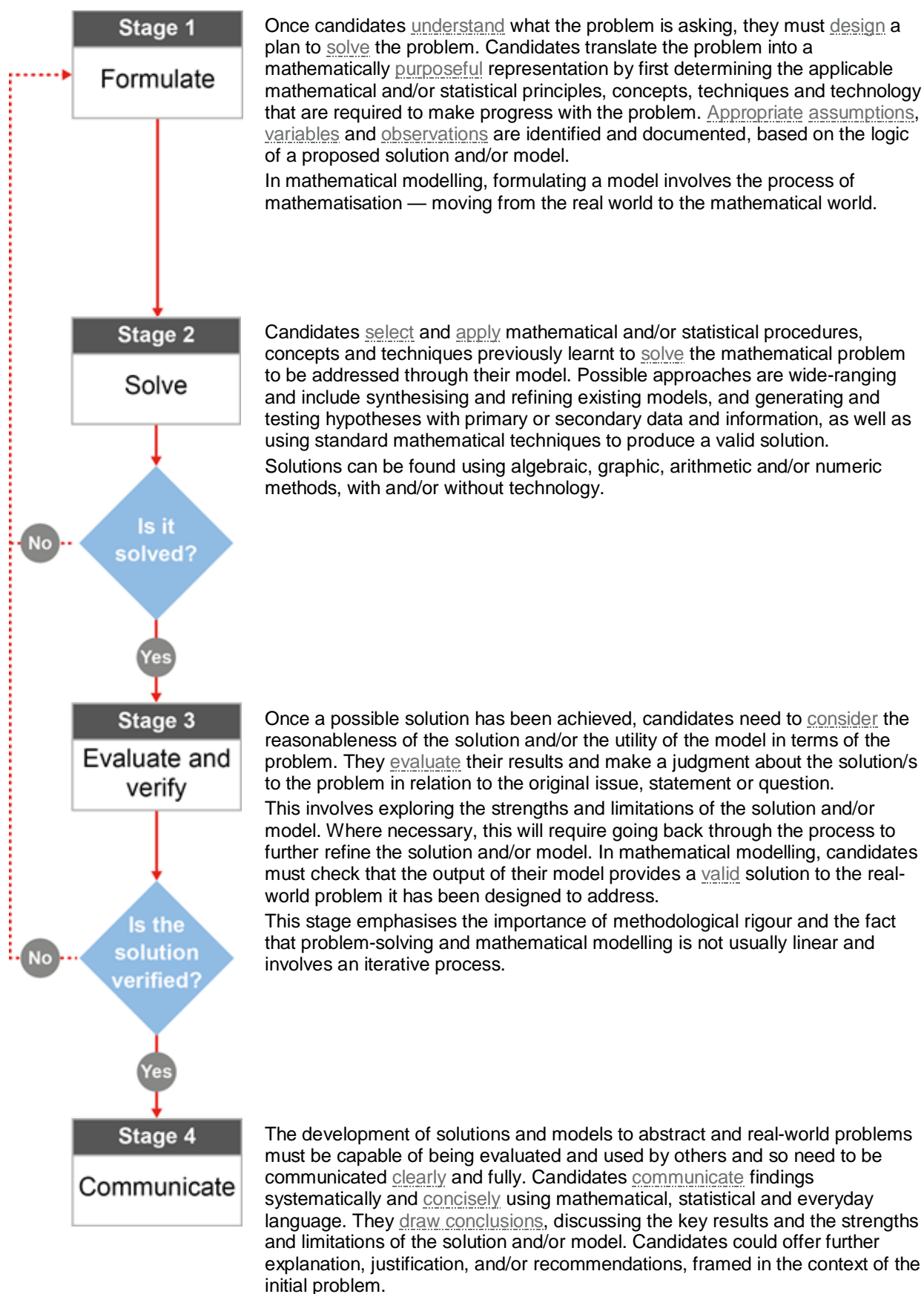
Through developing and applying mathematical models, candidates cumulatively become real-world problem-solvers. Ultimately, this means that not only can they productively address problems set by others, but also that they develop the ability to identify and address problems and answer questions that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

The following section outlines an approach to problem-solving and mathematical modelling.<sup>3</sup> Problems must be real-world, and can be presented to candidates as issues, statements or questions that may require them to use primary or secondary data.

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<sup>3</sup> 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 2015, 2003) 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



## 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*, candidates 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*, candidates 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, candidates 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<sup>4</sup> along the continua between *teaching for* and *learning through*:

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

These approaches are not mutually exclusive. An independent approach (*learning through*) might be undertaken as an extension of a dependent or guided activity that candidates have previously undertaken (*teaching for*). Candidates need to have attained the relevant foundational understanding and skills before working independently during a problem-solving and modelling task. This capacity needs to be built over time through the course of study with teachers closely monitoring candidate 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 candidates' learning and engagement with General Mathematics. It is particular to each unit in the course of study and provides the basis for candidate 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 candidate 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.

Subject matter in General Mathematics is organised into topics and sub-topics. Notional time allocations have been provided for each sub-topic.

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<sup>4</sup> Based on Galbraith (1989).

## 1.3 Assessment — general information

External examinations will be based on topics and subject matter from Units 3 and 4.

Examinations require assumed knowledge from Units 1 and 2.

Assessment	Unit 1	Unit 2	Unit 3	Unit 4
Senior external examination1			•	
Senior external examination2			•	•

### 1.3.1 Formative assessments — Units 1 and 2

If this syllabus is delivered in an educational setting, assessment of Units 1 and 2 will be a matter for each education provider to decide. Where providers choose to conduct assessment for Units 1 and 2, they are encouraged to use the A–E descriptors in the [reporting standards](#) to provide formative feedback to candidates, and to report on progress.

### 1.3.2 Summative assessments — Units 3 and 4

Senior external examinations are developed and marked by the QCAA.

In General Mathematics it contributes 100% to a candidate's overall subject result.

Candidates will complete a total of *two* external examinations, both of which will count towards their final mark in this subject.

**Examinations will be based on topics and subject matter from Units 3 and 4. Examinations require assumed knowledge from Units 1 and 2.**

**Note:** Senior external examination 2 (SEE 2) is the same as the Summative external assessment (EA) in the *General Mathematics General Senior Syllabus 2019*.

The external examinations provide the evidence of achievement for a candidate's profile.

External examinations are:

- common to all candidates
- administered under the same conditions at the same time and on the same day
- developed and marked by the QCAA according to a commonly applied marking scheme.

## 1.4 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 reporting on candidate progress. If this syllabus is delivered in an educational setting, these descriptors can also be used to help providers give formative feedback to candidates.

### Reporting standards

A
<p>The candidate <u>demonstrates</u> a <u>comprehensive</u> knowledge and understanding of the subject matter; <u>recognises</u>, <u>recalls</u> and <u>uses</u> facts, rules, definitions and procedures; and <u>comprehends</u> and applies mathematical concepts and techniques to <u>solve</u> problems drawn from Number and algebra, Measurement and geometry, Statistics and Networks and matrices in <u>simple familiar</u>, <u>complex familiar</u> and <u>complex unfamiliar</u> situations.</p> <p>The candidate <u>explains</u> mathematical reasoning to <u>justify</u> procedures and decisions; <u>evaluates</u> the <u>reasonableness of solutions</u>; <u>communicates</u> using mathematical, statistical and everyday language and conventions; and makes decisions about the choice of technology, and uses the technology, to solve problems in simple familiar, complex familiar and complex unfamiliar situations.</p>
B
<p>The candidate <u>demonstrates</u> a <u>thorough</u> knowledge and understanding of the subject matter; <u>recognises</u>, <u>recalls</u> and <u>uses</u> facts, rules, definitions and procedures; and <u>comprehends</u> and applies mathematical concepts and techniques to <u>solve</u> problems drawn from Number and algebra, Measurement and geometry, Statistics and Networks and matrices in <u>simple familiar</u> and <u>complex familiar</u> situations.</p> <p>The candidate <u>explains</u> mathematical reasoning to <u>justify</u> procedures and decisions; <u>evaluates</u> the <u>reasonableness of solutions</u>; <u>communicates</u> using mathematical, statistical and everyday language and conventions; and makes decisions about the choice of technology, and uses the technology, to solve problems in simple familiar and complex familiar situations.</p>
C
<p>The candidate <u>demonstrates</u> knowledge and understanding of the subject matter; <u>recognises</u>, <u>recalls</u> and <u>uses</u> facts, rules, definitions and procedures; and <u>comprehends</u> and applies mathematical concepts and techniques to <u>solve</u> problems drawn from Number and algebra, Measurement and geometry, Statistics and Networks and matrices in <u>simple familiar</u> situations.</p> <p>The candidate <u>explains</u> mathematical reasoning to <u>justify</u> procedures and decisions; <u>evaluates</u> the <u>reasonableness of solutions</u>; <u>communicates</u> using mathematical, statistical and everyday language and conventions; and uses technology to solve problems in simple familiar situations.</p>
D
<p>The candidate <u>demonstrates</u> <u>partial</u> knowledge and understanding of the subject matter; <u>recognises</u>, <u>recalls</u> and <u>uses</u> some facts, rules, definitions and procedures; and <u>comprehends</u> and applies <u>aspects</u> of mathematical concepts and techniques to <u>solve</u> some problems drawn from Number and algebra, Measurement and geometry, Statistics and Networks and matrices in <u>simple familiar</u> situations.</p> <p>The candidate <u>explains</u> some mathematical reasoning to <u>justify</u> procedures and decisions; sometimes <u>evaluates</u> the <u>reasonableness of solutions</u>; <u>communicates</u> using some mathematical, statistical and everyday language and conventions; and uses technology to solve some problems in simple familiar situations.</p>

## E

The candidate 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 and algebra, Measurement and geometry, Statistics and Networks and matrices in simple familiar situations.

The candidate 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 in simple familiar situations.

## 2 Unit 1: Money, measurement and relations

### 2.1 Unit description

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

- Topic 1: Consumer arithmetic
- Topic 2: Shape and measurement
- Topic 3: Linear equations and their graphs.

Consumer arithmetic reviews the concepts of rate and percentage change in the context of earning and managing money, and provides an opportunity for the use of spreadsheets. Shape and measurement builds on and extends the knowledge and skills candidates developed in the P–10 Australian Curriculum with the concept of similarity and problems involving simple and compound geometric shapes. Candidates apply these skills in a range of practical contexts, including those involving three-dimensional shapes. Linear equations and their graphs uses linear equations and straight-line graphs, as well as piece-wise linear graphs and step graphs, to model and analyse practical situations.

#### Unit requirements

Subject matter describes the concepts, ideas, knowledge, understanding and skills that candidates 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.

Candidates 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 Topic 1: Consumer arithmetic

### Subject matter

#### Applications of rates, percentages and use of spreadsheets (14 hours)

In this sub-topic, candidates will:

- review definitions of rates and percentages
- calculate weekly or monthly wages from an annual salary, and wages from an hourly rate, including situations involving overtime and other allowances and earnings based on commission or piecework
- calculate payments based on government allowances and pensions, such as youth allowances, unemployment, disability and study
- prepare a personal budget for a given income, taking into account fixed and discretionary spending
- compare prices and values using the unit cost method
- apply percentage increase or decrease in various contexts, e.g. determining the impact of inflation on costs and wages over time, calculating percentage mark-ups and discounts, calculating GST, calculating profit or loss in absolute and percentage terms, and calculating simple and compound interest
- use currency exchange rates to determine the cost in Australian dollars of purchasing a given amount of a foreign currency, such as US\$1500, or the value of a given amount of foreign currency when converted to Australian dollars, such as the value of €2050 in Australian dollars
- calculate the dividend paid on a portfolio of shares, given the percentage dividend or dividend paid per share, for each share; and compare share values by calculating a price-to-earnings ratio
- use a spreadsheet to display examples of the above computations when multiple or repeated computations are required, e.g. preparing a wage sheet displaying the weekly earnings of workers in a fast-food store where hours of employment and hourly rates of pay may differ, preparing a budget or investigating the potential cost of owning and operating a car over a year.

## 2.4 Topic 2: Shape and measurement

### Subject matter

#### Pythagoras' theorem (3 hours)

In this sub-topic, candidates will:

- review Pythagoras' theorem and use it to solve practical problems in two dimensions and simple applications in three dimensions.

#### Mensuration (8 hours)

In this sub-topic, candidates will:

- solve practical problems requiring the calculation of perimeters and areas of circles, sectors of circles, triangles, rectangles, trapeziums, parallelograms and composites
- calculate the volumes and capacities of standard three-dimensional objects, including spheres, rectangular prisms, cylinders, cones, pyramids and composites in practical situations, such as the volume of water contained in a swimming pool
- calculate the surface areas of standard three-dimensional objects, e.g. spheres, rectangular prisms, cylinders, cones, pyramids and composites in practical situations, such as the surface area of a cylindrical food container.

#### Similar figures and scale factors (7 hours)

In this sub-topic, candidates will:

- review the conditions for similarity of two-dimensional figures, including similar triangles
- use the scale factor for two similar figures to solve linear scaling problems
- obtain measurements from scale drawings, such as maps or building plans, to solve problems
- obtain a scale factor and use it to solve scaling problems involving the calculation of the areas of similar figures, including the use of shadow sticks, calculating the height of trees, use of a clinometer
- obtain a scale factor and use it to solve scaling problems involving the calculation of surface areas and volumes of similar solids.

## 2.5 Topic 3: Linear equations and their graphs

### Subject matter

#### Linear equations (5 hours)

In this sub-topic, candidates will:

- identify and solve linear equations, including variables on both sides, fractions, non-integer solutions
- develop a linear equation from a description in words.

#### Straight-line graphs and their applications (7 hours)

In this sub-topic, candidates will:

- construct straight-line graphs using  $y = a + bx$  both with and without the aid of technology
- determine the slope and intercepts of a straight-line graph from both its equation and its plot
- interpret, in context, the slope and intercept of a straight-line graph used to model and analyse a practical situation
- construct and analyse a straight-line graph to model a given linear relationship, such as modelling the cost of filling a fuel tank of a car against the number of litres of petrol required.

#### Simultaneous linear equations and their applications (6 hours)

In this sub-topic, candidates will:

- solve a pair of simultaneous linear equations in the format  $y = mx + c$ , using technology when appropriate; they must solve equations algebraically, graphically, by substitution and by the elimination method
- solve practical problems that involve finding the point of intersection of two straight-line graphs, such as determining the break-even point where cost and revenue are represented by linear equations.

#### Piece-wise linear graphs and step graphs (5 hours)

In this sub-topic, candidates will:

- sketch piece-wise linear graphs and step graphs, using technology where appropriate
- interpret piece-wise linear and step graphs used to model practical situations.

## 2.6 Assessment guidance

If this syllabus is delivered in an educational setting, providers should ensure that the objectives being assessed cover, or are chosen from, the unit objectives. If one formative assessment instrument is developed for a unit, it must assess all the unit objectives; if more than one formative assessment instrument is developed, the unit objectives must be covered across those instruments.

## 3 Unit 2: Applied trigonometry, algebra, matrices and univariate data

### 3.1 Unit description

In Unit 2, candidates will develop mathematical understandings and skills to solve problems relating to:

- Topic 1: Applications of trigonometry
- Topic 2: Algebra and matrices
- Topic 3: Univariate data analysis.

Applications of trigonometry extends candidates' knowledge of trigonometry to solve practical problems involving non-right-angled triangles in both two and three dimensions, including problems involving the use of angles of elevation and depression and bearings in navigation. Algebra and matrices continues the study of algebra and introduces the new topic of matrices. Univariate data analysis develops candidates' ability to organise and summarise univariate data in the context of conducting a statistical investigation.

#### Unit requirements

Subject matter describes the concepts, ideas, knowledge, understanding and skills that candidates are to learn in Unit 2. It is organised into 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.

Candidates 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 Topic 1: Applications of trigonometry

### Subject matter

#### Applications of trigonometry (11 hours)

In this sub-topic, candidates will:

- review the use of the trigonometric ratios to find the length of an unknown side or the size of an unknown angle in a right-angled triangle
- determine the area of a triangle given two sides and an included angle by using the rule  $\text{area} = \frac{1}{2}bc \sin A$ , or given three sides by using Heron's rule  $A = \sqrt{s(s-a)(s-b)(s-c)}$ , where  $s = \frac{a+b+c}{2}$ , and solve related practical problems
- solve two-dimensional problems involving non-right-angled triangles using the sine rule (ambiguous case excluded) and the cosine rule
- solve two-dimensional practical problems involving the trigonometry of right-angled and non-right-angled triangles, including problems involving angles of elevation and depression and the use of true bearings.

## 3.4 Topic 2: Algebra and matrices

### Subject matter

#### Linear and non-linear relationships (8 hours)

In this sub-topic, candidates will:

- substitute numerical values into linear algebraic and simple non-linear algebraic expressions, and evaluate, e.g. order two polynomials, proportional, inversely proportional
- find the value of the subject of the formula, given the values of the other pronumerals in the formula
- transpose linear equations and simple non-linear algebraic equations, e.g. order two polynomials, proportional, inversely proportional
- use a spreadsheet or an equivalent technology to construct a table of values from a formula, including two-by-two tables for formulas with two variable quantities, e.g. a table displaying the body mass index (BMI) of people with different weights and heights.

#### Matrices and matrix arithmetic (10 hours)

In this sub-topic, candidates will:

- use matrices for storing and displaying information that can be presented in rows and columns, e.g. tables, databases, links in social or road networks
- recognise different types of matrices (row matrix, column matrix (or vector matrix), square matrix, zero matrix, identity matrix) and determine the size of the matrix
- perform matrix addition, subtraction, and multiplication by a scalar
- perform matrix multiplication (manually up to a 3 x 3 but not limited to square matrices)
- determining the power of a matrix using technology with matrix arithmetic capabilities when appropriate
- use matrices, including matrix products and powers of matrices, to model and solve problems, e.g. costing or pricing problems, squaring a matrix to determine the number of ways pairs of people in a communication network can communicate with each other via a third person.

## 3.5 Topic 3: Univariate data analysis

### Subject matter

#### Making sense of data relating to a single statistical variable (14 hours)

In this sub-topic, candidates will:

- define univariate data
- classify statistical variables as categorical or numerical
- classify a categorical variable as ordinal or nominal and use tables and pie, bar and column charts to organise and display the data, e.g. ordinal: income level (high, medium, low); or nominal: place of birth (Australia, overseas)
- classify a numerical variable as discrete or continuous, e.g. discrete: the number of rooms in a house; or continuous: the temperature in degrees Celsius
- select, construct and justify an appropriate graphical display to describe the distribution of a numerical dataset, including dot plot, stem-and-leaf plot, column chart or histogram
- describe the graphical displays in terms of the number of modes, shape (symmetric versus positively or negatively skewed), measures of centre and spread, and outliers and interpret this information in the context of the data
- determine the mean,  $\bar{x}$ , and standard deviation (using technology) of a dataset and use statistics as measures of location and spread of a data distribution, being aware of the significance of the size of the standard deviation.

#### Comparing data for a numerical variable across two or more groups (12 hours)

In this sub-topic, candidates will:

- construct and use parallel box plots (including the use of the  $Q_1 - 1.5 \times \text{IQR} \leq x \leq Q_3 + 1.5 \times \text{IQR}$  criteria for identifying possible outliers) to compare datasets in terms of median, spread (IQR and range) and outliers to interpret and communicate the differences observed in the context of the data
- compare datasets using medians, means, IQRs, ranges or standard deviations for a single numerical variable, interpret the differences observed in the context of the data and report the findings in a systematic and concise manner.

## 3.6 Assessment guidance

If this syllabus is delivered in an educational setting, providers should ensure that the objectives being assessed cover, or are chosen from, the unit objectives. If one formative assessment instrument is developed for a unit, it must assess all the unit objectives; if more than one formative assessment instrument is developed, the unit objectives must be covered across those instruments.

## 4 Unit 3: Bivariate data, sequences and change, and Earth geometry

### 4.1 Unit description

In Unit 3, candidates will develop mathematical understandings and skills to solve problems relating to:

- Topic 1: Bivariate data analysis
- Topic 2: Time series analysis
- Topic 3: Growth and decay in sequences
- Topic 4: Earth geometry and time zones.

Bivariate data analysis introduces candidates to some methods for identifying, analysing and describing associations between pairs of variables, including the use of the least-squares method as a method for analysing linear associations. Time series analysis continues candidates' study of statistics by introducing them to the concepts and techniques of time series analysis. Growth and decay in sequences employs recursion to generate sequences that can be used to model and investigate patterns of growth and decay in discrete situations. These sequences find application in a wide range of practical situations, including modelling the growth of a compound interest investment, the growth of a bacterial population or the decrease in the value of a car over time. Sequences are also essential to understanding the patterns of growth and decay in loans and investments that are studied in detail in Unit 4. Earth geometry and time zones offers an opportunity to use contexts relevant to candidates.

#### Unit requirements

Subject matter describes the concepts, ideas, knowledge, understanding and skills that candidates are to learn in Unit 3. It is organised into 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 will be assessed at least once.

Candidates will:

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

## 4.3 Topic 1: Bivariate data analysis

### Subject matter

#### Identifying and describing associations between two categorical variables (4 hours)

In this sub-topic, candidates will:

- define bivariate data
- construct two-way frequency tables and determine the associated row and column sums and percentages
- use an appropriately percentaged two-way frequency table to identify patterns that suggest the presence of an association
- understand an association in terms of differences observed in percentages across categories in a systematic and concise manner, and interpret this in the context of the data.

#### Identifying and describing associations between two numerical variables (6 hours)

In this sub-topic, candidates will:

- construct a scatterplot to identify patterns in the data suggesting the presence of an association
- understand an association between two numerical variables in terms of direction (positive/negative), form (linear) and strength (strong/moderate/weak)
- calculate and interpret the correlation coefficient ( $r$ ) to quantify the strength of a linear association using Pearson's correlation coefficient.

#### Fitting a linear model to numerical data (7 hours)

In this sub-topic, candidates will:

- identify the response variable and the explanatory variable
- use a scatterplot to identify the nature of the relationship between variables
- model a linear relationship by fitting a least-squares line to the data
- use a residual plot to assess the appropriateness of fitting a linear model to the data
- interpret the intercept and slope of the fitted line
- use, not calculate, the coefficient of determination ( $R^2$ ) to assess the strength of a linear association in terms of the explained variation
- use the equation of a fitted line to make predictions
- distinguish between interpolation and extrapolation when using the fitted line to make predictions, recognising the potential dangers of extrapolation.

#### Association and causation (7 hours)

In this sub-topic, candidates will:

- recognise that an observed association between two variables does not necessarily mean that there is a causal relationship between them
- identify and communicate possible non-causal explanations for an association, including coincidence and confounding due to a common response to another variable
- solve practical problems by identifying, analysing and describing associations between two categorical variables or between two numerical variables.



## 4.4 Topic 2: Time series analysis

### Subject matter

#### Describing and interpreting patterns in time series data (4 hours)

In this sub-topic, candidates will:

- construct time series plots
- describe time series plots by identifying features such as trend (long-term direction), seasonality (systematic, calendar-related movements) and irregular fluctuations (unsystematic, short-term fluctuations), and recognise when there are outliers, e.g. one-off unanticipated events.

#### Analysing time series data (10 hours)

In this sub-topic, candidates will:

- smooth time series data by using a simple moving average, including the use of spreadsheets to implement this process
- calculate seasonal indices by using the average percentage method
- deseasonalise a time series by using a seasonal index, including the use of spreadsheets to implement this process
- fit a least-squares line to model long-term trends in time series data, using appropriate technology
- solve practical problems that involve the analysis of time series data.

## 4.5 Topic 3: Growth and decay in sequences

### Subject matter

#### The arithmetic sequence (4 hours)

In this sub-topic, candidates will:

- use recursion to generate an arithmetic sequence
- display the terms of an arithmetic sequence in both tabular and graphical form and demonstrate that arithmetic sequences can be used to model linear growth and decay in discrete situations
- use the rule for the  $n^{\text{th}}$  term using  $t_n = t_1 + (n - 1)d$ , where  $t_n$  represents the  $n^{\text{th}}$  term of the sequence,  $t_1$  = first term,  $n$  = term number and  $d$  = common difference of a particular arithmetic sequence from the pattern of the terms in an arithmetic sequence, and use this rule to make predictions
- use arithmetic sequences to model and analyse practical situations involving linear growth or decay, such as analysing a simple interest loan or investment, calculating a taxi fare based on the flag fall and the charge per kilometre, or calculating the value of an office photocopier at the end of each year using the straight-line method or the unit cost method of depreciation.

#### The geometric sequence (5 hours)

In this sub-topic, candidates will:

- use recursion to generate a geometric sequence
- display the terms of a geometric sequence in both tabular and graphical form and demonstrate that geometric sequences can be used to model exponential growth and decay in discrete situations
- use the rule for the  $n^{\text{th}}$  term using  $t_n = t_1 r^{(n-1)}$  where  $t_n$  represents the  $n^{\text{th}}$  term of the sequence,  $t_1$  = first term,  $n$  = term number and  $r$  = common ratio of a particular geometric sequence from the pattern of the terms in the sequence, and use this rule to make predictions
- use geometric sequences to model and analyse (numerically or graphically only) practical problems involving geometric growth and decay (logarithmic solutions not required), such as analysing a compound interest loan or investment, the growth of a bacterial population that doubles in size each hour or the decreasing height of the bounce of a ball at each bounce; or calculating the value of office furniture at the end of each year using the declining (reducing) balance method to depreciate.



## 4.6 Topic 4: Earth geometry and time zones

### Subject matter

#### Locations on the Earth (3 hours)

In this sub-topic, candidates will:

- define the meaning of great circles
- define the meaning of angles of latitude and longitude in relation to the equator and the prime meridian
- locate positions on Earth's surface given latitude and longitude, e.g. using a globe, an atlas, GPS and other digital technologies
- state latitude and longitude for positions on Earth's surface and world maps (in degrees only)
- use a local area map to state the position of a given place in degrees and minutes, e.g. investigating the map of Australia and locating boundary positions for Aboriginal language groups, such as the Three Sisters in the Blue Mountains or the local area's Aboriginal land and the positions of boundaries
- calculate angular distance (in degrees and minutes) and distance (in kilometres) between two places on Earth on the same meridian using  $D = 111.2 \times \text{angular distance}$
- calculate angular distance (in degrees and minutes) and distance (in kilometres) between two places on Earth on the same parallel of latitude using  $D = 111.2 \cos \theta \times \text{angular distance}$
- calculate distances between two places on Earth, using appropriate technology.

#### Time zones (5 hours)

In this sub-topic, candidates will:

- define Greenwich Mean Time (GMT), International Date Line and Coordinated Universal Time (UTC)
- understand the link between longitude and time
- determine the number of degrees of longitude for a time difference of one hour
- solve problems involving time zones in Australia and in neighbouring nations, making any necessary allowances for daylight saving, including seasonal time systems used by Aboriginal peoples and Torres Strait Islander peoples
- solve problems involving GMT, International Date Line and UTC
- calculate time differences between two places on Earth
- solve problems associated with time zones, such as online purchasing, making phone calls overseas and broadcasting international events
- solve problems relating to travelling east and west incorporating time zone changes, such as preparing an itinerary for an overseas holiday with corresponding times.

## 4.7 Assessment

### 4.7.1 Senior external examination 1 (SEE 1): Examination (50%)

#### General information

The problem-solving and modelling task will use subject matter from at least one of the following topics in Unit 3:

- Topic 1: Bivariate data analysis
- Topic 2: Time series analysis
- Topic 3: Growth and decay in sequences.

Candidate responses must be completed individually, under supervised conditions, and in a set timeframe.

The total examination time is 3 hours plus 15 minutes planning time.

#### Problem-solving and modelling task

##### Description

This examination is in the form of a problem-solving and modelling task that focuses on the interpretation, analysis and evaluation of ideas and information. Candidates are required to respond to a particular given situation or stimuli.

##### Assessment objectives

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

1. select, recall and use facts, rules, definitions and procedures drawn from Unit 3 Topics 1, 2 and/or 3
2. comprehend mathematical concepts and techniques drawn from 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 Unit 3 Topics 1, 2 and/or 3.

##### Specifications

##### Description

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

Candidates must provide a written response to a specific task or issue set in a context that highlights a real-life application of mathematics. The task requires candidates to use provided stimulus material involving subject matter from the nominated topic/s, which will have sufficient

scope to allow candidates to address all the stages of the problem-solving and mathematical modelling approach (see Figure 4).

**Relationship between the stages of the approach to problem-solving and mathematical modelling and the assessment objectives**

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

**Conditions**

Time: 3 hours plus 15 minutes planning time.

Length: The task should allow candidates to complete the response in the set time.

**Note:** The word length excludes raw or processed data in tables, figures and diagrams.

Other: The use of a QCAA-approved handheld scientific calculator is required.

## 4.7.2 Senior external examination 2 (SEE 2): Examination (50%)

### General information

This examination assesses learning from Units 3 and 4. Subject matter from Units 1 and 2 is assumed knowledge and may be drawn on, as applicable, in the development of the examination.

Candidate responses must be completed individually, under supervised conditions, and in a set timeframe.

The total examination time is 3 hours plus a total of 10 minutes perusal time.

**Note:** This examination (SEE 2) is the same as the Summative external assessment (EA) in the *General Mathematics General Senior Syllabus 2019*, and will be administered in the same way and at the same time as the Summative external assessment (EA) in the *General Mathematics General Senior Syllabus 2019*.

The percentage allocation of marks for the external examination will match the specifications below.

### Mark allocations

Percentage of marks	Degree of difficulty
~ 20%	<b>Complex unfamiliar</b> Problems of this degree of difficulty require students to <u>demonstrate</u> knowledge and understanding of the <u>subject matter</u> and application of skills in a situation where: <ul style="list-style-type: none"><li>relationships and interactions have a number of <u>elements</u>, such that connections are made with subject matter within and/or across the domains of mathematics; and</li><li>all the information to <u>solve</u> the problem is not immediately identifiable; that is<ul style="list-style-type: none"><li>the required procedure is not <u>clear</u> from the way the problem is posed, and</li><li>in a context in which students have had limited prior experience.</li></ul></li></ul> Students <u>interpret</u> , <u>clarify</u> and <u>analyse</u> problems to <u>develop</u> responses. Typically, these problems focus on objectives 4, 5 and 6.
~ 20%	<b>Complex familiar</b> Problems of this degree of difficulty require students to <u>demonstrate</u> knowledge and understanding of the <u>subject matter</u> and application of skills in a situation where: <ul style="list-style-type: none"><li>relationships and interactions have a number of elements, such that connections are made with subject matter within and/or across the domains of mathematics; and</li><li>all of the information to <u>solve</u> the problem is identifiable; that is<ul style="list-style-type: none"><li>the required procedure is <u>clear</u> from the way the problem is posed, or</li><li>in a context that has been a focus of prior learning.</li></ul></li></ul> Some interpretation, clarification and analysis will be required to <u>develop</u> responses. These problems can focus on any of the objectives.
~ 60%	<b>Simple familiar</b> Problems of this degree of difficulty require students to <u>demonstrate</u> knowledge and understanding of the <u>subject matter</u> and application of skills in a situation where: <ul style="list-style-type: none"><li>relationships and interactions are <u>obvious</u> and have few <u>elements</u>; and</li><li>all of the information to <u>solve</u> the problem is identifiable; that is<ul style="list-style-type: none"><li>the required procedure is <u>clear</u> from the way the problem is posed, or</li><li>in a context that has been a focus of prior learning.</li></ul></li></ul> Students are <i>not</i> required to <u>interpret</u> , <u>clarify</u> and <u>analyse</u> problems to <u>develop</u> responses. Typically, these problems focus on objectives 1, 2 and 3.

## 5 Unit 4: Investing and networking

### 5.1 Unit description

In Unit 4, candidates will develop mathematical understandings and skills to solve problems relating to:

- Topic 1: Loans, investments and annuities
- Topic 2: Graphs and networks
- Topic 3: Networks and decision mathematics.

Loans, investments and annuities aims to provide candidates with sufficient knowledge of financial mathematics to solve practical problems associated with taking out or refinancing a mortgage and making investments. Graphs and networks introduces candidates to the language of graphs and the ways in which graphs, represented as a collection of points and interconnecting lines, can be used to model and analyse everyday situations such as a rail or social network. Networks and decision mathematics uses networks to model and aid decision-making in practical situations.

#### Unit requirements

Subject matter describes the concepts, ideas, knowledge, understanding and skills that candidates are to learn in Unit 4. It is organised into 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 will be assessed at least once.

Candidates will:

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

## 5.3 Topic 1: Loans, investments and annuities

### Subject matter

#### Compound interest loans and investments (6 hours)

In this sub-topic, candidates will:

- use a recurrence relation  $A_{n+1} = rA_n$  to model a compound interest loan or investment, and investigate (numerically and graphically) the effect of the interest rate and the number of compounding periods on the future value of the loan or investment, e.g. payday loan
- calculate the effective annual rate of interest and use the results to compare investment returns and cost of loans when interest is paid or charged daily, monthly, quarterly or six-monthly
- solve problems involving compound interest loans or investments, e.g. determining the future value of a loan, the number of compounding periods for an investment to exceed a given value, the interest rate needed for an investment to exceed a given value.

#### Reducing balance loans (compound interest loans with periodic repayments) (6 hours)

In this sub-topic, candidates will:

- use a recurrence relation,  $A_{n+1} = rA_n - R$  (where  $R$  = monthly repayment) to model a reducing balance loan and investigate (numerically or graphically) the effect of the interest rate and repayment amount on the time taken to repay the loan
- with the aid of appropriate technology, solve problems involving reducing balance loans, e.g. determining the monthly repayments required to pay off a housing loan.

#### Annuities and perpetuities (compound interest investments with periodic payments made from the investment) (8 hours)

In this sub-topic, candidates will:

- use a recurrence relation  $A_{n+1} = rA_n + d$  to model an annuity and investigate (numerically or graphically) the effect of the amount invested, the interest rate, and the payment amount on the duration of the annuity
- solve problems involving annuities, including perpetuities as a special case, e.g. determining the amount to be invested in an annuity to provide a regular monthly income of a certain amount.

## 5.4 Topic 2: Graphs and networks

### Subject matter

#### Graphs, associated terminology and the adjacency matrix (4 hours)

In this sub-topic, candidates will:

- understand the meanings of the terms graph, edge, vertex, loop, degree of a vertex, subgraph, simple graph, complete graph, bipartite graph, directed graph (digraph), arc, weighted graph and network
- identify practical situations that can be represented by a network and construct such networks, e.g. trails connecting camp sites in a national park, a social network, a transport network with one-way streets, a food web, the results of a round-robin sporting competition
- construct an adjacency matrix from a given graph or digraph.

#### Planar graphs, paths and cycles (8 hours)

In this sub-topic, candidates will:

- understand the meaning of the terms planar graph and face
- apply Euler's formula,  $v + f - e = 2$ , to solve problems relating to planar graphs
- understand the meaning of the terms walk, trail, path, closed walk, closed trail, cycle, connected graph and bridge
- investigate and solve practical problems to determine the shortest path between two vertices in a weighted graph (by trial-and-error methods only)
- understand the meaning of the terms Eulerian graph, Eulerian trail, semi-Eulerian graph, semi-Eulerian trail and the conditions for their existence, and use these concepts to investigate and solve practical problems, e.g. the Königsberg bridge problem, planning a garbage bin collection route
- understand the meaning of the terms Hamiltonian graph and semi-Hamiltonian graph and use these concepts to investigate and solve practical problems (by trial-and-error methods only), e.g. planning a sightseeing tourist route around a city, the travelling-salesman problem.

## 5.5 Topic 3: Networks and decision mathematics

### Subject matter

#### Trees and minimum connector problems (4 hours)

In this sub-topic, candidates will:

- understand the meaning of the terms tree and spanning tree
- identify practical examples
- identify a minimum spanning tree in a weighted connected graph, e.g. using Prim's algorithm
- use minimal spanning trees to solve minimal connector problems, e.g. minimising the length of cable needed to provide power from a single power station to substations in several towns.

#### Project planning and scheduling using critical path analysis (CPA) (8 hours)

In this sub-topic, candidates will:

- construct a network diagram to represent the durations and interdependencies of activities that must be completed during the project, e.g. preparing a meal
- use forward and backward scanning to determine the earliest starting time (EST) and latest starting times (LST) for each activity in the project
- use ESTs and LSTs to locate the critical path/s for the project
- use the critical path to determine the minimum time for a project to be completed
- calculate float times for non-critical activities.

#### Flow networks (3 hours)

In this sub-topic, candidates will:

- solve small-scale network flow problems including the use of the 'maximum-flow minimum-cut' theorem, e.g. determining the maximum volume of oil that can flow through a network of pipes from an oil storage tank to a terminal.

#### Assigning order and the Hungarian algorithm (8 hours)

In this sub-topic, candidates will:

- use a bipartite graph and its tabular or matrix form to represent an assignment/allocation problem, e.g. assigning four swimmers to the four places in a medley relay team to maximise the team's chances of winning
- determine the optimum assignment/s for small-scale problems by inspection, or by use of the Hungarian algorithm ( $3 \times 3$ ) for larger problems.



## 5.6 Assessment

### 5.6.1 Senior external examination 2 (SEE 2): Examination (50%)

#### General information

This examination assesses learning from Units 3 and 4. Subject matter from Units 1 and 2 is assumed knowledge and may be drawn on, as applicable, in the development of the examination. Candidate responses must be completed individually, under supervised conditions, and in a set timeframe.

The total examination time is 3 hours plus a total of 10 minutes perusal time.

**Note:** This examination (SEE 2) is the same as the Summative external assessment (EA) in the *General Mathematics General Senior Syllabus 2019*, and will be administered in the same way and at the same time as the Summative external assessment (EA) in the *General Mathematics General Senior Syllabus 2019*.

The percentage allocation of marks for the external examination will match the specifications below.

#### Mark allocations

Percentage of marks	Degree of difficulty
~ 20%	<b>Complex unfamiliar</b> Problems of this degree of difficulty require students to <u>demonstrate</u> knowledge and understanding of the <u>subject matter</u> and application of skills in a situation where: <ul style="list-style-type: none"><li>relationships and interactions have a number of <u>elements</u>, such that connections are made with subject matter within and/or across the domains of mathematics; and</li><li>all the information to <u>solve</u> the problem is not immediately identifiable; that is<ul style="list-style-type: none"><li>the required procedure is not <u>clear</u> from the way the problem is posed, and</li><li>in a context in which students have had limited prior experience.</li></ul></li></ul> Students <u>interpret</u> , <u>clarify</u> and <u>analyse</u> problems to <u>develop</u> responses. Typically, these problems focus on objectives 4, 5 and 6.
~ 20%	<b>Complex familiar</b> Problems of this degree of difficulty require students to <u>demonstrate</u> knowledge and understanding of the <u>subject matter</u> and application of skills in a situation where: <ul style="list-style-type: none"><li>relationships and interactions have a number of <u>elements</u>, such that connections are made with subject matter within and/or across the domains of mathematics; and</li><li>all of the information to <u>solve</u> the problem is identifiable; that is<ul style="list-style-type: none"><li>the required procedure is <u>clear</u> from the way the problem is posed, or</li><li>in a context that has been a focus of prior learning.</li></ul></li></ul> Some interpretation, clarification and analysis will be required to <u>develop</u> responses. These problems can focus on any of the objectives.
~ 60%	<b>Simple familiar</b> Problems of this degree of difficulty require students to <u>demonstrate</u> knowledge and understanding of the <u>subject matter</u> and application of skills in a situation where: <ul style="list-style-type: none"><li>relationships and interactions are <u>obvious</u> and have few <u>elements</u>; and</li><li>all of the information to <u>solve</u> the problem is identifiable; that is<ul style="list-style-type: none"><li>the required procedure is <u>clear</u> from the way the problem is posed, or</li><li>in a context that has been a focus of prior learning.</li></ul></li></ul> Students are <i>not</i> required to <u>interpret</u> , <u>clarify</u> and <u>analyse</u> problems to <u>develop</u> responses. Typically, these problems focus on objectives 1, 2 and 3.

## Paper 1: Short response (simple familiar questions)

### Description

This examination assesses the application of a range of cognitions to a number of items drawn from all topics in Units 3 and 4. Paper 1 contributes 30% to a candidate's overall subject result and consists of multiple choice and short response, simple familiar questions.

### Assessment objectives

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

1. select, recall and use facts, rules, definitions and procedures drawn from Units 3 and 4
2. comprehend mathematical concepts and techniques drawn from Units 3 and 4
3. communicate using mathematical, statistical and everyday language and conventions.

### Specifications

#### Description

The external assessment for General Mathematics representatively samples subject matter from all topics in Units 3 and 4.

#### Conditions

- Time: 90 minutes plus 5 minutes perusal
- Length: the number of short-response items should allow candidates to complete the response in the set time.
- Short-response format, consisting of a number of items that ask candidates to respond to the following activities:
  - calculating using algorithms
  - drawing, labelling or interpreting graphs, tables or diagrams
  - short items requiring multiple-choice, single-word, term, sentence or short-paragraph responses
  - responding to seen or unseen stimulus materials
- Other:
  - the QCAA formula sheet will be provided
  - notes are not permitted
  - access to a handheld QCAA-approved scientific calculator is required (no other form of technology is permitted).

## Paper 2: Short response (complex familiar and complex unfamiliar questions).

### Description

This examination assesses the application of a range of cognitions to a number of items drawn from all topics in Units 3 and 4. Paper 2 contributes 20% to a candidate's overall subject result and consists of short response, complex familiar and complex unfamiliar questions.

### Assessment objectives

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

1. select, recall and use facts, rules, definitions and procedures drawn from Units 3 and 4
2. comprehend mathematical concepts and techniques drawn from Units 3 and 4
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 Units 3 and 4.

### Specifications

#### Description

The external assessment for General Mathematics representatively samples subject matter from all topics in Units 3 and 4.

#### Conditions

- Time: 90 minutes plus 5 minutes perusal
- Length: the number of short-response items should allow candidates to complete the response in the set time.
- Short-response format, consisting of a number of items that ask candidates 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:
  - the QCAA formula sheet will be provided
  - notes are not permitted
  - access to a handheld QCAA-approved scientific calculator is required (no other form of technology is permitted).

## 6 Glossary

Term	Explanation
<b>A</b>	
<b>accomplished</b>	highly trained or skilled in a particular activity; perfected in knowledge or training; expert
<b>accuracy</b>	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
<b>accurate</b>	precise and exact; to the point; consistent with or exactly conforming to a truth, standard, rule, model, convention or known facts; free from error or defect; meticulous; correct in all details
<b>adept</b>	very/highly skilled or proficient at something; expert
<b>adequate</b>	satisfactory or acceptable in quality or quantity equal to the requirement or occasion
<b>adjacency matrix</b>	an adjacency matrix for a non-directed graph with $n$ vertices is an $n \times n$ matrix in which the entry in row $i$ and column $j$ is the number of edges joining the vertices $i$ and $j$ ; in an adjacency matrix, a loop is counted as one edge; for a directed graph, the entry in row $i$ and column $j$ is the number of directed edges (arcs) joining the vertex $i$ and $j$ in the direction $i$ to $j$
<b>algorithm</b>	a precisely defined procedure that can be applied and systematically followed through to a conclusion
<b>analyse</b>	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
<b>analytic procedures</b>	using algebraic and/or numerical techniques as the primary approach to solving a problem
<b>annuity</b>	a compound interest investment from which payments are made on a regular basis for a defined period of time
<b>applied learning</b>	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

Term	Explanation
<b>Applied subject</b>	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
<b>apply</b>	use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation
<b>appraise</b>	evaluate the worth, significance or status of something; judge or consider a text or piece of work
<b>appreciate</b>	recognise or make a judgment about the value or worth of something; understand fully; grasp the full implications of
<b>appropriate</b>	acceptable; suitable or fitting for a particular purpose, circumstance, context, etc.
<b>apt</b>	suitable to the purpose or occasion; fitting, appropriate
<b>area of study</b>	a division of, or a section within a unit
<b>argue</b>	give reasons for or against something; challenge or debate an issue or idea; persuade, prove or try to prove by giving reasons
<b>arithmetic sequence</b>	a sequence of numbers such that the difference between any two successive members of the sequence is constant, e.g. the sequence 2, 5, 8, 11, 14, 17, ... is an arithmetic sequence with first term 2 and common difference 3, by inspection of the sequence, the rule for the $n$ th term $t_n$ of this sequence is $t_n = 2 + (n - 1)3 = 3n - 1, n \geq 1$ , if $t_n$ is used to denote the $n^{th}$ term in the sequence, then a recursion relation that will generate this sequence is $t_1 = 2, t_{n+1} = t_n + 3, n \geq 1$
<b>aspect</b>	a particular part of a feature of something; a facet, phase or part of a whole
<b>assess</b>	measure, determine, evaluate, estimate or make a judgment about the value, quality, outcomes, results, size, significance, nature or extent of something
<b>assessment</b>	purposeful and systematic collection of information about candidates' achievements
<b>assessment instrument</b>	a tool or device used to gather information about candidate achievement
<b>assessment objectives</b>	drawn from the unit objectives and contextualised for the requirements of the assessment instrument (see also 'syllabus objectives', 'unit objectives')
<b>assessment technique</b>	the method used to gather evidence about candidate achievement, (e.g. examination, project, investigation)

Term	Explanation
<b>association</b>	a general term used to describe the relationship between two (or more) variables; often used interchangeably with 'correlation'; association does not imply causation
<b>assumptions</b>	conditions that are stated to be true when beginning to solve a problem
<b>astute</b>	showing an ability to accurately assess situations or people; of keen discernment
<b>ATAR</b>	Australian Tertiary Admission Rank
<b>authoritative</b>	able to be trusted as being accurate or true; reliable; commanding and self-confident; likely to be respected and obeyed
<b>average percentage method</b>	used for calculating a seasonal index, the data for each season are expressed as percentages of the average for the year; the percentages for the corresponding seasons for different years are then averaged using a mean or median to arrive at a seasonal index
<b>B</b>	
<b>balanced</b>	keeping or showing a balance; not biased; fairly judged or presented; taking everything into account in a fair, well-judged way
<b>basic</b>	fundamental
<b>bearing</b>	the direction of a fixed point, or the path of an object, from the point of observation
<b>bipartite graph</b>	a graph whose set of vertices can be split into two distinct groups in such a way that each edge of the graph joins a vertex in the first group to a vertex in the second group
<b>break-even point</b>	the point at which revenue begins to exceed costs
<b>bridge</b>	a bridge is an edge in a connected graph that, if removed, leaves a graph disconnected
<b>C</b>	
<b>calculate</b>	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
<b>categorical variable</b>	a variable whose values are categories, e.g. favourite colour, type of pet
<b>categorise</b>	place in or assign to a particular class or group; arrange or order by classes or categories; classify, sort out, sort, separate
<b>causal relationship</b>	a relationship between an explanatory variable and a response variable is said to be causal if the change in the explanatory variable causes a change in the response variable

Term	Explanation
<b>challenging</b>	difficult but interesting; testing one's abilities; demanding and thought-provoking; usually involving unfamiliar or less familiar elements
<b>characteristic</b>	a typical feature or quality
<b>clarify</b>	make clear or intelligible; explain; make a statement or situation less confused and more comprehensible
<b>clarity</b>	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
<b>classify</b>	arrange, distribute or order in classes or categories according to shared qualities or characteristics
<b>clear</b>	free from confusion, uncertainty, or doubt; easily seen, heard or understood
<b>clearly</b>	in a clear manner; plainly and openly, without ambiguity
<b>coefficient of determination</b>	in a linear model between two variables, the coefficient of determination ( $R^2$ ) is the proportion of the total variation that can be explained by the linear relationship existing between the two variables, usually expressed as a percentage
<b>coherent</b>	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
<b>cohesive</b>	characterised by being united, bound together or having integrated meaning; forming a united whole
<b>column matrix</b>	a matrix that has only one column
<b>comment</b>	express an opinion, observation or reaction in speech or writing; give a judgment based on a given statement or result of a calculation
<b>communicate</b>	convey knowledge and/or understandings to others; make known; transmit
<b>compare</b>	display recognition of similarities and differences and recognise the significance of these similarities and differences
<b>competent</b>	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
<b>competently</b>	in an efficient and capable way; in an acceptable and satisfactory, though not outstanding, way
<b>complete graph</b>	a simple graph in which every vertex is joined to every other vertex by an edge; a complete graph with $n$ vertices is denoted $K_n$

Term	Explanation
<b>complex</b>	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
<b>complex familiar</b>	<p>problems of this degree of difficulty require candidates to demonstrate knowledge and understanding of the subject matter and application of skills in a situation where:</p> <ul style="list-style-type: none"> <li>relationships and interactions have a number of elements, such that connections are made with subject matter within and/or across the domains of mathematics; and</li> <li>all of the information to solve the problem is identifiable; that is <ul style="list-style-type: none"> <li>the required procedure is clear from the way the problem is posed, or</li> <li>in a context that has been a focus of prior learning.</li> </ul> </li> </ul> <p>Some interpretation, clarification and analysis will be required to develop responses. These problems can focus on any of the objectives.</p>
<b>complex unfamiliar</b>	<p>problems of this degree of difficulty require candidates to demonstrate knowledge and understanding of the subject matter and application of skills in a situation where:</p> <ul style="list-style-type: none"> <li>relationships and interactions have a number of elements, such that connections are made with subject matter within and/or across the domains of mathematics; and</li> <li>all the information to solve the problem is not immediately identifiable; that is <ul style="list-style-type: none"> <li>the required procedure is not clear from the way the problem is posed, and</li> <li>in a context in which candidates have had limited prior experience.</li> </ul> </li> </ul> <p>Candidates interpret, clarify and analyse problems to develop responses. Typically, these problems focus on objectives 4, 5 and 6.</p>
<b>compound interest</b>	<p>the interest earned when each successive interest payment is added to the principal for the purpose of calculating the next interest payment,</p> <p>e.g. if the principal <math>P</math> earns compound interest <math>A</math> at the rate of <math>i\%</math> per period, then after <math>n</math> periods the total amount accrued is</p> $A = P(1 + i)^n$ <p>when plotted on a graph, the total amount accrued is shown to grow exponentially</p>
<b>comprehend</b>	understand the meaning or nature of; grasp mentally
<b>comprehensive</b>	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
<b>concise</b>	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
<b>concisely</b>	in a way that is brief but comprehensive; expressing much in few words; clearly and succinctly



Term	Explanation
<b>conduct</b>	direct in action or course; manage; organise; carry out
<b>connected graph</b>	a graph is connected if there is a path between each pair of vertices
<b>consider</b>	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
<b>considerable</b>	fairly large or great; thought about deliberately and with a purpose
<b>considered</b>	formed after careful and deliberate thought
<b>consistent</b>	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
<b>construct</b>	create or put together (e.g. an argument) by arranging ideas or items; display information in a diagrammatic or logical form; make; build
<b>continuous variable</b>	a numerical variable that can take any value that lies within an interval, e.g. height or reaction time
<b>contrast</b>	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
<b>controlled</b>	shows the exercise of restraint or direction over; held in check; restrained, managed or kept within certain bounds
<b>convention</b>	the generally agreed upon way in which something is done; in a mathematical context this refers to notation symbols, abbreviations, usage and setting out
<b>convincing</b>	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
<b>Coordinated Universal Time</b>	UTC; a system of time measurement used to regulate time and clocks around the world, based on International Atomic Time with leap seconds added at irregular intervals to compensate for the earth's slowing rotation; except in highly technical situations, regarded as equivalent to Greenwich Mean Time; initiated in 1961 and adopted internationally in 1972
<b>correlation coefficient</b>	the correlation coefficient ( $r$ ) is a measure of the strength of the linear relationship between a pair of variables; for variables $x$ and $y$ , and computed for $n$ cases, the formula for $r$ is $r = \frac{1}{n-1} \sum \left( \frac{x_i - \bar{x}}{s_x} \times \frac{y_i - \bar{y}}{s_y} \right)$

Term	Explanation
<b>cosine rule</b>	for a triangle of side lengths $a, b$ and $c$ , and corresponding angles $A, B$ and $C$ , the cosine rule states that $c^2 = a^2 + b^2 - 2ab \cos C$
<b>course</b>	a defined amount of learning developed from a subject syllabus
<b>create</b>	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
<b>creative</b>	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
<b>credible</b>	capable or worthy of being believed; believable; convincing
<b>criterion</b>	the property or characteristic by which something is judged or appraised
<b>critical</b>	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
<b>critical path analysis</b>	a project often involves many related activities, some of which cannot be started until one or more earlier tasks have been completed, one way of scheduling such activities that takes this into account is to construct a network diagram
<b>critique</b>	review (e.g. a theory, practice, performance) in a detailed, analytical and critical way
<b>cursory</b>	hasty, and therefore not thorough or detailed; performed with little attention to detail; going rapidly over something, without noticing details; hasty; superficial
<b>D</b>	
<b>decide</b>	reach a resolution as a result of consideration; make a choice from a number of alternatives
<b>deduce</b>	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
<b>defensible</b>	justifiable by argument; capable of being defended in argument
<b>define</b>	give the meaning of a word, phrase, concept or physical quantity; state meaning and identify or describe qualities
<b>degree of a vertex</b>	in a graph, the degree of a vertex is the number of edges incident with the vertex, with loops counted twice
<b>demonstrate</b>	prove or make clear by argument, reasoning or evidence, illustrating with practical example; show by example; give a practical exhibition

Term	Explanation
<b>derive</b>	arrive at by reasoning; manipulate a mathematical relationship to give a new equation or relationship; in mathematics, obtain the derivative of a function
<b>describe</b>	give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something
<b>design</b>	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)
<b>detailed</b>	executed with great attention to the fine points; meticulous; including many of the parts or facts
<b>determine</b>	establish, conclude or ascertain after consideration, observation, investigation or calculation; decide or come to a resolution
<b>develop</b>	elaborate, expand or enlarge in detail; add detail and fullness to; cause to become more complex or intricate
<b>devise</b>	think out; plan; contrive; invent
<b>differentiate</b>	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
<b>directed graph</b>	a diagram comprising points, called vertices, joined by directed lines called arcs; directed graphs are commonly called digraphs
<b>discerning</b>	discriminating; showing intellectual perception; showing good judgment; making thoughtful and astute choices; selected for value or relevance
<b>discrete variable</b>	a numerical variable that can take only certain values, e.g. number of people in a car, shoe size
<b>discriminate</b>	note, observe or recognise a difference; make or constitute a distinction in or between; differentiate; note or distinguish as different
<b>discriminating</b>	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
<b>discuss</b>	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
<b>disjointed</b>	disconnected; incoherent; lacking a coherent order/sequence or connection

Term	Explanation
<b>distinguish</b>	recognise as distinct or different; note points of difference between; discriminate; discern; make clear a difference/s between two or more concepts or items
<b>diverse</b>	of various kinds or forms; different from each other
<b>document</b>	support (e.g. an assertion, claim, statement) with evidence (e.g. decisive information, written references, citations)
<b>draw conclusions</b>	make a judgment based on reasoning and evidence
<b>E</b>	
<b>earliest starting time</b>	using a forward scan of a network diagram to determine the earliest time an activity can begin
<b>effective</b>	successful in producing the intended, desired or expected result; meeting the assigned purpose
<b>effective annual rate of interest</b>	<p>the effective annual rate of interest <math>i_{effective}</math> is used to compare the interest paid on loans (or investments) with the same nominal annual interest rate <math>i</math> but with different compounding periods (daily, monthly, quarterly, annually, other);</p> <p>if the number of compounding periods per annum is <math>n</math>, then</p> $i_{effective} = \left(1 + \frac{i}{n}\right)^n - 1$
<b>efficient</b>	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
<b>element</b>	a component or constituent part of a complex whole; a fundamental, essential or irreducible part of a composite entity
<b>elementary</b>	simple or uncompounded; relating to or dealing with elements, rudiments or first principles (of a subject); of the most basic kind; straightforward and uncomplicated
<b>erroneous</b>	based on or containing error; mistaken; incorrect
<b>essential</b>	absolutely necessary; indispensable; of critical importance for achieving something
<b>Euler's formula</b>	<p>for a connected planar graph, Euler's rule states that</p> $v + f - e = 2$ <p>where <math>v</math> = number of vertices, <math>e</math> = number of edges and <math>f</math> = number of faces</p>
<b>Eulerian graph</b>	<p>a connected graph is Eulerian if it has a closed trail (starts and ends at the same vertex), that is, includes every edge once only, such a trail is called a Eulerian trail;</p> <p>a Eulerian trail may include repeated vertices; a connected graph is semi-Eulerian if there is an open trail that includes every edge once only</p>

Term	Explanation
<b>evaluate</b>	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
<b>examination</b>	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; candidate responses are completed individually, under supervised conditions, and in a set timeframe
<b>examine</b>	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
<b>experiment</b>	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
<b>explain</b>	make an idea or situation plain or clear by describing it in more detail or revealing relevant facts; give an account; provide additional information
<b>explanatory variable</b>	when investigating relationships in bivariate data, the explanatory variable (independent variable) is the variable used to explain or predict a difference in the response variable (dependent variable), e.g. when investigating the relationship between the temperature of a loaf of bread and the time it has spent in a hot oven, temperature is the response variable and time is the explanatory variable
<b>explicit</b>	clearly and distinctly expressing all that is meant; unequivocal; clearly developed or formulated; leaving nothing merely implied or suggested
<b>explore</b>	look into both closely and broadly; scrutinise; inquire into or discuss something in detail
<b>express</b>	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
<b>extended response</b>	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 candidates 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
<b>Extension subject</b>	a two-unit subject (Units 3 and 4) for which a syllabus has been developed by QCAA, that is an extension of one or more General subject/s, studied concurrently with, Units 3 and 4 of that subject or after completion of, Units 3 and 4 of that subject
<b>extensive</b>	of great extent; wide; broad; far-reaching; comprehensive; lengthy; detailed; large in amount or scale

Term	Explanation
<b>external assessment</b>	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
<b>external examination</b>	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; candidate responses are completed individually, under supervised conditions, and in a set timeframe
<b>extrapolate</b>	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
<b>F</b>	
<b>face</b>	the faces of a planar graph are the regions bounded by the edges including the outer infinitely large region
<b>factual</b>	relating to or based on facts; concerned with what is actually the case; actually occurring; having verified existence
<b>familiar</b>	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
<b>feasible</b>	capable of being achieved, accomplished or put into effect; reasonable enough to be believed or accepted; probable; likely
<b>float time</b>	the amount of time that a task in a project network can be delayed without causing a delay to subsequent tasks; also called <i>slack time</i>
<b>flow network</b>	a directed graph where each edge has a capacity and each edge receives a flow, the amount of flow on an edge cannot exceed the capacity of the edge; a flow must satisfy the restriction that the amount of flow into a node equals the amount of flow out of it, except when it is a source, which has more outgoing flow, or a sink, which has more incoming flow
<b>fluent</b>	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
<b>fluently</b>	in a graceful and seemingly effortless manner; in a way that progresses smoothly and readily
<b>formative assessment</b>	assessment whose major purpose is to improve teaching and candidate achievement
<b>fragmented</b>	disorganised; broken down; disjointed or isolated

Term	Explanation
<b>frequent</b>	happening or occurring often at short intervals; constant, habitual, or regular
<b>fundamental</b>	forming a necessary base or core; of central importance; affecting or relating to the essential nature of something; part of a foundation or basis
<b>G</b>	
<b>General subject</b>	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
<b>generate</b>	produce; create; bring into existence
<b>geometric growth or decay</b>	a sequence displays geometric growth or decay when each term is some constant multiple (greater or less than one) of the preceding term: a multiple greater than one corresponds to growth, a multiple less than one corresponds to decay, e.g. 1, 2, 4, ... displays geometric growth because each term is double the previous term, 100, 10, 0.1, ... displays geometric decay because each term is one tenth of the previous term
<b>geometric sequence</b>	a sequence of numbers where each term after the first is found by multiplying the previous term by a fixed non-zero number (excluding $\pm 1$ ) called the common ratio, e.g. 2, 6, 18, ... is a geometric sequence with first term 2 and common ratio 3; by inspection of the sequence, the rule for the $n^{th}$ term of this sequence is $t_n = 2 \times 3^{(n-1)}, n \geq 1$ if $t_n$ is used to denote the $n^{th}$ term in the sequence, then a recursion relation that will generate this sequence is $t_1 = 2, t_n + 1 = 3t_n, n \geq 1$
<b>global positioning system</b>	GPS; a navigational system that relies on information received from a network of satellites to provide the latitude and longitude of an object
<b>GMT</b>	Greenwich Mean Time, the mean solar time of the meridian through Greenwich, England, widely used throughout the world (from 1884 to 1972) as a basis for calculating local time; equivalent to UTC
<b>goods and services tax</b>	GST; a broad sales tax of 10% on most goods and services transactions in Australia
<b>GPS</b>	global positioning system, a navigational system that relies on information received from a network of satellites to provide the latitude and longitude of an object
<b>great circle</b>	in earth geometry, a circle that cuts through the centre of the Earth; a circle that has a radius the same as the earth, e.g. the equator and the meridians of longitude

Term	Explanation
<b>Greenwich Mean Time</b>	GMT; the mean solar time of the meridian through Greenwich, England, widely used throughout the world (from 1884 to 1972) as a basis for calculating local time; equivalent to UTC
<b>GST</b>	goods and services tax, a broad sales tax of 10% on most goods and services transactions in Australia
<b>H</b>	
<b>Hamiltonian graph</b>	a network diagram that begins and ends at the same vertex and connects every vertex only once
<b>Heron's rule</b>	a rule for determining the area of a triangle given the lengths of its sides: the area $A$ of a triangle of side lengths $a$ , $b$ and $c$ is given by $A = \sqrt{s(s-a)(s-b)(s-c)}$ , where $s = \frac{a+b+c}{2}$
<b>hypothesise</b>	formulate a supposition to account for known facts or observed occurrences; conjecture, theorise, speculate; especially on uncertain or tentative grounds
<b>I</b>	
<b>identify</b>	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
<b>identity matrix</b>	a square matrix in which all of the elements in the leading diagonal are 1s and the remaining elements are 0s; identity matrices are designated by the letter $I$ e.g. $I_3 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ there is an identity matrix for each size (or order) of a square matrix
<b>illogical</b>	lacking sense or sound reasoning; contrary to or disregarding the rules of logic; unreasonable
<b>implement</b>	put something into effect, e.g. a plan or proposal
<b>implicit</b>	implied, rather than expressly stated; not plainly expressed; capable of being inferred from something else
<b>improbable</b>	not probable; unlikely to be true or to happen; not easy to believe
<b>inaccurate</b>	not accurate
<b>inappropriate</b>	not suitable or proper in the circumstances
<b>inconsistent</b>	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
<b>independent</b>	thinking or acting for oneself, not influenced by others
<b>in-depth</b>	comprehensive and with thorough coverage; extensive or profound; well-balanced or fully developed



Term	Explanation
<b>infer</b>	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
<b>informed</b>	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)
<b>innovative</b>	new and original; introducing new ideas; original and creative in thinking
<b>insightful</b>	showing understanding of a situation or process; understanding relationships in complex situations; informed by observation and deduction
<b>instrument-specific marking guide</b>	ISMG; a tool for marking that describes the characteristics evident in candidate responses and aligns with the identified objectives for the assessment (see 'assessment objectives')
<b>integral</b>	<i>adjective</i> necessary for the completeness of the whole; essential or fundamental; <i>noun</i> in mathematics, the result of integration; an expression from which a given function, equation, or system of equations is derived by differentiation
<b>intended</b>	designed; meant; done on purpose; intentional
<b>internal assessment</b>	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 candidate's final result
<b>International Date Line</b>	a line, theoretically coinciding with the meridian of 180° from Greenwich, England, the regions on either side of which are counted as differing by one day in their calendar dates
<b>interpolation</b>	in the context of fitting a linear relationship between two variables, interpolation occurs when the fitted model is used to make predictions using values of the explanatory variable that lie within the range of the original data
<b>interpret</b>	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

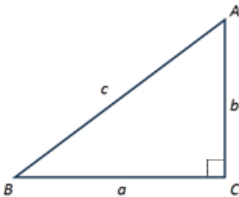
Term	Explanation
<b>interquartile range</b>	<p>a measure of the spread within a numerical dataset; it is equal to the upper quartile (<math>Q_3</math>) minus the lower quartile (<math>Q_1</math>), that is, <math>IQR = Q_3 - Q_1</math></p> <ul style="list-style-type: none"> <li>• <math>Q_1</math> is the median of the lower half of the data (excluding the median, <math>Q_2</math>, of the dataset)</li> <li>• <math>Q_3</math> is the median of the upper half of the data (excluding the median, <math>Q_2</math>, of the dataset)</li> </ul> <p>hence <math>IQR</math> 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</p>
<b>investigate</b>	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
<b>investigation</b>	an assessment technique that requires candidates 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
<b>irrelevant</b>	not relevant; not applicable or pertinent; not connected with or relevant to something
<b>ISMG</b>	instrument-specific marking guide; a tool for marking that describes the characteristics evident in candidate responses and aligns with the identified objectives for the assessment (see 'assessment objectives')
<b>isolated</b>	detached, separate, or unconnected with other things; one-off; something set apart or characterised as different in some way
<b>J</b>	
<b>judge</b>	form an opinion or conclusion about; apply both procedural and deliberative operations to make a determination
<b>justified</b>	sound reasons or evidence are provided to support an argument, statement or conclusion
<b>justify</b>	give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable
<b>L</b>	
<b>latitude</b>	the angular distance north or south from the equator of a point on the Earth's surface, usually measured in degrees, minutes and seconds, e.g. Canberra has a latitude of $35^{\circ}17' S$
<b>learning area</b>	a grouping of subjects, with related characteristics, within a broad field of learning, e.g. the Arts, sciences, languages

Term	Explanation
<b>least-squares line</b>	<p>the line of best fit for which the sum of the squared residuals is the smallest; the general form of this line is:</p> $y = a + bx$ <p>where the slope of the line is <math>b = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sum(x_i - \bar{x})^2} = r \frac{s_y}{s_x}</math></p> <p>and the <math>y</math>-intercept is <math>a = \bar{y} - b\bar{x}</math></p>
<b>least-squares method</b>	in fitting a straight line $y = a + bx$ to the relationship between a response variable $y$ and an explanatory variable $x$ , the least-squares line is the line for which the sum of the squared residuals is the smallest
<b>length</b>	in graphs and networks, the length of a walk is the number of edges it includes
<b>linear equation</b>	<p>a linear equation in one variable <math>x</math> is an equation of the form <math>ax + b = 0</math>, e.g. <math>3x + 1 = 0</math>;</p> <p>a linear equation in two variables <math>x</math> and <math>y</math> is an equation of the form <math>ax + by + c = 0</math>, e.g. <math>2x - 3y + 5 = 0</math></p>
<b>linear graph</b>	a graph of a linear equation with two variables; if the linear equation is written in the form $y = a + bx$ , then $a$ represents the $y$ -intercept and $b$ represents the slope (or gradient) of the linear graph
<b>linear growth or decay</b>	<p>a sequence displays linear growth or decay when the difference between successive terms is constant; a positive constant difference corresponds to linear growth while a negative constant difference corresponds to decay</p> <p>e.g. the sequence, 1, 4, 7, ... displays linear growth because the difference between successive terms is 3;</p> <p>the sequence, 100, 90, 80, ... displays linear decay because the difference between successive terms is <math>-10</math>;</p> <p>by definition, arithmetic sequences display linear growth or decay</p>
<b>logical</b>	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
<b>logically</b>	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
<b>longitude</b>	angular distance east or west on the Earth's surface, measured along the equator by the angle contained between the meridian of a particular place and the prime meridian, usually in degrees, minutes and seconds, e.g. Canberra has a longitude of $149^{\circ}08'$ E
<b>M</b>	
<b>make decisions</b>	select from available options; weigh up positives and negatives of each option and consider all the alternatives to arrive at a position
<b>manipulate</b>	adapt or change to suit one's purpose

Term	Explanation
<b>mathematical model</b>	a depiction of a situation that expresses relationships using mathematical concepts and language, usually as an algebraic, diagrammatic, graphical or tabular representation
<b>mathematical modelling</b>	involves: <ul style="list-style-type: none"> <li>• formulating a mathematical representation of a problem derived from within a real-world context</li> <li>• using mathematics concepts and techniques to obtain results</li> <li>• interpreting the results by referring back to the original problem context</li> <li>• revising the model (where necessary)</li> </ul>
<b>matrix</b>	a rectangular array of elements or entities, usually numbers, displayed in rows and columns
<b>matrix addition</b>	if <b>A</b> and <b>B</b> are matrices of the same size (order) and the elements of <b>A</b> are $a_{ij}$ and the elements of <b>B</b> are $b_{ij}$ , then the elements of <b>A</b> + <b>B</b> are $a_{ij} + b_{ij}$ e.g. $\begin{bmatrix} 2 & 1 \\ 0 & 4 \end{bmatrix} + \begin{bmatrix} 3 & -3 \\ 0 & 8 \end{bmatrix} = \begin{bmatrix} 5 & -2 \\ 0 & 12 \end{bmatrix}$
<b>matrix multiplication</b>	the process of multiplying a matrix by another matrix
<b>mean</b>	the arithmetic mean, $\bar{x}$ , of a list of numbers is the sum of the data values divided by the number of values in the list
<b>median</b>	the median is the value in an 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 is an even number of data values, the median is the mean of the two central values
<b>mental procedures</b>	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)
<b>meridian</b>	the half of a great circle of the Earth ending at the poles, used in measuring east–west position
<b>methodical</b>	performed, disposed or acting in a systematic way; orderly; characterised by method or order; performed or carried out systematically
<b>minimal</b>	least possible; small, the least amount; negligible
<b>minimum spanning tree</b>	for a given connected weighted graph, the edges that connect all vertices together with the minimum total edge
<b>mode</b>	in mathematics, the most frequently occurring value in a dataset; a dataset can have more than one mode
<b>modify</b>	change the form or qualities of; make partial or minor changes to something

Term	Explanation
<b>moving average</b>	a process that reduces the effect of non-typical data and makes the overall trend easier to see; in a time series, a simple moving average is a method used to smooth the time series by replacing each observation with a simple average of the observation and its near neighbours
<b>multimodal</b>	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
<b>N</b>	
<b>narrow</b>	limited in range or scope; lacking breadth of view; limited in amount; barely sufficient or adequate; restricted
<b>network diagram</b>	a set of points, called vertices, that are joined by a set of lines called edges; each edge joins two vertices
<b>nuanced</b>	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
<b>O</b>	
<b>objectives</b>	see 'syllabus objectives', 'unit objectives', 'assessment objectives'
<b>observation</b>	data or information required to solve a mathematical problem and/or develop a mathematical model; empirical evidence
<b>obvious</b>	clearly perceptible or evident; easily seen, recognised or understood
<b>optimal</b>	best, most favourable, under a particular set of circumstances
<b>organise</b>	arrange, order; form as or into a whole consisting of interdependent or coordinated parts, especially for harmonious or united action
<b>organised</b>	systematically ordered and arranged; having a formal organisational structure to arrange, coordinate and carry out activities
<b>outlier</b>	an outlier in a set of data is an observation that appears to be inconsistent with the other data $Q_1 - 1.5 \times \text{IQR} \leq x \leq Q_3 + 1.5 \times \text{IQR}$
<b>outstanding</b>	exceptionally good; clearly noticeable; prominent; conspicuous; striking
<b>P</b>	
<b>partial</b>	not total or general; existing only in part; attempted, but incomplete
<b>particular</b>	distinguished or different from others or from the ordinary; noteworthy

Term	Explanation
<b>path</b>	in a graph, a walk in which all the edges and all the vertices are different; a path that starts and finishes at different vertices is said to be open, while a path that starts and finishes at the same vertex is said to be closed; a cycle is a closed path
<b>perceptive</b>	having or showing insight and the ability to perceive or understand; discerning (see also 'discriminating')
<b>performance</b>	an assessment technique that requires candidates 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 candidate 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
<b>persuasive</b>	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')
<b>perusal time</b>	time allocated in an assessment to reading items and tasks and associated assessment materials; no writing is allowed; candidates may not make notes and may not commence responding to the assessment in the response space/book
<b>piece-wise linear graph</b>	a graph consisting of one or more overlapping line segments, sometimes called a line segment graph
<b>planar graph</b>	a graph that can be drawn in the plane; a planar graph can always be drawn so that no two edges cross
<b>planning time</b>	time allocated in an assessment to planning how to respond to items and tasks and associated assessment materials; candidates 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
<b>polished</b>	flawless or excellent; performed with skilful ease
<b>polynomial</b>	an expression consisting of the sum of two or more terms, each of which is the product of a constant and a variable raised to an integral power: $ax^2 + bx + c$ is a polynomial, where $a$ , $b$ , and $c$ are constants and $x$ is a variable.
<b>precise</b>	definite or exact; definitely or strictly stated, defined or fixed; characterised by definite or exact expression or execution
<b>precision</b>	accuracy; exactness; exact observance of forms in conduct or actions
<b>predict</b>	give an expected result of an upcoming action or event; suggest what may happen based on available information
<b>price-to-earnings ratio</b>	the price to earnings ratio of a share (P/E ratio) is defined as: $\text{P/E ratio} = \frac{\text{market price per share}}{\text{annual earnings per share}}$

Term	Explanation
<b>Prim's algorithm</b>	an algorithm for determining a minimum spanning tree in a connected weighted graph
<b>prime meridian</b>	the meridian from which longitude east and west is reckoned, usually that of Greenwich, England
<b>procedural vocabulary</b>	instructional terms used in a mathematical context (e.g. calculate, convert, determine, identify, justify, show, sketch, solve, state)
<b>product</b>	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
<b>proficient</b>	well advanced or expert in any art, science or subject; competent, skilled or adept in doing or using something
<b>project</b>	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
<b>propose</b>	put forward (e.g. a point of view, idea, argument, suggestion) for consideration or action
<b>prove</b>	use a sequence of steps to obtain the required result in a formal way
<b>psychomotor procedures</b>	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)
<b>purposeful</b>	having an intended or desired result; having a useful purpose; determined; resolute; full of meaning; significant; intentional
<b>Pythagoras' theorem</b>	<p>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, <math>a^2 + b^2 = c^2</math></p> 
<b>Q</b>	
<b>QCE</b>	Queensland Certificate of Education

Term	Explanation
<b>qualitative statements</b>	statements relating to a quality or qualities; statements of a non-numerical nature
<b>quantitative analysis</b>	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
<b>Queensland Certificate of Education</b>	QCE
<b>R</b>	
<b>realise</b>	create or make (e.g. a musical, artistic or dramatic work); actualise; make real or concrete; give reality or substance to
<b>reasonable</b>	endowed with reason; having sound judgment; fair and sensible; based on good sense; average; appropriate, moderate
<b>reasonableness of solutions</b>	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
<b>reasoned</b>	logical and sound; based on logic or good sense; logically thought out and presented with justification; guided by reason; well-grounded; considered
<b>recall</b>	remember; present remembered ideas, facts or experiences; bring something back into thought, attention or into one's mind
<b>recognise</b>	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
<b>recurrence relation</b>	an equation that recursively defines a sequence, that is, once one or more initial terms are given, each further term of the sequence is defined as a function of the preceding terms
<b>reducing balance loan</b>	a type of compound interest loan where the loan is repaid in regular payments and the interest paid is calculated on the amount still owing (the reducing balance of the loan) after each payment is made
<b>refined</b>	developed or improved so as to be precise, exact or subtle
<b>reflect on</b>	think about deeply and carefully
<b>rehearsed</b>	practised; previously experienced; practised extensively
<b>related</b>	associated with or linked to
<b>relevance</b>	being related to the matter at hand
<b>relevant</b>	bearing upon or connected with the matter in hand; to the purpose; applicable and pertinent; having a direct bearing on
<b>repetitive</b>	containing or characterised by repetition, especially when unnecessary or tiresome



Term	Explanation
<b>reporting</b>	providing information that succinctly describes candidate performance at different junctures throughout a course of study
<b>representatively sample</b>	in this syllabus, a selection of subject matter that accurately reflects the intended learning of a topic
<b>resolve</b>	in the Arts, consolidate and communicate intent through a synthesis of ideas and application of media to express meaning
<b>response variable</b>	also known as the dependent variable; its value is dependent on the value of the explanatory (or independent) variable
<b>routine</b>	often encountered, previously experienced; commonplace; customary and regular; well-practised; performed as part of a regular procedure, rather than for a special reason
<b>row matrix</b>	a matrix that has only one row
<b>rudimentary</b>	relating to rudiments or first principles; elementary; undeveloped; involving or limited to basic principles; relating to an immature, undeveloped or basic form
<b>S</b>	
<b>safe</b>	secure; not risky
<b>scale factor</b>	a number that scales, or multiplies, some quantity; in the equation $y = kx$ , $k$ is the scale factor for $x$ ; if two or more figures are similar, their sizes can be compared; the scale factor is the ratio of the length of one side on one figure to the length of the corresponding side on the other figure; a measure of magnification; the change of size
<b>scatterplot</b>	a two-dimensional data plot using Cartesian co-ordinates to display the values of two variables in a bivariate dataset
<b>seasonal adjustment</b>	adjusting for seasonality; a term used to describe a time series from which periodic variations due to seasonal effects have been removed
<b>seasonal index</b>	the seasonal index can be used to remove seasonality from data; an index value is attached to each period of the time series within a year; for the seasons of the year (summer, autumn, winter, spring) there are four separate seasonal indices; for months, there are 12 separate seasonal indices, one for each month, and so on; there are several methods for determining seasonal indices
<b>seasonal variation</b>	a regular rise and fall in the time series that recurs each year; seasonal variation is measured in terms of a seasonal index
<b>secure</b>	sure; certain; able to be counted on; self-confident; poised; dependable; confident; assured; not liable to fail
<b>select</b>	choose in preference to another or others; pick out

Term	Explanation
<b>sensitive</b>	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
<b>sequence</b>	place in a continuous or connected series; arrange in a particular order
<b>show</b>	provide the relevant reasoning to support a response
<b>significant</b>	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
<b>similar figures</b>	two geometric figures are similar if they are of the same shape but not necessarily of the same size
<b>simple</b>	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
<b>simple familiar</b>	problems of this degree of difficulty require candidates to demonstrate knowledge and understanding of the subject matter and application of skills in a situation where: <ul style="list-style-type: none"> <li>relationships and interactions are obvious and have few elements; and</li> <li>all of the information to solve the problem is identifiable; that is <ul style="list-style-type: none"> <li>the required procedure is clear from the way the problem is posed, or</li> <li>in a context that has been a focus of prior learning.</li> </ul> </li> </ul> Candidates are not required to interpret, clarify and analyse problems to develop responses. Typically, these problems focus on objectives 1, 2 and 3.
<b>simple graph</b>	a simple graph has no loops or multiple edges
<b>simple interest</b>	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: $I = Pin$ when plotted on a graph, the total amount accrued is shown to grow linearly
<b>simplistic</b>	characterised by extreme simplification, especially if misleading; oversimplified
<b>sine rule</b>	for a triangle of side lengths, $a$ , $b$ and $c$ and angles $A$ , $B$ and $C$ , the sine rule states that: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$
<b>size of the matrix</b>	two matrixes are said to have the same size (or order) if they have the same number of rows and columns, a matrix with $m$ rows and $n$ columns is an $m \times n$ matrix

Term	Explanation
<b>sketch</b>	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
<b>skilful</b>	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
<b>skilled</b>	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
<b>slope</b>	the steepness, incline, or grade of a line; slope is normally described by the ratio of the 'rise' divided by the 'run' between two points on a line; also 'gradient'
<b>solve</b>	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
<b>sophisticated</b>	of intellectual complexity; reflecting a high degree of skill, intelligence, etc.; employing advanced or refined methods or concepts; highly developed or complicated
<b>specific</b>	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.
<b>sporadic</b>	happening now and again or at intervals; irregular or occasional; appearing in scattered or isolated instances
<b>square matrix</b>	a square matrix has the same number of rows and columns e.g. $\begin{bmatrix} 4 & 0 \\ 7 & -2 \end{bmatrix}$
<b>standard deviation</b>	a measure of the variability or spread of a dataset; it indicates the degree to which the individual data values are spread around their mean; the standard deviation of $n$ observations $x_1, x_2, \dots, x_n$ is: $s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n - 1}}$
<b>step graph</b>	a graph consisting of one or more non-overlapping horizontal line segments that follow a step-like pattern
<b>statement</b>	a sentence or assertion
<b>straightforward</b>	without difficulty; uncomplicated; direct; easy to do or understand

Term	Explanation
<b>structure</b>	<i>verb</i> give a pattern, organisation or arrangement to; construct or arrange according to a plan; <i>noun</i> 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
<b>structured</b>	organised or arranged so as to produce a desired result
<b>subject</b>	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')
<b>subject matter</b>	the subject-specific body of information, mental procedures and psychomotor procedures that are necessary for candidates' learning and engagement within that subject
<b>substantial</b>	of ample or considerable amount, quantity, size, etc.; of real worth or value; firmly or solidly established; of real significance; reliable; important, worthwhile
<b>substantiated</b>	established by proof or competent evidence
<b>subtle</b>	fine or delicate in meaning or intent; making use of indirect methods; not straightforward or obvious
<b>successful</b>	achieving or having achieved success; accomplishing a desired aim or result
<b>succinct</b>	expressed in few words; concise; terse; characterised by conciseness or brevity; brief and clear
<b>sufficient</b>	enough or adequate for the purpose
<b>suitable</b>	appropriate; fitting; conforming or agreeing in nature, condition, or action
<b>summarise</b>	give a brief statement of a general theme or major point/s; present ideas and information in fewer words and in sequence
<b>summative assessment</b>	assessment whose major purpose is to indicate candidate achievement; summative assessments contribute towards a candidate's subject result
<b>superficial</b>	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
<b>supported</b>	corroborated; given greater credibility by providing evidence
<b>sustained</b>	carried on continuously, without interruption, or without any diminishing of intensity or extent
<b>syllabus</b>	a document that prescribes the curriculum for a course of study

Term	Explanation
<b>syllabus objectives</b>	outline what the school is required to teach and what candidates 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')
<b>symbolise</b>	represent or identify by a symbol or symbols
<b>synthesise</b>	combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding
<b>systematic</b>	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
<b>T</b>	
<b>technical vocabulary</b>	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)
<b>test</b>	take measures to check the quality, performance or reliability of something
<b>thorough</b>	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
<b>thoughtful</b>	occupied with, or given to thought; contemplative; meditative; reflective; characterised by or manifesting thought
<b>time series</b>	values of a variable recorded, usually at regular intervals, over a period of time; the observed movement and fluctuations of many such series comprise long-term trend, seasonal variation, and irregular variation or noise
<b>time series plot</b>	the graph of a time series with time plotted on the horizontal axis
<b>time zone</b>	one of the 24 regions or divisions of the globe approximately coinciding with meridians at successive hours from the observatory at Greenwich
<b>topic</b>	a division of, or sub-section within a unit; all topics/sub-topics within a unit are interrelated
<b>trail</b>	in a graph, a trail is a walk in which no edge is repeated; a closed trail must start and finish at the same vertex, whereas an open trail does not
<b>transpose</b>	to rearrange a formula, or equation, usually for the purpose of changing the subject of the formula
<b>tree</b>	in a network, a connected graph with no cycles

Term	Explanation
<b>trend</b>	in a time series, the general direction of the series (increasing/decreasing) over a long period of time
<b>true bearings</b>	true (or three-figure) bearings are measured clockwise in degrees from the north line; three figures are used to specify the direction
<b>two-way frequency table</b>	used for displaying the two-way frequency distribution that arises when a group of individuals or objects are categorised according to two criteria
<b>U</b>	
<b>unclear</b>	not clear or distinct; not easy to understand; obscure
<b>understand</b>	perceive what is meant by something; grasp; be familiar with (e.g. an idea); construct meaning from messages, including oral, written and graphic communication
<b>uneven</b>	unequal; not properly corresponding or agreeing; irregular; varying; not uniform; not equally balanced
<b>unfamiliar</b>	not previously encountered; situations or materials that have not been the focus of prior learning experiences or activities
<b>unit</b>	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
<b>unit objectives</b>	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')
<b>unrelated</b>	having no relationship; unconnected
<b>use</b>	operate or put into effect; apply knowledge or rules to put theory into practice
<b>UTC</b>	Coordinated Universal Time; a system of time measurement used to regulate time and clocks around the world, based on International Atomic Time with leap seconds added at irregular intervals to compensate for the earth's slowing rotation; except in highly technical situations, regarded as equivalent to Greenwich Mean Time; initiated in 1961 and adopted internationally in 1972
<b>V</b>	
<b>vague</b>	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
<b>valid</b>	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

Term	Explanation
<b>variable</b>	<i>adjective</i> apt or liable to vary or change; changeable; inconsistent; (readily) susceptible or capable of variation; fluctuating, uncertain; <i>noun</i> in mathematics, a symbol, or the quantity it signifies, that may represent any one of a given set of number and other objects
<b>variety</b>	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
<b>W</b>	
<b>walk</b>	in a graph, a walk is sequence of vertices such that from each vertex there is an edge to the next vertex in the sequence; a walk that starts and finishes at different vertices is said to be an open walk; a walk that starts and finishes at the same vertex is said to be closed walk
<b>weighted graph</b>	a graph in which each edge is labelled with a number used to represent some quantity associated with the edge
<b>wide</b>	of great range or scope; embracing a great number or variety of subjects, cases, etc.; of full extent
<b>with expression</b>	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
<b>Z</b>	
<b>zero matrix</b>	a matrix with all of its entries being zero e.g. $\begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$

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