Australian CURRICULUM Review

# MATHEMATICS

## CONSULTATION CURRICULUM

**All elements 7–10**

AUSTRALIAN CURRICULUM, ASSESSMENT AND REPORTING AUTHORITY

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# F–10 AUSTRALIAN CURRICULUM: MATHEMATICS

## ABOUT THE LEARNING AREA

### Introduction

The Australian Curriculum: Mathematics has been developed on the basis that all students will study Mathematics in each year of schooling from Foundation to Year 10.

### Rationale

Learning mathematics creates opportunities for, enriches and improves the lives of all Australians. The Australian Curriculum: Mathematics provides students with essential mathematical knowledge, skills and processes in number, algebra, measurement, space, probability and statistics. It develops the numeracy capabilities that all students need in their personal, work and civic lives and provides the fundamentals on which mathematical specialties and professional applications of mathematics are built.

Mathematics has its own value and beauty, and the Australian Curriculum: Mathematics aims to instil in students an appreciation of the elegance and power of mathematical reasoning. It provides students with essential content through which they can develop a deep understanding of mathematical structures, and the skills, procedures and processes to mathematise contexts and approach problem situations mathematically. The curriculum ensures that links between the various aspects of mathematics, as well as the relationship between mathematics and other disciplines, are made clear.

Throughout schooling, actions such as posing questions, abstracting, recognising patterns, practising skills, modelling, investigating, experimenting, simulating, making and testing conjectures, play an important role in the growth of students' mathematical knowledge and skills. Grasping how things are related to each other is a critical aspect of understanding the world and the capacity of students to engage with it.

Looking for, recognising, and analysing connections and relationships are key parts of sense making for humans from the very earliest age. Through its focus on relationships within and beyond the discipline, school mathematics makes a significant contribution to the capacity of young people for sense making that is transferable throughout their lives.

The modern world is influenced by ever expanding computer power, digital systems, automation, artificial intelligence, economics and a data driven society. This leads to the need for an increased Science, Technology, Engineering and Mathematics (STEM) workforce. Mathematics is not only integral to quantifying, thinking critically and making sense of the world, it is central to building students' pattern recognition, visualisation, spatial reasoning and computational skills, which are essential to STEM.

The Mathematics curriculum supports students in applying their mathematical understanding creatively and efficiently. It enables teachers to help students become self-motivated, confident learners through inquiry and active participation in relevant and challenging experiences.

## Aims

The Australian Curriculum: Mathematics aims to ensure that students:

- become confident and effective users, critical thinkers and communicators of mathematics, able to investigate, represent and interpret situations in their personal and work lives and make choices as active, numerate citizens
- develop capabilities for mathematical concepts, skills and processes and use them to pose and solve problems and reason with number, algebra, measurement, space, statistics and probability
- make connections between the areas of mathematics and apply mathematics to model situations in various fields and disciplines
- appreciate mathematics as an accessible, equitable, applicable and enjoyable discipline to study
- acquire the specialist knowledge and skills in mathematics that underpin numeracy development and lead to further study in the discipline.

## Organisation of the learning area

### *Content structure*

The Australian Curriculum: Mathematics is presented in year levels for each year from Foundation to Year 10.

### *Year level descriptions*

Year level descriptions provide an overview of the learning that students should experience at each year level. They highlight the important interrelationships of the content strands and of the content strands to the core concepts for each year level.

### *Achievement standards*

Achievement standards describe the expected quality of learning that students should typically demonstrate by the end of each year.

### *Content descriptions*

Content descriptions specify the essential knowledge, understanding and skills that students are expected to learn, and teachers are expected to teach, in each year. The content descriptions are organised into strands.

### *Content elaborations*

Content elaborations provide teachers with suggestions and illustrations of ways to teach the content descriptions. They are optional material only; they are not a set of complete or comprehensive content points that all students need to be taught. They illustrate and exemplify content descriptions with a diverse range of examples.

### *Strands*

Content in the Australian Curriculum: Mathematics is organised under six interrelated strands:

- Number
- Algebra
- Measurement
- Space
- Statistics
- Probability.

Natural connections exist between the content of these strands. It is important that students develop the capability to identify and use the many connections that exist within and across all strands of the Australian Curriculum: Mathematics. This will help them to develop a deeper understanding of the core concepts of mathematics.

### *Read more*

#### Number

Number develops ways of working with mental constructs that deal with correspondence, magnitude and order, for which operations can be defined. Numbers have immense application and specific uses in counting, measuring and other means of quantifying situations and the attributes of objects. Number systems are constructed to deal with different contexts and problems, involving finite and infinite, discrete and continuous sets. Being able to work with numbers is critical to being an active and productive citizen who is successful at work and in future learning, financially literate, equitable and engages with the world and other individuals.

### Algebra

Algebra develops ways of using symbols and symbolic representations to think and reason about relationships in both mathematical and real-world contexts. It provides a means for manipulating mathematical objects, recognising patterns, abstracting information, working with variables and generalising relationships. Algebra connects symbolic, graphic and numeric representations and deals with situations of generality, communicating abstract ideas applied in areas such as science, health, finance, sports, engineering, and building and construction.

### Measurement

Measurement develops ways of quantifying aspects of the human and physical world. Measures and units are defined selected and to be relevant and appropriate to the context. Measurement is used to answer questions, show results, demonstrate value, justify allocation of resources, evaluate performance, identify opportunities for improvement and manage results. Measurement underpins understanding, comparison and decision making in many personal, societal, environmental, agricultural, industrial, health and economic contexts.

### Space

Space develops ways of visualising, representing and working with the location, direction, shape, placement, proximity and transformation of objects at macro, local and micro size in natural and created worlds. It underpins the capacity to construct pictures, diagrams, maps, projections, models and graphic images that enable the manipulation and analysis of shapes and objects through actions and the senses. This includes notions such as continuity, curve, surface, region, boundary, object, dimension, connectedness, symmetry, direction, congruence and similarity in art, design, architecture, planning, transportation, construction and manufacturing, physics, engineering, chemistry, biology and medicine.

### Statistics

Statistics provides ways of understanding and describing variability in data and its distribution. Statistics provides a story, supports an argument and is a means for the comparative analysis that underpins decision making and informs a process for making informed judgements. Statistical literacy requires an understanding of statistical information and processes, including an awareness of data and the ability to interpret, evaluate and communicate statistically, whilst providing a basis for the critical scrutiny of the accuracy of representations and the validity of inferences and claims. Acknowledging and expecting variation in the collection, analysis and interpretation of data are essential to the effective practice of statistics.

## Probability

Probability provides ways of dealing with uncertainty, making predictions and characterising the likelihood of events. It allows us to analyse random phenomena – events that are governed by chance and for which it is impossible to determine the outcome(s) before it occurs. In contexts where chance plays a role, probability provides both experimental and theoretical approaches to making numerical estimates of how likely a particular outcome is to occur or how likely it is that a proposition is the case. This allows us to better understand contexts involving chance and to build mathematical models that help us make better informed decisions in a range of areas of human endeavour. These areas include but are not limited to finance, science, gambling, computer science and artificial intelligence.

### *Core concepts*

Core concepts are the big ideas, understandings, skills or processes that are central to the Mathematics curriculum. They give clarity and direction about what content matters most in the learning area. In the curriculum development process, core concepts help identify the essential content students should learn to develop a deep and increasingly sophisticated understanding of mathematics across the years of schooling. They ensure content is connected within and across the strands, building in sophistication across the year levels.

Core concepts in Mathematics centre around the three organising ideas of mathematical structures, approaches and mathematising. The core concepts underpin the study of mathematics across the six content strands of number, algebra, measurement, space, statistics and probability. Knowledge and conceptual understanding of mathematical structures and approaches enables students to mathematise situations, making sense of the world.

The use of core concepts has enabled the proficiencies of understanding, fluency, reasoning and problem solving from the previous version of the Australian Curriculum: Mathematics to be integrated across the six content strands and the achievement standards of this version. The curriculum enables the development of increasingly sophisticated and refined mathematical understanding, fluency, reasoning and problem-solving skills interdependently through the specification of essential content in the content descriptions, and the expectations for student learning in the achievement standards, both of which are designed to promote thinking and working mathematically. This ensures that students’ mathematical proficiency develops throughout the curriculum and becomes increasingly sophisticated over the years of schooling.

Figure 1 gives an overview of the relationship between the six strands and the three core concept organisers in Mathematics.

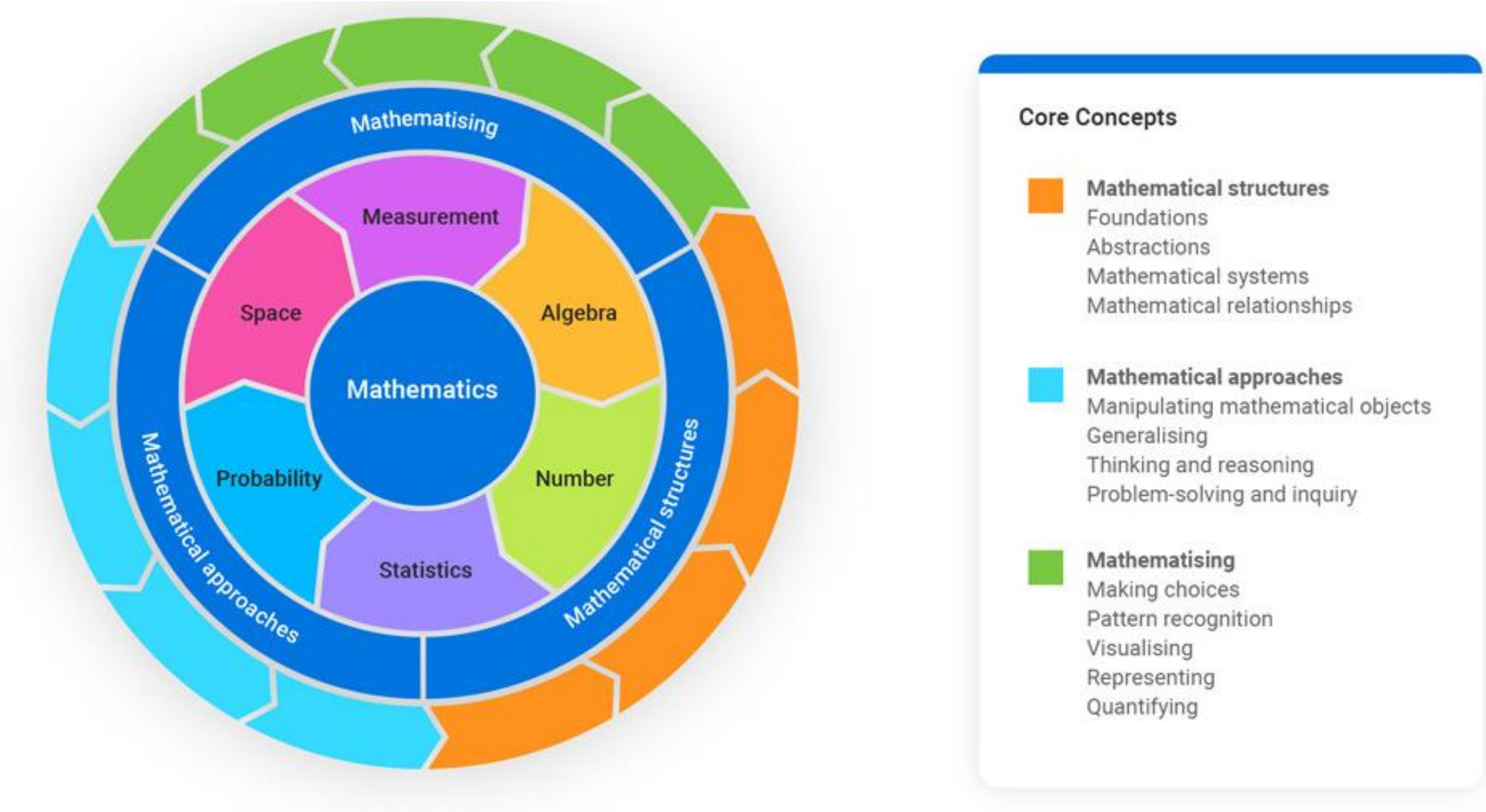


*Figure 1: Relationship between the six strands and three core concept organisers*

***Read more***

**Mathematical structures –** the fundamental elements of mathematical systems, objects, operations and computations and how they are defined and relate to each other. Core concepts critical to understanding mathematical structures are:

- *Foundations* – the building blocks underpinning and supporting mathematical structures
- *Abstractions* – the results of the process of identifying and purposefully paying attention to key aspects of a situation, context, problem or issue and disregarding others that are not seen as relevant to the focus
- *Mathematical systems* – those symbols, objects, operations, variables, relations and functions that provide an interpretation of a structure that can be used in context
- *Mathematical relationships* – how mathematical objects are connected to each other.

**Mathematical approaches –** the processes and ways of thinking and working with mathematical objects, ideas, structures to conduct experiments and simulations, carry out investigations, apply mathematics to model situations, make deductions and solve problems. Core concepts important to understanding mathematical approaches are:

- *Manipulating mathematical objects* – skills and procedures associated with operations and transformations applied to mathematical structures to efficiently obtain answers, modify existing objects or create new ones, in order to provide a basis for insights and conclusions
- *Generalising* – enabling or providing the description of general rules that flow from operating on and with mathematical objects
- *Thinking and reasoning* – skills and processes that enable generalisation and the transfer of learning from one context to another and that support effective problem solving, inquiry and other ways of working mathematically
- *Problem-solving and inquiry* – skills and processes that require thinking and working mathematically to understand the situation, plan, choose an approach, formulate, apply the relevant mathematics, selecting appropriate and efficient computation strategies, consider results and communicate findings and reasoning; Problem-solving and inquiry approaches that involve thinking and working mathematically include experimenting, investigating, modelling and computational thinking.

**Mathematising –** the process of seeing the world using mathematics by recognising, interpreting and representing situations mathematically. Core concepts important to mathematising draw on the concepts related to mathematical structures and approaches and are:

- *Making choices* – recognising mathematical structures and making systematic choices about mathematical approaches
- *Pattern recognition* – identifying likeness, coherence, commonality, difference or regularity fundamental to identifying structures, relationships, generalisations and the means for mathematising a problem
- *Visualising* – forming and thinking about mental images of mathematical objects and the relationships between them
- *Representing* – using words, physical and virtual materials, symbols, drawings, diagrams and graphs to represent abstract mathematical ideas and objects in order to analyse, generalise and communicate mathematically
- *Quantifying* – assigning numerical or qualitative measures to properties of objects and events that can be used to define, measure, compare or interpret the property.

## Key connections

### *General capabilities*

In the Australian Curriculum, general capabilities equip young Australians with the knowledge, skills, behaviours and dispositions to live and work successfully.  General capabilities are developed through learning area content; they are not separate learning areas, subjects or isolated skills.

While literacy and numeracy are fundamental to all learning, numeracy development is core to the Mathematics curriculum.

Opportunities to develop general capabilities in learning area content vary. In addition to Numeracy and Literacy, the general capabilities of most relevance and application to Mathematics are Critical and Creative Thinking, Digital Literacy and Ethical Understanding.

General capabilities are identified in content descriptions when they are developed or applied through learning area content. They are also identified in content elaborations when they offer opportunities to add depth and richness to student learning.

***Read more***

#### Numeracy

The Australian Curriculum: Mathematics has a central role in the development of numeracy in a manner that is more direct than is the case in other learning areas. It is important that the Mathematics curriculum provides the opportunity to apply mathematical understanding and skills in other learning areas and to real-world contexts. A particularly important context for the application of *number, algebra, measurement* and *probability* is financial mathematics. In *measurement* and *space*, there is an opportunity to apply understanding to design and construction. Today's world is information driven, and through *statistics* and *probability,* students can interpret and critically analyse data and make informed judgements about events involving uncertainty.

### Literacy

The Australian Curriculum: Mathematics focuses on the development of the essential skills and understandings necessary for students to communicate their thinking, reasoning and solutions to problems using appropriate mathematical language, notation and symbology within the context of given situations. Students learn the vocabulary associated with mathematical concepts and processes, number, algebra, space, measurement and statistics and probability. This vocabulary includes technical terminology, common words with specific meanings in a mathematical context. They also learn that context affects the understanding of mathematical terminology and that mathematical understandings are expressed using particular language forms and features. Students use their developing literacy skills to interpret and create a range of texts that typically relate to mathematics. These range from calendars and maps to complex data displays and statistical reports. Students use literacy skills to understand and interpret contexts and problem situations and formulate them into mathematical questions using the language features of mathematics. They pose and answer questions, discuss and collaborate in mathematical problem solving and produce and justify solutions.

### Critical and Creative Thinking

In the Australian Curriculum: Mathematics, students develop critical and creative thinking as they learn to evaluate information, ideas and possibilities when seeking solutions. The engagement of students in reasoning and thinking about solutions to problems and the strategies needed to find these solutions is a core part of the Australian Curriculum: Mathematics. Students are encouraged to be critical thinkers when justifying their choice of a computation strategy or developing relevant questions during a statistical investigation. They are encouraged to look for alternative ways to approach mathematical problems, for example, identifying when a problem is similar to a previous one, experimenting with new ideas or simplifying a problem to control or limit the number of variables.

### Digital Literacy

In the Australian Curriculum: Mathematics, students develop an understanding of digital literacy and related skills when they investigate, create and communicate mathematical ideas and concepts using automated, interactive and multimodal technologies. They draw on digital literacy skills to perform computations; construct graphs; conduct probability simulations; collect, manage, analyse and interpret data; experiment mathematically; share and exchange information and ideas; and investigate and model concepts and relationships.

Digital tools, with numerical, graphical, spatial, symbolic and statistical functionality, such as spreadsheets, graphing software, statistical software, dynamic geometry software and computer algebra software, can engage students, enable them to work on complex and sophisticated problems and promote the understanding of core concepts.

### Ethical Understanding

In the Australian Curriculum: Mathematics, there are opportunities to explore, develop and apply ethical understanding in a range of contexts. Examples of these contexts include rational inquiry, including sampling, collecting, analysing and interpreting data and statistics; being alert to intentional and accidental errors or distortions and questions of validity in propositions and inferences; finding inappropriate or inconsistent comparisons and misleading scales when exploring the importance of fair comparison; providing equitable solutions; and interrogating financial claims and sources.

## *Cross-curriculum priorities*

Cross-curriculum priorities support the Australian Curriculum to be a relevant, contemporary and engaging curriculum that reflects regional, national and global contexts. Cross-curriculum priorities are incorporated through learning area content; they are not separate learning areas or subjects. They provide opportunities to enrich the content of the learning areas, where most appropriate and authentic, allowing students to engage with and better understand their world.

Opportunities to apply cross-curriculum priorities to learning area content vary. The cross-curriculum priorities of most relevance and meaning to the Mathematics curriculum are Sustainability and Aboriginal and Torres Strait Islander Histories and Cultures. Both cross-curriculum priorities are identified in content elaborations where they can offer opportunities to add depth and richness to student learning.

***Read more***

### Aboriginal and Torres Strait Islander Histories and Cultures

In the Australian Curriculum: Mathematics, students can engage with and value Aboriginal and Torres Strait Islander Peoples' histories and cultures in relation to mathematics. Aboriginal and Torres Strait Islander Peoples have complex kinship systems that connect all people to environmental systems, which is the hallmark of sustainability. They tend to be systems thinkers who are adept at pattern and algebraic thinking, which informs Aboriginal and Torres Strait Islander Peoples' cultural expressions, ways of caring for Country/Place, and the development of material culture.

Content elaborations in Mathematics have been structured around identified themes in Aboriginal and Torres Strait Islander Peoples' mathematical thinking, understandings and processes, in contexts that can be taught across the content strands and through the year levels. They provide a rich, connected narrative by returning to contextual examples from all over Australia. For example, within the probability and statistics strands, stochastic reasoning is developed through Aboriginal and Torres Strait Islander instructive games and toys. Spatial reasoning is linked to land/cultural/star maps and proportional reasoning is learned in relation to material culture, such as weaving or strings and cordage.

### Sustainability

In the Australian Curriculum: Mathematics, students develop skills in mathematical modelling, statistical investigation and analysis, which are essential for the exploration of sustainability issues and proposed solutions. Students can apply spatial reasoning, measurement, estimation, calculation and comparison to gauge the health of local ecosystems and to cost proposed actions for sustainability. Mathematical understandings and skills are necessary to model, measure, monitor and quantify change in social, economic and ecological systems over time. Statistical analysis enables the prediction of probable futures based on findings and helps inform decision making and actions that will lead to preferred futures.

## *Learning areas*

The Australian Curriculum: Mathematics provides opportunities to integrate and connect content to other learning areas; in particular, Science, Technologies, The Arts, and Humanities and Social Sciences (HASS).

***Read more***

### Mathematics and Science

Mathematics and Science share a focus on modelling, measurement, empirical reasoning, inquiry, experimentation and investigation. In Science and Mathematics, students develop models to represent amounts, relationships, relative scales and patterns. They are introduced to measurement, first using informal units, then using formal units. Later, they consider issues of uncertainty and reliability in measurement. As students progress, they collect qualitative and quantitative data, which are analysed and represented in a range of forms. Students learn data analysis skills, including identifying trends and patterns from numerical data and graphs.

### Mathematics and Digital Technologies

Mathematics and Digital Technologies share a focus on data, computational and algorithmic thinking. The Mathematics curriculum supports students to gain the knowledge and skills that underpin pattern recognition, data collection, interpretation and representation, which form the basis of statistical investigation. Digital Technologies focuses on how digital systems represent data. It develops students' foundational understanding of algorithms in the early years, which Mathematics then builds upon. The implementation, design and creation of algorithms in Mathematics form an integral part of a computational approach to learning and experimenting in mathematics; it complements Digital Technologies and supports the development of computational and algorithmic thinking skills.

### Mathematics and Design and Technologies

Design and Technologies gives students opportunities to interpret and use mathematical knowledge and skills in a range of real-life situations. Students use number to quantify, measure and estimate; interpret and draw conclusions from statistics; measure and record throughout the process of generating ideas; develop, refine and test concepts; and cost and sequence when making products and managing projects. They use three-dimensional models, create accurate technical drawings, work with digital models and use computational thinking in decision-making processes when designing and creating best-fit solutions.

### Mathematics and The Arts

Mathematics and The Arts share understandings about pattern, measurement and spatial reasoning. In Mathematics, students use this knowledge to solve problems and model solutions. In The Arts, the knowledge is applied when creating, interpreting, analysing and learning about art works. Mathematics and The Arts both give students opportunities to learn about, and through, observation of natural and constructed environments. Students can communicate their mathematical understandings through forms of art such as visual, sonic, dramatic and kinaesthetic. They can use, for example, traditional art-making materials, found or recycled materials, or digital technology. There are opportunities for students to apply mathematical understanding when they use specific arts processes or practices; for example, using knowledge of measurement and spatial reasoning when creating an observational drawing or choosing pathways and levels in dance and drama. In music, students can apply knowledge of patterns and algorithms when composing.

### Mathematics and Humanities and Social Sciences

Mathematics and Humanities and Social Sciences (HASS) share a focus on financial literacy and exploratory data analysis; this includes understanding the principles of financial management to make informed financial and business decisions. Mathematics draws on aspects of the HASS curriculum to provide rich contexts through which to teach and apply mathematics. Students learn to organise, interpret, analyse and present information about historical and civic events and developments in numerical and graphical form to make meaning of the past and present. They learn to use scaled timelines, including those involving negative and positive numbers, and calendars and dates to represent information on topics of historical significance and to illustrate the passing of time. In constructing and interpreting maps, students work with numerical concepts associated with grids, scale, distance, area and projections.

## Key considerations

Learning mathematics requires sustained effort in response to deep and rich learning activities. The Australian Curriculum: Mathematics emphasises the importance of providing opportunities for students to develop mathematical proficiency. It focuses on the development of an increasingly sophisticated understanding of mathematical concepts and fluency in procedures, interconnected with sound mathematical reasoning, problem-solving skills and acceptance of the relevance and importance of learning mathematics. Proficiency in mathematics enables students to respond to familiar and unfamiliar situations by employing mathematical strategies to make informed decisions and solve problems efficiently.

The breadth of opportunities that teachers can plan for, and the interdependent actions in which students can engage when developing mathematical proficiency, are described below.

### *Understanding*

The Australian Curriculum: Mathematics provides opportunities for students to build and refine a robust knowledge and understanding of mathematical concepts. This helps students make connections between related ideas and progressively draw upon their reasoning skills to adapt and transfer understanding of familiar applications to unfamiliar contexts and cultivate new ideas. They develop an understanding of the relationship between the 'why' and the 'how' of mathematics. Students build conceptual understanding and procedural fluency when they connect related ideas, represent concepts in different ways, identify commonalities and differences between aspects of content, describe their thinking mathematically and interpret mathematical information.

### *Fluency*

The Australian Curriculum: Mathematics provides opportunities for students to develop and consolidate the skills choose appropriate procedures; carry out procedures flexibly, accurately, efficiently and appropriately; and apply knowledge and understanding of concepts readily. Students are fluent when they choose and use computational strategies efficiently, when they recognise robust ways of answering questions, when they choose appropriate representations and approximations, when they understand and regularly apply definitions, facts and theorems, and when they can manipulate mathematical objects, expressions, relations and equations to find solutions to problems.

### *Reasoning*

The Australian Curriculum: Mathematics emphasises mathematical reasoning as a critical component in the development of mathematical proficiency as well as a core concept central to the approaches for thinking and working mathematically. The Australian Curriculum: Mathematics guides students in developing an increasingly sophisticated capacity for logical thought and actions, such as analysing, proving, experimenting, modelling, evaluating, explaining, inferring, justifying and generalising. Students are reasoning mathematically when they explain their thinking, deduce and justify strategies used and conclusions reached, adapt the known to the unknown, transfer learning from one context to another, prove that something is true or false, and when they compare and contrast related ideas and reflect upon and explain their choices.

### *Problem solving*

The Australian Curriculum: Mathematics recognises the importance of providing students with meaningful opportunities to apply mathematics to authentic problems relating to both the natural and created worlds. Mathematical problem solving is a core concept central to the approaches for thinking and working mathematically and an essential component to the development of mathematical proficiency. The Australian Curriculum: Mathematics supports students to develop the ability to make choices, interpret, formulate, model and investigate problem situations. It helps them to draw upon their understanding, fluency and reasoning skills to provide and communicate solutions effectively. Students formulate and solve problems when they: apply mathematics to model and represent meaningful or unfamiliar situations; design investigations and plan their approaches; choose and apply their existing strategies to seek solutions; reflect upon and evaluate approaches; and verify that their answers are reasonable.

In the Australian Curriculum: Mathematics, proficiency in problem solving is developed through applying the understanding, thinking and reasoning skills and processes involved in *experimenting, investigating, modelling and computational thinking.*

### *Experimentation*

The Australian Curriculum: Mathematics promotes experimentation in mathematics through an emphasis on exploration and play based learning in the early years leading to chance experiments, probability simulations and an explicit introduction to experimentation with computational thinking. As outlined below, the Australian Curriculum: Mathematics introduces students to this way of thinking and some of the relevant techniques. However, experimentation in mathematics need not involve the use of digital tools. When students of all ages ask the question “What if...?”, the stage can be set for them to experiment with the mathematics they know to find an answer (if there is one). The result matters *to them*, thus their engagement and ownership is enhanced. Experimenting with mathematics requires mathematical reasoning for students to plan what to do and evaluate what they find out.

### *Investigation*

The Australian Curriculum: Mathematics provides opportunity for students to conduct investigations. These will begin as informal exploration in the early years, then guided processes which eventually lead them to conduct, review and critique their and others’ investigation processes. There are common and distinctive aspects of investigative approaches in mathematics and statistical inquiry. Statistical inquiry deals with uncertainty and variability in data arising from a context. Statistical investigations can be initiated by a specific question, a situation, or an issue. Mathematical investigations provide opportunities for students to explore practical or theoretical situations systematically, formulate problems, recognise patterns, make conjectures and discover meaning.

### *Mathematical modelling*

The Australian Curriculum: Mathematics recognises the importance of mathematical modelling to the development of conceptual understanding and application of mathematical structures. Modelling is central to the contemporary discipline of mathematics and is fundamental to the practical application of mathematics. Mathematical modelling is the process of using mathematics to make decisions, predict outcomes and understand relationships that exist in authentic real-world scenarios by mathematising a situation, recognising, connecting and applying mathematical structures and using mathematical approaches to manipulate, analyse, generalise, interpret and communicate within the context of the modelling situation. A key aspect of modelling is to identify and attend to key aspects of a situation or context while ignoring others. This enables a simpler version to be constructed for a particular purpose and predictions to be made based on the model, which can then be tested and the model validated or further refined.

### *Computational thinking*

The Australian Curriculum: Mathematics aims to develop students' computational thinking through the application of its various components, including decomposition, abstraction, pattern recognition, modelling and simulation, algorithms and evaluation. Computational thinking provides the strategic basis that underpins the central role of computation and algorithms in mathematics and their application to inquiry, modelling and problem solving in mathematics and other fields. Computational approaches involve experimental and logical analysis, empirical reasoning and computer-based simulations. These enable large sets of examples and other results to be obtained quickly, accurately, and reliably to generate and test hypotheses and conjectures, identify patterns and key features, and dynamically explore variation in the behaviour of structures, systems and scenarios.

### *Computation, algorithms and the use of digital tools in mathematics*

The term *computation* is used in mathematics to refer to operations, transformations and processes that are applied to mathematical objects to produce an output or result. This may be an arithmetic calculation, an algorithm, the graph of a relation or function, a set, list, sequence or table of values, a diagram or shape, a proposition, or an algebraic expression.

Some computations may be *dynamic*, that is, they enable parameters, conditions and constraints to be varied and the corresponding results to be progressively shown. Examples include the effect of varying an outlier on; the mean of a data set; the behaviour of an algorithm; ordering the elements of a set; observing the relative frequency of an event as the number of experiments increases; manipulating an object in three dimensions and observing any symmetries; or the transformation of the graph of a function or relation by varying defining parameters, for example, the effect of changing the gradient of a linear function.

The objects of computations may be sets of numbers, letters or words, types of data, points, shapes and objects in space, images, diagrams, networks, or symbolic and logical expressions including equations. Different types of digital tools or platforms provide functionalities that can carry out computations and implement algorithms using various types of numerical, textual, statistical, probabilistic, financial, geometrical, graphical, logical, and symbolic functionalities.

These functionalities may be accessed through hand-held devices such as calculators of various kinds (arithmetic four operation, scientific, graphics, financial, CAS), software on a computer or tablet (spreadsheet, dynamic geometry, statistical, financial, graphing, computer, algebra), an application on a personal device, or accessed from the internet or cloud.

The capacity to purposefully select and effectively use functionality from a device or platform is a key aspect of computational thinking in the Mathematics curriculum that is to be explicitly developed and used to learn and apply mathematics in and across the six strands.

## CURRICULUM ELEMENTS

### Year 7

| Level description |
|---|
| The Australian Curriculum: Mathematics focuses on the development of a deep knowledge and conceptual understanding of mathematical structures and fluency with procedures. Students learn through the approaches for working mathematically, including modelling, investigation, experimentation and problem solving, all underpinned by the different forms of mathematical reasoning. As students engage in learning mathematics in Year 7 they:<br>• develop their understanding of integer and rational number systems and their fluency with mental calculation, written algorithms, and digital tools and routinely consider the reasonableness of results in context<br>• use exponents and exponent notation to consolidate and formalise their understanding of representations of natural numbers and use these to explore conjectures involving natural numbers by experiment and computational thinking with the assistance of digital tools<br>• explore the use of algebraic expressions and formulas using conventions, notations, symbols and pronumerals as well as natural language. They interpret algebraic expressions and formulas, use substitution to evaluate and determine unknown terms given values for other terms<br>• use variables, constants, relations and functions to express relationships in real life data and interpret key features of their representation in rules, tables and graphs<br>• classify shapes in the plane and use tools to construct shapes, including two-dimensional representations of prisms and other objects. They investigate spatial patterns involving repetition created with transformations and line and point symmetry<br>• they apply the statistical investigation cycle to obtain numerical data related to questions of interest, choose displays for the distributions of data and interpret summary statistics for determining the centre and spread of the data in context<br>• conduct simple experiments involving chance events, construct corresponding sample spaces and explore related frequencies, comparing expected and experimental results. |
| **Achievement standard** |
| By the end of Year 7, students use all four operations in calculations involving positive fractions and decimals, using the properties of number systems and choosing the computational approach. They represent natural numbers in expanded form and as products of prime factors, using exponent notation. Students model and solve problems involving addition and subtraction of integers. They determine equivalent representations of rational numbers and choose from fraction, decimal and percentage forms to assist in computations. They solve problems involving rational numbers, percentages and ratios and explain their |

choice of representation of rational numbers and results when they model situations, including those in financial contexts. They use algebraic expressions to model situations and represent formulas. Students substitute values into these formulas to determine unknown values and interpret these in the context. They use computational thinking and digital tools to generate tables of values related to algebraic expressions including formulas, evaluating the effect of variation.

Students apply knowledge of angle relationships involving parallel lines and a transversal, and the sum of angles in a triangle to solve problems, giving reasons. They develop, explain and apply measurement formulas involving the areas of triangles and parallelograms and the volumes of rectangular and triangular prisms to solve practical problems Students describe the relationships between the radius, diameter and circumference of a circle. They classify polygons and other shapes according to their features and represent objects two-dimensionally in different ways reasoning about these representations. Students use coordinates to describe transformations of points in the plane.

They plan and conduct statistical investigations involving numerical data, use appropriate displays to represent the distribution and interpret this data in terms of summary statistics, with informal consideration of possible outliers. Students decide which central measure (mean, median or mode) is most suitable and explain their reasoning. They list sample spaces for single step experiments, assign probabilities to outcomes, determine probabilities for related events and compare these to results obtained empirically, giving reasons for differences between expected and observed results.

| Strand | Content description<br>*Students learn to:* | Elaboration<br>*This may involve students:* |
|---|---|---|
| Number | investigate and use square roots of perfect square numbers (AC9M7N01) | investigating squares of natural numbers from 1 to 20, linking them to visual representations such as dots arranged in a square pattern; using visual representations to connect the square root and square root notation (AC9M7N01_E1) |
| | | investigating between which two natural numbers the square root of a given number lies, for example, 43 is between the square numbers 36 and 49 so $\sqrt{43}$ is between $\sqrt{36}$ and $\sqrt{49}$ therefore between 6 and 7 (AC9M7N01_E2) |
| | | creating an algorithm that will generate a list of perfect square numbers and exploring and describing any emerging patterns, for example, exploring the difference between consecutive square numbers and recognising the emerging pattern (AC9M7N01_E3) |
| | | using the relationship between perfect square numbers and their square roots to determine the perimeter of a square tiled floor given its respective area (AC9M7N01_E4) |

| | | |
|---|---|---|
| | investigate exponent notation and represent natural numbers as products of powers of prime numbers (AC9M7N02) | applying knowledge of factors including repeated division by prime factors to express natural numbers as products of powers of prime factors, such as $48 = 6 \times 8 = 2 \times 3 \times 2 \times 2 \times 2 = 3^1 \times 2^4 = 3 \times 2^4$ (AC9M7N02_E1) |
| | | developing familiarity with the sequence 1, 2, 4, 8, 16, 32, 64, 128, 256, 512 and powers of 2; the sequence 1, 3, 9, 27, 18, 243, 729 and powers of 3; and the sequence 1, 5, 25, 125, 625 and powers of 5 (AC9M7N02_E2) |
| | | solving problems involving lowest common multiples and greatest common divisors (highest common factors) for pairs of natural numbers by comparing their prime factorization (AC9M7N02_E3) |
| | | applying knowledge of factors to strategies for expressing natural numbers as products of powers of prime factors, such as repeated division by prime factors or creating factor trees (AC9M7N02_E4) |
| | use place value and powers of 10 to represent natural numbers in expanded notation (AC9M7N03) | investigating exponent notation for powers of ten such as '*one hundred thousand'* is $100\,000 = 10 \times 10 \times 10 \times 10 \times 10 = 10^5$ (AC9M7N03_E1) |
| | | relating the sequences 10, 100, 1000, 100 000 … and $10^1$, $10^2$, $10^3$, $10^4$ ... (AC9M7N03_E2) |
| | | applying and explaining the connections between place value and expanded notations, for example, $7000 = 7 \times 10^3$ and $3750 = 3 \times 10^3 + 7 \times 10^2 + 5 \times 10$ (AC9M7N03_E3) |
| | round decimals correct to a given accuracy with respect to the context and the purpose of the calculation. Use appropriate rounding and estimation to make decisions about the reasonableness of solutions (AC9M7N04) | identifying the interval between a pair of consecutive integers that includes a given rational number (AC9M7N04_E1) |
| | | applying the convention for rounding correct to a specified number of decimal places (AC9M7N04_E2) |
| | | checking that the accuracy of rounding is suitable for context and purpose such as the amount of paint required and cost estimate for renovating a house, for example, purchasing 2 litres of paint to paint the bedroom even though 1.89 litres is the exact answer or estimating a renovation budget to the nearest $100 rather than exactly (AC9M7N04_E3) |
| | determine equivalent fraction, decimal and percentage representations of rational numbers. Locate and represent | investigating equivalence of fractions using common multiples and a fraction wall, diagrams or a number line to show that a fraction such as $\frac{2}{3}$ is equivalent to $\frac{4}{6}$ and $\frac{6}{9}$ and therefore $\frac{2}{3} < \frac{5}{6}$ (AC9M7N05_E1) |
| | | expressing a fraction in simplest form using common divisors (AC9M7N05_E2) |

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| | positive and negative fractions, decimals and mixed numbers on a number line (AC9M7N05) | applying and explaining the equivalence between fraction, decimal and percentage representations of rational numbers, for example, 16%, 0.16, $\frac{16}{100}$ and $\frac{4}{25}$, using manipulatives, number lines or diagrams (AC9M7N05_E3) |
| | | representing positive and negative fractions and mixed numbers on various intervals of the real number line, for example, from -1 to 1, -10 to 10 and number lines that are not symmetrical about zero or without graduations marked (AC9M7N05_E4) |
| | | investigating equivalence in fractions, decimals and percentage forms in the patterns used in the weaving designs of Aboriginal and Torres Strait Islander Peoples (AC9M7N06_E5) |
| | carry out the four operations with fractions and decimals and solve problems involving rational numbers and percentages, choosing representations that are suited to the context and enable efficient computational strategies (AC9M7N06) | exploring addition and subtraction problems involving fractions and decimals, for example, using rectangular arrays with dimensions equal to the denominators, algebra tiles, digital tools or informal jottings (AC9M7N06_E1) |
| | | choosing an appropriate numerical representation for a problem so that efficient computations can be made, such as 12.5%, $\frac{1}{8}$, 0.125 or $\frac{25}{1000}$ (AC9M7N06_E2) |
| | | developing efficient strategies with appropriate use of the commutative and associative properties, place value, patterning, multiplication facts to solve multiplication and division problems involving fractions and decimals, for example, using the commutative property to calculate $\frac{2}{3}$ of $\frac{1}{2}$ giving $\frac{1}{2}$ of $\frac{2}{3} = \frac{1}{3}$ (AC9M7N06_E3) |
| | | exploring multiplicative (multiplication and division) problems involving fractions and decimals such as fraction walls, rectangular arrays, algebra tiles, calculators or informal jottings (AC9M7N06_E4) |
| | | developing efficient strategies with appropriate use of the commutative and associative properties, regrouping or partitioning to solve additive (addition and subtraction) problems involving fractions and decimals (AC9M7N06_E5) |
| | | calculating solutions to problems using the representation that makes computations efficient such as 12.5% of 96 is more efficiently calculated as $\frac{1}{8}$ of 96, including contexts such as, comparing land-use by calculating the total local municipal area set aside for parkland or manufacturing and retail, the amount of protein in daily food intake across several days, or increases/decreases in energy accounts each account cycle (AC9M7N06_E6) |
| | | using the digits 0 to 9 as many times as you want to find a value that is 50% of one number and 75% of another |

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| | | using two-digit numbers (AC9M7N06_E7) |
| | compare, order, add and subtract integers. Model and solve problems (including financial contexts) involving addition and subtraction of integers (AC9M7N07) | using less-than and greater-than notation in expressions when comparing and ordering integers, for example, negative five is less than positive two and can be represented as $(-5) < (+2)$ ; $(-3) > (-6)$ (AC9M7N07_E1) |
| | | applying knowledge of integers when solving financial problems involving profit and loss (AC9M7N07_E2) |
| | | discussing language such as ‘addition’, ‘subtraction’, ‘magnitude’, ‘difference’, ‘sign’ and synonyms of these terms, and using them to model practical situations involving addition and subtraction of integers such as credits and debits, gains and losses (AC9M7N07_E3) |
| | model situations (including financial contexts) and solve problems using rational numbers and percentages and digital tools as appropriate. Interpret results in terms of the situation (AC9M7N08) | calculating mentally or with calculator using rational numbers and percentages to find a proportion of a given quantity, for example, 0.2 of total pocket money is spent on bus fares, 55% of Year 7 students attended the end of term function, 23% of the school population voted yes to a change of school uniform (AC9M7N08_E1) |
| | | interpreting tax tables to determine income tax at various levels of income, including overall percentage of income allocated to tax (AC9M7N08_E2) |
| | | using modelling contexts to investigate proportion such as proportion of canteen total sales happening on Monday and Friday, proportion of bottle cost to recycling refund, proportion of school site that is green space; interpreting and communicating answers in terms of the context of the situation (AC9M7N08_E3) |
| | | expressing profit and loss as a percentage of cost or selling price, comparing the difference (AC9M7N08_E4) |
| | | investigating the methods used in retail stores to express discounts, for example, investigating advertising brochures to explore the ways discounts are expressed (AC9M7N08_E5) |
| | | investigating the proportion of land mass/area of Aboriginal Peoples’ traditional grain belt compared with Australia’s current grain belt (AC9M7N08_E6) |
| | | investigating the nutritional value of grains traditionally cultivated by Aboriginal Peoples in proportion to the grains currently cultivated by Australia’s farmers (AC9M7N08_E7) |

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| **Algebra** | explore the use of variables in everyday formulas and substitute values into formulas to determine an unknown, in practical contexts (AC9M7A01) | linking the variables to attributes and measures being modelled when using formulas such as area of a rectangle = length × width as $a = l \times w$ or using $p = 6g + b$ to describe a total points score in a football match where a team kicks $g$ goals (worth six points) and $b$ behinds (worth one point) (AC9M7A01_E1) |
| | | substituting numerical values for variables when using formulas and calculating the value of an unknown in practical situations, for example, calculating weekly wage $(W)$ given base wage $(b)$ and overtime hours $(h)$ at 1.5 times rate $(r)$, $W = b + 1.5 \times h \times r$, using values for mass $(m)$ and volume $(v)$ to determine density $(d)$ of a substance where $d = \frac{m}{v}$ (AC9M7A01_E2) |
| | | exploring everyday formulas and their application to contexts on-Country/Place, investigating the relationships between variables (AC9M7A01_E3) |
| | create algebraic expressions using constants, variables, operations and brackets. Interpret and factorise these expressions, applying the associative, commutative, identity and distributive laws as applicable (AC9M7A02) | generalising arithmetic expressions to algebraic expressions involving constants, variables, operations and brackets, for example, $7 + 7 + 7 = 3 \times 7$ and $x + x + x = 3 \times x$ and this is also written concisely as $3x$ with implied multiplication (AC9M7A02_E1) |
| | | applying the associative, commutative and distributive laws to algebraic expressions involving positive and negative constants, variables, operations and brackets to solve equations from situations involving linear relationships (AC9M7A02_E2) |
| | | exploring how cultural expressions of Aboriginal and Torres Strait Islander Peoples such as storytelling communicate mathematical relationships which can be represented as mathematical expressions (AC9M7A02_E3) |
| | | exploring the concept of variable as something that can change in value the relationships between variables, and investigating its application to processes on-Country/Place including changes in the seasons (AC9M7A02_E4) |
| | interpret, discuss and analyse relationships represented in graphs from authentic data (AC9M7A03) | using graphs to explore water storage levels over a period of time, the value of shares on a stock market, or the temperature during a day (AC9M7A03_E1) |
| | | using travel graphs to investigate and compare the distance travelled to and from school interpreting features of travel graphs such as the slope of lines and the meaning of horizontal line segments (AC9M7A03_E2) |

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| | | using graphs of evaporation rates to explore Aboriginal and Torres Strait Islander Peoples' methods of water resource management (AC9M7A03_E3) |
| | generate a table of values using the rule of a simple function. Develop tables to represent and describe relationships and plot these relationships on the Cartesian plane (AC9M7A04) | plotting points from a table of values generated using simple linear functions and recognising patterns, such as points that lie on a straight line (AC9M7A04_E1) |
| | | discussing and using variables to create a general rule and use the rule to determine the value of the dependent variable for any given value of the independent variable (AC9M7A04_E2) |
| | | using models to generate a table and describe the relationship in words and informal rules; creating rules using variables and using these rules to extend values beyond the practicality of a table; plotting these relationships on the Cartesian plane (AC9M7A04_E3) |
| | | using function machines to generate a table of values, plotting the relationships on a cartesian plane using graphing software and describing the graph in terms of shape (AC9M7A04_E4) |
| | | modelling linear growing patterns using manipulatives then moving to diagrams. Representing of linear growing patterns in tables and describing the relationship in terms of the way the pattern is growing and in the context of the situation (AC9M7A04_E5) |
| | | exploring Aboriginal and Torres Strait Islander Peoples' methods of water resource management, developing tables/graphs of evaporation rates to represent and describe relationships (AC9M7A04_E6) |
| | apply computational thinking and digital tools to construct tables of values from formulas involving several variables, and systematically explore the effect of variation in one variable while assigning fixed values for other variables (AC9M7A05) | experimenting with different sets of tables of values from formulas, for example, using *volume of a rectangular prism* = *length* × *width* × *height,* and specifying a fixed *width* and equal *length* and varying the *height* (AC9M7A05_E1) |
| | | using spreadsheets and the formula function to explore changing parameters and the effect this has on the entries in cells (AC9M7A05_E2) |
| | | investigating distance travelled for different combinations of average speed and time of travel using a table of values and the distance formula (AC9M7A05_E3) |
| | | investigating online financial calculators for home and car loans and experimenting with changing parameters including the amount borrowed, interest rate, number of years of the loan, using a spreadsheet to record the results |

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| | | (AC9M7A05_E4) |
| Measurement | establish the formulas for areas of triangles and parallelograms, using their relationship to rectangles and use these to solve practical problems using appropriate units (AC9M7M01) | exploring the spatial relationship between rectangles and different types of triangles to establish that the area of a triangle is half the area of an appropriate rectangle (AC9M7M01_E1) |
| | | using dynamic geometry software to demonstrate how the sliding of the vertex of a triangle at a fixed altitude opposite a side leaves the area of the triangle unchanged (invariant) (AC9M7M01_E2) |
| | | using established formulas to solve practical problems involving the area of triangles, parallelograms and rectangles, for example, estimating the cost of materials needed to make shade sails based on a price per metre (AC9M7M01_E3) |
| | establish the formula for the volume of a prism. Use formulas and appropriate units to solve problems involving the volume of prisms including rectangular and triangular prisms (AC9M7M02) | packing a rectangular prism, with whole-number side lengths, with unit cubes and showing that the volume is the same as would be found by multiplying the edge lengths or by multiplying the height by the area of the base (AC9M7M02_E1) |
| | | developing the connection between the area of the parallel cross section (base), the height and volume of a rectangular or triangular prism to other prisms (AC9M7M02_E2) |
| | | connecting the footprint and the number of floors to model the space taken up by a building (AC9M7M02_E3) |
| | | representing threefold whole-number products as volumes, for example, to represent the associative property of multiplication (AC9M7M02_E4) |
| | | using dynamic geometry software and prediction to develop the formula for the volume of prisms (AC9M7M02_E5) |
| | | exploring the relationship between volume and capacity of different sized nets used by Aboriginal and Torres Strait Islander Peoples to catch different sized fish (AC9M7M02_E6) |
| | | exploring Aboriginal and Torres Strait Islander Peoples' water resource management and the relationship between volume and capacity (AC9M7M02_E7) |
| | investigate the relationship between the ratio $\pi$ and features of circles such as the | recognising the features of circles and their relationships to one another, for example, labelling the parts of a circle including centre, radius, diameter, circumference and recognising that the diameter is twice the radius (AC9M7M03_E1) |

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| | circumference, radius and diameter (AC9M7M03) | investigating the circumference of circles in relation to radius and diameter with materials and measuring, to establish measurement formulas, for example, using a compass to draw a number of circles then using string to approximate the circumference, comparing the length of string to the diameter of the circle (AC9M7M03_E2) |
| | | experimenting with a variety of circular shapes and cylinders to explore the proportional relationship between the distance around the circle (circumference) and diameter (AC9M7M03_E3) |
| | | investigating the ratio $\pi$ as the proportional relationship between the circumference of a circle and its diameter (AC9M7M03_E4) |
| | | investigating the applications and significance of circles in everyday life of Aboriginal and Torres Strait Islander Peoples such as in basketry, symbols and architecture, exploring the relationships between the centre, radius, diameter and circumference (AC9M7M03_E5) |
| | explore the use of ratios to compare quantities. Model situations (including investigating 'best buys') using ratios and solve practical problems, interpreting results in terms of the situation (AC9M7M04) | using fractions to model and solve ratio problems involving comparison of quantities and considering part-part and part-whole relations (AC9M7M04_E1) |
| | | solving practical problems involving ratios of length, capacity or mass such as in construction, design, food or textile production (AC9M7M04_E2) |
| | | modelling the situation using either manipulatives, diagrams and/or mathematical discussion, for example, mixing primary colours in a variety of ratios to explore how new colours are created, and the strength of those colours (AC9M7M04_E3) |
| | | choosing the most efficient form, and formulating mathematical expressions, including unitary method or comparing cost per 100 g to identify 'best buys' situations, discussing the advantages of different representations for different purposes, for example, determining value for money versus budgeting for a number of people (AC9M7M04_E4) |
| | | using comparative measures when shopping and how savings can add up over a period of a year (AC9M7M04_E5) |
| | | using ratios to express the probability of outcomes (AC9M7M04_E6) |
| | | exploring the ratios of circumference to diameter, area to radius, original length, area, and volume to related measures after enlargement, corresponding sides in shapes which look the same (AC9M7M04_E7) |

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| | | investigating commercialised substances founded on Aboriginal and Torres Strait Islander Peoples’ knowledges of substances including pharmaceuticals and toxins, understanding how ratios are used in the development of them (AC9M7M04_E8) |
| | establish relationships between angles formed when parallel lines are crossed by a transversal including a perpendicular line. Apply knowledge of vertically opposite, complementary, supplementary, corresponding, alternate and co-interior angles to solve problems and explain reasoning.(AC9M7M05) | constructing parallel and perpendicular lines using their properties, a pair of compasses and a ruler, and dynamic geometry software acknowledging that a perpendicular line is the locus of points that are equidistant from two points whether one or both points are imagined and that parallel lines in the plane are always the same distance apart (AC9M7M05_E1) |
| | | using dynamic geometry software to identify relationships between alternate, corresponding and co-interior angles for a pair of parallel lines cut by a transversal (AC9M7M05_E2) |
| | | using dynamic geometry software to explore how angles and their properties are involved in the design and construction of scissor lifts, folding umbrellas, toolboxes and cherry pickers (AC9M7M05_E3) |
| | | using geometric reasoning of angle properties to generalise the angle relationships of parallel lines and transversals and related properties such as the exterior angle of a triangle is equivalent to the sum of the opposite and non-adjacent interior angles and the sum of angles in a triangle in the plane is two right angles or 180° (AC9M7M05_E4) |
| | demonstrate that the angle sum of a triangle in the plane is 180°. Use this to determine the angle sum of other two-dimensional shapes and to indirectly determine the size of unknown angles in practical contexts (AC9M7M06) | investigating the relationship between the sum of the three angles of triangles in practical situations, such as three non-collinear points on a sports ground (AC9M7M06_E1) |
| | | investigating the connection between polygons and triangles and using the angle sum of a triangle to generalise the angle sum of an $n$-sided polygon (AC9M7M06_E2) |
| **Space** | explore different ways of representing objects in two-dimensions. Discuss and reason about the advantages | deconstructing packaging to identify shapes and nets (AC9M7SP01_E1) |
| | | using different nets to construct prisms and determining which nets will make a cube, rectangular prism, triangular prism or pyramid (AC9M7SP01_E2) |

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| | and disadvantages of each representation (AC9M7SP01) | using aerial views of buildings and other three-dimensional structures to visualise the footprint made by the building or structure, identifying prisms which could approximate the structure (AC9M7SP01_E3) |
| | | building objects by interpreting isometric and perspective drawings (AC9M7SP01_E4) |
| | | using isometric and square grid paper to draw views (front, back, side, top and bottom) of objects (AC9M7SP01_E5) |
| | | exploring different representations of objects in Aboriginal and Torres Strait Islander Peoples artworks or cultural maps of Country/Place (AC9M7SP01_E6) |
| | classify triangles, quadrilaterals and other shapes according to their side and angle properties, identify and reason about relationships (AC9M7SP02) | investigating which lengths of strips can make triangles and quadrilaterals and contrasting the rigidity of triangles with the flexibility of quadrilaterals (AC9M7SP02_E1) |
| | | using the concept of locus to construct triangles with three given side lengths and discussing the question '*Can any three lengths be used to form the sides of a triangle*?' (AC9M7SP02_E2) |
| | | identifying side and angle properties of scalene, isosceles, equilateral, right-angled, acute and obtuse triangles (AC9M7SP02_E3) |
| | | describing, comparing and contrasting squares, rectangles, rhombuses, parallelograms, kites and trapeziums (AC9M7SP02_E4) |
| | | creating a classification scheme for triangles based on sides and angles using a flow chart and extending to regular, irregular, concave or convex polygons (AC9M7SP02_E5) |
| | | creating and explaining a family tree or hierarchy for quadrilaterals which shows the relationships between trapeziums, parallelograms, rhombuses, rectangles, squares and kites (AC9M7SP02_E6) |
| | | exploring the conjecture that the area of a shape is the product of the average of the lengths of a pair of parallel sides and the distance between them (AC9M7SP02_E7) |
| | use coordinates to describe transformations in the Cartesian | using digital tools to transform shapes on a Cartesian plane, describing how one shape can turn into another (AC9M7SP03_E1) |

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| | plane of a set of points using translations, reflections on an axis, and rotations of multiples of right angles (AC9M7SP03) | describing patterns and investigating different ways to produce the same transformation such as using two successive reflections to provide the same result as a translation (AC9M7SP03_E2) |
| | | experimenting with, creating and re-creating patterns using combinations of translations, reflections and rotations using digital tools (AC9M7SP03_E3) |
| | apply computational thinking to design and create an algorithm that will sort and classify shapes (AC9M7SP04) | creating a classification scheme for triangles based on sides and angles using a flow chart (AC9M7SP04_E1) |
| | | creating a flowchart or hierarchy for quadrilaterals which shows the relationships between trapeziums, parallelograms, rhombuses, rectangles, squares and kites (AC9M7SP04_E2) |
| | | creating a classification scheme for regular, irregular, concave or convex polygons that are sorted according to the number of sides (AC9M7SP04_E3) |
| **Statistics** | construct a range of stem-and-leaf and dot plots with appropriate intervals and partition these plots to interpret and compare the distributions including determining the range, median, mean and mode (AC9M7ST01) | using ordered stem-and-leaf plots to record and display numerical data collected in a class investigation, such as constructing a class plot of height in centimetres on a shared stem-and-leaf plot for which the stems 12, 13, 14, 15, 16 and 17 have been produced (AC9M7ST01_E1) |
| | | understanding that some data representations are more appropriate than others for particular data sets, and answering questions about those data sets (AC9M7ST01_E2) |
| | | comparing the typical heights and variation, of male and female students in the class using split stem and leaf plots or dot plots by interpreting the shape of the distribution using qualitative terms to describe symmetry or skewness, 'average' heights in terms of the median and mode and the amount of variation of heights based on qualitative descriptions of the spread of the data (AC9M7ST01_E3) |
| | make and justify decisions of which measure(s) of central tendency provide(s) useful insights into the nature of the distribution of data in a given | understanding that summarising data by calculating measures of centre can help make sense of the data (AC9M7ST02_E1) |
| | | comparing the mean, median, mode and range of displays of data from a given context, explaining how outliers may affect the summarising of the data (AC9M7ST02_E2) |

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| | context (AC9M7ST02) | exploring how different data sets can have the same measures of central tendency and experimenting with how varying data effects these measures (AC9M7ST02_E3) |
| | create different types of displays or visualisations using software where appropriate. Describe and compare the distribution of data commenting on the spread (including outliers) and determine the range, median, mean and mode (AC9M7ST03) | using mean and median to compare data sets identifying possible outliers and explaining how these may affect the comparison (AC9M7ST03_E1) |
| | | exploring how different displays make specific information about data more evident, including proportions, measures of mean, mode or median, spread and extreme values (AC9M7ST03_E2) |
| | | identifying the mean, median and range on graphs, understanding that the median and the mean will be the same or similar for symmetric distributions but different for distributions that are skewed (AC9M7ST03_E3) |
| | | connecting features of the data display, for example, highest frequency, clusters, gaps, symmetry or skewness, to the mode, range and median and the question in context (AC9M7ST03_E4) |
| | | comparing the mean and median of data with and without extremes as in incomes, house prices or estimation of standard measures for length or mass, informally considering for a given set of data what might constitute an unexpected, unusual or extreme data value (AC9M7ST03_E5) |
| | | critiquing different displays, including using different scales on the same type, to see what measures of the data are most evident and which displays allow for appropriate conclusions or decisions to be made about the question in context (AC9M7ST03_E6) |
| | plan and conduct statistical investigations that produce numerical data sets. Represent the data using appropriate displays. Analyse and interpret data distributions reporting results in terms of summary statistics (AC9M7ST04) | conducting an investigation to draw conclusions about whether teenagers have faster reaction times than adults (AC9M7ST04_E1) |
| | | conducting an investigation to support claims that a modification of a Science Technology Engineering Mathematics (STEM) related design has improved performance (AC9M7ST04_E2) |
| | | using secondary data from the Reconciliation Barometer to conduct and report on statistical investigations relating to Aboriginal and Torres Strait Islander Peoples (AC9M7ST04_E3) |

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| **Probability** | list the sample space for single-step events. Assign probabilities to the outcomes of these events and determine probabilities for related events (AC9M7P01) | discussing the meaning of probability terminology, for example, probability, sample space, favourable outcome, trial, experiment and event (AC9M7P01_E1) |
| | | listing samples spaces for games involving throwing a coin or a die, spinners, lucky dip (AC9M7P01_E2) |
| | use probability to predict the expected number of favourable outcomes for an event. Compare this with simulated results of an increasingly large number of trials explaining the differences between observed and expected results (AC9M7P02) | developing an understanding of the law of large numbers through using experiments and simulations to conduct large numbers of trials for seemingly random events and discussing findings (AC9M7P02_E1) |
| | | conducting simulations using online simulation tools and comparing the combined results of a large number of trials to predicted results (AC9M7P02_E2) |
| | | exploring and observing Aboriginal and Torres Strait Islander children's instructive games, for example, *Koara* from the Jawi and Bardi Peoples of Sunday Island in Western Australia, to investigate probability, predicting outcomes for an event and comparing with increasingly larger numbers of trials and between observed and expected results (AC9M7P02_E3) |

## Year 8

### Level description

The Australian Curriculum: Mathematics focuses on the development of a deep knowledge and conceptual understanding of mathematical structures and fluency with procedures. Students learn through the approaches for working mathematically, including modelling, investigation, experimentation and problem solving, all underpinned by the different forms of mathematical reasoning.

As students engage in learning mathematics in Year 8 they:

- extend computation with combinations of the four operations with integers and positive rational numbers, including the extension of exponent laws to numerical calculations involving positive, zero and negative exponents and solve a broad range of practical problems, using mental methods, written algorithms and digital tools
- explore the relationship between fractions and their terminating or infinite recurring decimal expansions. They convert between fraction and decimal forms of rational numbers and locate them on the real number line
- model problems in a broad range of contexts that involve ratios with two or more terms, percentage increase and decrease, proportions with decimal values, and rates in measurement contexts
- explore and explain proofs of Pythagoras' theorem and investigate irrational numbers from certain measurement contexts involving right-angled triangles, squares and circles, their infinite non-recurring decimal expansion and their approximate location on the real number line
- manipulate linear and other simple algebraic expressions and model situations using linear and simple non-linear relations (doubling, halving, squaring, square root and product of two factors), and solve related equations using tables, graphs and algebra
- select metric measurement units fit for purpose, convert between units, explore the effects of different levels of measurement accuracy on the results of computations and relate these to interval estimates for measurements in various contexts. They establish sets of congruency and similarity conditions for common shapes in the plane, discuss examples and counterexamples, and use digital tools to construct and locate objects with reference to three-dimensional coordinates
- consider a variety of situations involving complementary and mutually exclusive events, combinations of two events, represent these using tables and diagrams, and calculate corresponding probabilities. They examine experimental and observational data and identify populations and samples with respect to context, explore variation in summary statistics across samples, investigate the effect of outliers on these summary statistics and discuss their findings.

## Achievement standard

By the end of Year 8, students recognise the relationship between fractions and their terminating or recurring decimal expansion. They apply the exponent laws to calculations with numbers involving non-negative exponents. Students solve problems involving the four operations with integers and positive rational numbers, using mental, written and digital tools as appropriate. They apply proportional reasoning to solve practical problems involving ratios, percentage change, proportions of quantities and rates in measurement and financial contexts. Students apply algebraic properties to rearrange, expand and factorise linear expressions. They apply linear relations to model situations, representing these with tables, graphs and algebraically, and solve related equations interpreting them in context. Students apply computational thinking with digital tools to make and investigate conjectures involving rational numbers.

They choose and use suitable metric units when solving measurement problems involving the perimeter and area of composite shapes, and volume and capacity of prisms. Students use Pythagoras' theorem to solve simple measurement problems involving unknown lengths and apply formulas to solve problems involving area and circumference of circles. They solve problems of duration involving 12-hour and 24-hour cycles across multiple time zones. Students use three dimensions to locate and describe position in three-dimensional contexts. They apply computational thinking to evaluate algorithms designed to test for congruency and similarity of shapes and use these conditions to transform shapes in the plane and solve related problems.

Students conduct statistical investigations recognising the implications of obtaining data through sampling. They analyse and report on primary and secondary data from a range of contexts. Students compare the distributions of random samples of the same size from a given population with respect to variation, measures of central tendency and range, with consideration of the effects of outliers. They represent the possible combinations of two events with tables and diagrams and determine related probabilities to solve practical problems. Students design and conduct experiments and simulations to explore and identify complementary and mutually exclusive events and calculate related probabilities.

| Strand | Content description<br>*Students learn to:* | Elaboration<br>*This may involve students:* |
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| Number | recognise and investigate irrational numbers in applied contexts including certain square roots and $\pi$ (AC9M8N01) | recognising that the real number system includes irrational numbers which can be approximately located on the real number line, for example, the value of $\pi$ lies somewhere between 3.141 and 3.142 such that $3.141 < \pi < 3.142$ (AC9M8N01_E1) |
| | | using digital tools to explore contexts or situations that use irrational numbers such as finding length of hypotenuse in right angle triangle with sides of 1 m or 2 m and 1 m or given area of a square find the length of side where the result is irrational or the ratio between paper sizes A0, A1, A2, A3, A4 (AC9M8N01_E2) |
| | | investigate the Golden ratio as applied to art, flowers (seeds) and architecture (AC9M8N01_E3) |

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| | | connecting the ratio between the circumference and diameter of any circle to the irrational value of $\pi$ using circular objects and string or dynamic drawing software (AC9M8N01_E4) |
| | use exponent notation with numbers to establish the exponent laws with positive integral exponents and the zero exponent (AC9M8N02) | exploring the connection between exponent form and expanded form with the exponent laws of product of powers rule, quotient of powers rule, power of a power rule, for example, $2^3 \times 2^2$ can be represented as $(2 \times 2 \times 2) \times (2 \times 2) = 2^5$ and connecting the result to the addition of exponents (AC9M8N02_E1) |
| | | applying the exponent laws of product of powers rule, quotient of powers rule, power of a power rule and zero exponent individually and in combination, for example, using exponents to determine the effect on the volume of a 2 cm cube when the cube is enlarged to a 6 cm cube, $\frac{6^3}{2^3} = \frac{2^3 \times 3^3}{2^3} = 3^3$ , so the volume is increased by a factor of 27 (AC9M8N02_E2) |
| | | using digital tools to explore the application of the exponent laws; observing that the bases need to be the same (AC9M8N02_E3) |
| | | using expressions such as $\frac{3^4}{3^4} = 1$, and $3^{4-4} = 3^0$ to illustrate the convention that for any natural number $n, n^0 = 1$, for example, $10^0$=1 (AC9M8N02_E4) |
| | recognise and investigate terminating and recurring decimals (AC9M8N03) | using calculators to investigate fractions or computations involving division that result in terminating and recurring decimals (AC9M8N03_E1) |
| | | recognising terminating, recurring and non-terminating decimals and choosing their appropriate representations such as $\frac{1}{3}$ is represented as $0.\bar{3}$ (AC9M8N03_E2) |
| | | investigating the use of pronumerals to represent recurring decimals as their equivalent fractions, for example, let $x$ = $0.\bar{7}$ then $x$ = 0.77777… and 10$x$ = 7.77777… therefore 10$x$ – $x$ = 7 and 9$x$ = 7 so $x$ = $\frac{7}{9}$ (AC9M8N03_E3) |
| | use the four operations with integers and rational numbers to model and solve problems (including financial contexts), using efficient mental and | using patterns to assist in establishing the rules for the multiplication and division of integers (AC9M8N04_E1) |
| | | applying and explaining efficient strategies such as using the commutative or associative property for regrouping, partitioning, place value, patterning, multiplication or division facts to solve problems involving positive and negative integers, fractions and decimals (AC9M8N04_E2) |

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| | written strategies and appropriate digital tools (AC9M8N04) | solving problems involving financial decisions, weather and environmental contexts including temperature or sea depths by applying operations to positive and negative rational numbers, for example, problems where multiple people owe you money or involving average temperature increases and decreases (AC9M8N04_E3) |
| | | exploring the effect of sign in the multiplication of integers, for example, $(-1)^4 = 1$ and $(-1)^5 = -1$ (AC9M8N04_E4) |
| | model situations (including financial contexts) and solve problems using percentage increases and decreases, using digital tools as appropriate. Interpret the results in terms of the situation (AC9M8N05) | identifying situations that involve percentage increases or decreases and explain why it is an increase or decrease, such as mark-ups, discounts, Goods and Services Tax (GST), changes in median house prices, changes in populations or recycling rates (AC9M8N05_E1) |
| | | calculating percentage increase and decrease to solve problems with and without calculators, for example, mark-ups, discounts, GST, changes in median house prices, changes in populations, effect of Consumer Price Index (CPI) changes, private health rate increases or recycling rates (AC9M8N05_E2) |
| | | inferring the impact of percentage increase or decrease such as market trends, effects on population, effects on the environment over extended time periods (AC9M8N05_E3) |
| | | exploring Aboriginal and Torres Strait Islander Peoples' weaving, investigating ratio and percentage increase in the patterns (AC9M8N05_E4) |
| **Algebra** | extend and apply the associative, commutative, identity, distributive and inverse properties to create, expand, factorise, rearrange and simplify linear expressions. Use the simplified expressions to solve for given variables (AC9M8A01) | extending identity and inverse properties from number to algebraic expressions involving variables and integer coefficients (AC9M8A01_E1) |
| | | rearranging and simplifying linear expressions involving variables with integer coefficients and constants; using manipulatives such as algebra tiles to support calculations, for example, using manipulatives to demonstrate that $2x + 4 = 2(x + 2)$ or $3(a - b) = 3a - 3b$ (AC9M8A01_E2) |
| | | explaining the relationship between factorising and expanding using manipulatives, for example, algebra tiles or area models, and describing with mathematical language (AC9M8A01_E3) |
| | | rearranging and simplifying linear expressions involving variables with integer coefficients and constants prior to expanding or factorising (AC9M8A01_E4) |
| | | using the distributive, associative, commutative, identity and inverse properties to solve linear equations including in practical contexts such as taxi fares involving flag fall fees, trade quotes involving a call out fee, cooking that |

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| | | includes resting or cooling times (AC9M8A01_E5) |
| | graph linear relations on the Cartesian plane and solve linear equations and one-variable inequalities using algebraic and graphical techniques including the use of graphing software. Verify solutions by substitution (AC9M8A02) | exploring the meaning behind the components of linear equations using patterning connected to processes (AC9M8A02_E1) |
| | | graphing linear relations of the form $x = a$ , $y = a$ , $x \leq a$ , $x > a$ , $y \leq a$ , $y > a$ and $y = mx + b$ on the Cartesian plane (AC9M8A02_E2) |
| | | completing a table of values, plotting the resulting points on the Cartesian plane and determining whether the relationship is linear (AC9M8A02_E3) |
| | | graphing the linear relationship $ax + b = c$ and discussing for what values of $x$ is $ax + b < c$ and $ax + b > c$ using substitution to verify solutions (AC9M8A02_E4) |
| | | solving linear equations of the form $ax + b = c$ and one-variable inequalities of the form $ax + b < c$ or $ax + b > c$ where a > 0 using inverse operations and digital tools, checking and justifying solutions by substitution (AC9M8A02_E5) |
| | | developing an algorithm on-Country/Place for the solution of a linear equation of the form $ax + b = c$ (AC9M8A02_E6) |
| | use linear functions to model and interpret situations. Represent these using tables, graphs on the Cartesian plane and algebra to interpolate, extrapolate and solve equations. Interpret solutions in the modelling context (AC9M8A03) | modelling situations involving linear functions including practical contexts such as taxi fares involving flag fall fees, trade quotes involving a call out fee, cooking that includes resting or cooling times or water leakage from water tanks and interpreting the constant rate of change and initial value in context, and identifying when values of a model lie within a given range (AC9M8A03_E1) |
| | | interpreting solutions within the context of the problem including giving attention to all units of measure and if result is suitable, for example once a water tank is empty no more water can flow from it (AC9M8A03_E2) |
| | | representing linear functions from practical contexts using tables, and graphs which are drawn by hand or using digital tools, for example, using a table of values to represent the pay amounts and hours worked using an hourly rate of pay and graphing the relationship to make inferences (AC9M8A03_E3) |
| | | modelling patterns on-Country/Place and exploring their connections and meaning to linear equations, using the model as a predictive tool and critiquing results by connecting back to Country/Place (AC9M8A03_E4) |

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| | apply computational thinking and reasoning to make and evaluate conjectures that generalise patterns involving rational numbers, using algorithms and digital tools (AC9M8A04) | exploring decimal representations of fractions with large numerators and denominators (AC9M8A04_E1) |
| | | exploring and evaluating conjectures about sums or difference of fractions, for example, the pattern generated by sums of the form $\frac{1}{n}+\frac{1}{n+1}$ (AC9M8A04_E2) |
| | | making conjectures and explore conditions for a fraction to have a finite (terminating) decimal expansion (AC9M8A04_E3) |
| **Measurement** | solve problems involving the area and perimeter of composite shapes including the combinations of regular and irregular shapes in practical contexts using appropriate units (AC9M8M01) | determining and describing how and why changes in the dimensions of a shape or object affect the perimeter, area, surface area, or volume, including proportional and nonproportional dimensional change, using whole and rational number scale factors (AC9M8M01_E1) |
| | | using decomposition to determine the area of composite shapes, including puzzles involving the rearrangement of shapes (AC9M8M01_E2) |
| | | determining the perimeter and area of irregular shapes by sums of increasingly accurate covering measurements such as line segments and grids, for example, using millimetres or square millimetres as opposed to centimetres or square centimetres (AC9M8M01_E3) |
| | | using arrays and rectangles to approximate the area of irregular shapes in situations such as a council needing to work out how much mosquito spray for a swamp area or a farmer needing to work out how much seed, fertilizer, herbicide is required to cover a paddock (AC9M8M01_E4) |
| | | exploring the design and manufacturing of weaving by Aboriginal and Torres Strait Islander Peoples and the significance and use of composite areas (AC9M8M01_E5) |
| | choose and justify the appropriate metric units for solving problems involving perimeter, area, volume and capacity. Solve practical problems involving the volume and capacity of prisms and converting from one metric unit | using grids to demonstrate the connection between square centimetres and square metres (AC9M8M02_E1) |
| | | using models to demonstrate the number of cubic centimetres in a cubic metre and relating this to capacities of millilitres and litres, recognising that 1 ml is equivalent to 1 $cm^3$ (AC9M8M02_E2) |
| | | choosing which measurements are useful to consider when solving practical problems in context, for example, in purchasing a new washing machine the dimensions are useful when determining whether it will fit in the available space in the laundry and its capacity is useful when comparing the maximum washing load it can carry (AC9M8M02_E3) |

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| | to another (AC9M8M02) | investigating, reasoning and finding solutions to measurement problems involving dimensions, rates, volume and capacity of objects, for example, given the dimensions of a pool and the rate of flow from a tap, determine how long it will take to fill the pool to its normal capacity (AC9M8M02_E4) |
| | establish the formula for the area of a circle and use formulas to solve problems involving circumference and area of a circle (AC9M8M03) | investigating the area of circles using a square grid or by rearranging a circle divided into smaller and smaller sectors or slices to resemble a close approximation of a rectangle (AC9M8M03_E1) |
| | | applying the formulas for the area and circumference of a circles to solve practical problems, for example, to determine the length of material needed to edge a round table, given its dimensions as the area of the tabletop (AC9M8M03_E2) |
| | | investigating the circumference of a circle as a scaling of its radius or diameter and deduce that the area of a circle is between two radius squares and four radius squares (AC9M8M03_E3) |
| | model situations and solve problems using ratios including ratios with more than two terms and ratios involving rational numbers maintaining the proportional relationships in the context of the problem, using digital tools as appropriate, and interpret the results in terms of the situation (AC9M8M04) | recognising that ratios express the quantitative relationship between two or more groups and can be represented with discrete items (AC9M8M04_E1) |
| | | modelling equivalent fractions with discrete objects to show that 2 : 3 = 6 : 9 by grouping the higher ratio into groups that represent the other ratio, in this case 6 : 9 can be represented as 3 groups of 2 : 3 (AC9M8M04_E2) |
| | | representing ratios as part-whole fractions such as there are 5 shapes in the diagram, so each part is $\frac{1}{5}$ and therefore $\frac{2}{5}$ of the shapes are squares and $\frac{3}{5}$ of the shapes are triangles (AC9M8M04_E3) |
| | | applying ratios to realistic and meaningful contexts, for example, mixing up 500 ml of a liquid with a concentration of 1 : 4 means $\frac{1}{5}$ concentrate and $\frac{4}{5}$ water so, $\frac{1}{5}$ (0.2) of 500 ml is concentrate and $\frac{4}{5}$ (0.8) of 500 ml is water; interpreting results in context (AC9M8M04_E4) |
| | | applying relevant ratio and proportions to solve problems related to situations such as scales on maps and plans, in the mixing of chemicals or ingredients, or calculating magnification factors (AC9M8M04_E5) |
| | | investigating the ways rate and ratio are applied to steam Aboriginal and Torres Strait Islander Peoples' cooking practices, including time to cook based on the weight and number of fish (AC9M8M04_E6) |
| | | exploring the use of ratio in radiocarbon dating methods including 14C : 12C isotopes in organisms to measure |

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| | | dates of Aboriginal habitation on the Australian continent (AC9M8M04_E7) |
| | | investigating ratio and its application in the making of string and cordage by Aboriginal and Torres Strait Islander Peoples including the ratio of length to the weight of a rope, the strength of the ply in proportion to a rope's pulling force, and the proportion of fibre for the length of string required (AC9M8M04_E8) |
| | model situations (including financial contexts) using proportional thinking to indirectly measure quantities and solve problems involving rates, interpreting the results in terms of the situation (AC9M8M05) | planning a driving trip and performing calculations about speed, distance and time, emphasising estimation and correct units (AC9M8M05_E1) |
| | | applying rates to calculate solutions to problems in different contexts including shopping, units of measure from different countries such as kilometres to miles, household expenses, sport such as required run rates in cricket, chemicals such as dilution of concentrates, petrol consumption rates (AC9M8M05_E2) |
| | | investigating the benefits of different investment plans using different interest rates, associated fees and long-term gain to determine the best investment (AC9M8M05_E3) |
| | | investigating examples of rates in the real world, including constant rates, rate of pay, cost per kilogram, recipes, or simple interest and average rates (AC9M8M05_E4) |
| | | investigating income tax and the use of taxation rates on annual income, comparing different taxation brackets and rates of pay (AC9M8M05_E5) |
| | | investigating different exchange rates and applying them when planning and budgeting for overseas travel (AC9M8M05_E6) |
| | | connecting the rate of the Earth's rotation on its axis, as 15 degrees every 60 minutes, to time zones (AC9M8M05_E7) |
| | | exploring the application of rates in Aboriginal and Torres Strait Islander Peoples' land management practices, including the rate of fire spread under different environmental conditions such as fuel types, wind speed, temperature, and relative humidity (AC9M8M05_E8) |
| | | investigating the use of proportional thinking to conserve water by Aboriginal and Torres Strait Islander Peoples by estimating rates of water evaporation based on surface area and climatic conditions (AC9M8M05_E9) |

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| | solve problems involving duration, including using 12-hour and 24-hour time across multiple time zones (AC9M8M06) | using digital tools to investigate time zones around the world and convert from one zone to another, such as time in Perth Western Australia compared to Suva in Fiji or Toronto in Canada (AC9M8M06_E1) |
| | | exploring the challenges of planning regular virtual meeting times for a company that has both international staff and staff within different states and territories and the impact daylight savings has due to multiple time zones, explaining the mathematical language used to communicate current time such as Coordinated Universal Time (UTC)+8 (AC9M8M06_E2) |
| | | planning an international travel itinerary that covers destinations in different time zones (AC9M8M06_E3) |
| | | using an understanding of the Earth's rotation on its axis and the connection to longitude to explain why different time zones occur (AC9M8M06_E4) |
| | investigate Pythagoras' theorem and its application to solving problems involving right-angled triangles (AC9M8M07) | comparing and discussing different demonstrations and proofs of Pythagoras' theorem (AC9M8M07_E1) |
| | | understanding that Pythagoras' Theorem is a useful tool in determining unknown lengths in right-angled triangles, the Cartesian plane, and has widespread applications (AC9M8M07_E2) |
| | | exploring the relationship between the squares of sides of different types of triangles; right-angled, acute or obtuse, and hence identify Pythagorean triples (AC9M8M07_E3) |
| | | recognising that right-angled triangle calculations may generate results that can be integers, fractions or irrational numbers (AC9M8M07_E4) |
| **Space** | explore different ways of representing and describing the position and location in three-dimensions including using a three-dimensional coordinate system with the use of dynamic geometric software and other technologies (AC9M8SP01) | using three-dimensional location and movement with Artificial Intelligence and Virtual Reality gaming controls (AC9M8SP01_E1) |
| | | locating aircraft/drones using latitude, longitude and altitude as a three-dimensional coordinate system (AC9M8SP01_E2) |
| | | constructing three dimensional objects using 3D printers or designing software that uses a three-dimensional coordinate system (AC9M8SP01_E3) |
| | | comparing and contrasting two-dimensional and three-dimensional coordinate systems by highlighting what is the same, and what is different; including virtual maps versus street views (AC9M8SP01_E4) |

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| | | using dynamic geometry software to construct shapes and objects within the first quadrant of a three-dimensional coordinate system (AC9M8SP01_E5) |
| | | playing games based on three-dimensional coordinate systems such as three-dimensional noughts and crosses (tic tac toe) (AC9M8SP01_E6) |
| | | modelling and interpreting three-dimensional coordinate locations for objects such as multi-storey car parks (AC9M8SP01_E7) |
| | | exploring position and transformation through geospatial technologies used by Aboriginal and Torres Strait Islander communities (AC9M8SP01_E8) |
| | establish properties of quadrilaterals using congruent triangles and angle properties and solve related numerical problems using reasoning (AC9M8SP02) | establishing the properties of squares, rectangles, parallelograms, rhombuses, trapeziums and kites (AC9M8SP02_E1) |
| | | identifying properties related to side lengths, parallel sides, angles, diagonals and symmetry (AC9M8SP02_E2) |
| | | applying properties of triangles and quadrilaterals to construction design such as car jacks, scissor lifts, folding umbrellas, toolboxes and cherry pickers (AC9M8SP02_E3) |
| | establish and explain the conditions for sets of common shapes to be congruent or similar and relate these to transformations of the plane giving reasons (AC9M8SP03) | comparing angle and side measurements of shapes under transformation to answer questions, such as *'What changes?', 'What stays the same?'* (AC9M8SP03_E1) |
| | | developing a clear and shared understanding of what it means to be the same, geometrically congruent or geometrically similar (AC9M8SP03_E2) |
| | | using the concept of locus with dynamic geometric software or compass and protractor to draw triangles with a range of side and angle measures (AC9M8SP03_E3) |
| | | using the enlargement transformation to explain similarity and develop the conditions for triangles to be similar (AC9M8SP03_E4) |
| | | using digital tools to explore the idea that similar shapes occur when a shape has been shrunken or stretched proportionally (AC9M8SP03_E5) |
| | | investigating sufficient conditions to establish that two triangles are congruent (AC9M8SP03_E6) |

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| | | applying logical reasoning, including the use of congruence and similarity, to proofs and numerical exercises involving plane shapes (AC9M8SP03_E7) |
| | apply computational thinking to evaluate and refine algorithms designed to identify similar or congruent shapes (AC9M8SP04) | listing the properties or criteria necessary to determine if shapes are similar or congruent (AC9M8SP04_E1) |
| | | establishing conditions for similarity of triangles and congruence of triangles (AC9M8SP04_E2) |
| | | developing and evaluating algorithms or flowcharts as to their accuracy for classifying similar versus congruent triangles (AC9M8SP04_E3) |
| **Statistics** | investigate techniques for data collection including census, sampling and observation and discuss the practicalities and implications of obtaining data through these techniques (AC9M8ST01) | identifying situations where data can be collected by census and those where a sample is appropriate (AC9M8ST01_E1) |
| | | investigating the uses of random sampling to collect data (AC9M8ST01_E2) |
| | analyse and report on the distribution of data from primary and secondary sources using various sampling techniques to select and study samples (AC9M8ST02) | exploring the practicalities and implications of obtaining data through sampling using a variety of investigative processes (AC9M8ST02_E1) |
| | | investigating techniques for collecting data, including census, sampling and observation and identifying situations where each technique is appropriate (AC9M8ST02_E2) |
| | | investigating different methods of sampling to collect data, considering the source and size of samples (AC9M8ST02_E3) |
| | | comparing the different sampling methods such as simple random, systematic, stratified, quota, clustered or convenience, or judgement, and discussing the reliability of conclusions about the context that could be drawn (AC9M8ST02_E4) |
| | | defining and distinguishing between probabilistic terms such as random, sample space, sample, sample distribution (AC9M8ST02_E5) |

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| | | investigating primary and secondary data sources relating to reconciliation between Aboriginal and Torres Strait Islander Peoples and non-Indigenous Australians, analysing and reporting on findings (AC9M8ST02_E6) |
| | compare different random samples of the same size drawn from the same population with respect to variations in proportions, means, medians and range and explore the effect of possible outliers on these measures (AC9M8ST03) | exploring the variation of means and proportions of random samples drawn from the same population, using sample properties to predict characteristics of the population (AC9M8ST03_E1) |
| | | investigating the effect of individual data values, including outliers, on the mean and median using displays of data to explore effects (AC9M8ST03_E2) |
| | | connecting dot plots to box plots to highlight proportions of data and use these proportions to make inferences about the population (AC9M8ST03_E3) |
| | | using digital tools to simulate repeated sampling of the same population, such as heights or arm spans of students, recording and comparing means, median and range of data between samples (AC9M8ST03_E4) |
| | | using relative frequencies from historical data to predict proportions and the likely number of outcomes in situations such as weather forecasting or the countries of origin of visitors to tourist attractions (AC9M8ST03_E5) |
| | | exploring the effect that adding or removing data from a data set has on measures of central tendency and spread (AC9M8ST03_E6) |
| | | investigating First Nations Ranger Groups and other groups' use of sampling techniques to track biodiversity of species (AC9M8ST03_E7) |
| | plan and conduct statistical investigations based on the relationship between samples and a population and consideration of the context. Use ethical, fair, and efficient methods for gathering relevant data (AC9M8ST04) | using data such as electricity consumption to draw conclusions about the impacts of events, such as pandemics, on households or business (AC9M8ST04_E1) |
| | | identifying situations where the collection of data from a sample is necessary due to efficiency, cost or restricted time for collection of data and sufficiently reliable for making inferences about a population (AC9M8ST04_E2) |
| | | exploring progress in reconciliation between Aboriginal and Torres Strait Islander Peoples and non-Indigenous Australians, investigating and evaluating sampling techniques and methods to gather relevant data to measure progress (AC9M8ST04_E3) |

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| **Probability** | recognise that complementary events have a combined probability of 1 and that for a single event *A*, Pr(*A*) + Pr(not*A*) = 1. Use these relationships to calculate probabilities related to practical problems (AC9M8P01) | understanding that probabilities range between 0 to 1 and that calculating the probability of an event allows the probability of its complement to be found, including for those events that are not equally likely as in supermarket promotions where novelties are handed out (AC9M8P01_E1) |
| | | identifying complementary events and use the sum of probabilities to solve problems (AC9M8P01_E2) |
| | | using digital tools to conduct probability simulations to determine in the long run if events are complementary (AC9M8P01_E3) |
| | | using the sum of probabilities to solve problems, such as the probability of starting a game by throwing a 5 or 6 on a die which is $\frac{1}{3}$ and probability of not throwing a 5 or 6 is $\frac{2}{3}$ (AC9M8P01_E4) |
| | | applying the probability of complementary events to situations such as getting a specific novelty toy in a supermarket promotion (AC9M8P01_E5) |
| | determine all possible combinations for two events A and B and use the relation Pr(A and B) + Pr(A and not B) + Pr(not A and B) + Pr(not A and not B) = 1 with two-way tables and Venn diagrams and apply to practical probability problems (AC9M8P02) | describing events using language of 'at least', exclusive 'or' (*A* or *B* but not both), inclusive 'or' (*A* or *B* or both) and 'and' (AC9M8P02_E1) |
| | | understanding that representing data in Venn diagrams or two-way tables facilitates the calculation of probabilities, represent events in two-way tables and Venn diagrams and solve related problems (AC9M8P02_E2) |
| | | exploring Aboriginal and Torres Strait Islander children's instructive games, for example, *Battendi* from the Ngarrindjeri Peoples of Lake Murray and Lake Albert in southern Australia, applying possible combinations and relationships and calculating probabilities using two-way tables and Venn diagrams (AC9M8P02_E3) |
| | use observations and design and conduct experiments and simulations to explore and identify complementary and mutually exclusive events (AC9M8P03) | using digital tools to conduct probability simulations to determine in the long run if events are complementary (AC9M8P03_E1) |
| | | understanding that two events are complementary when one event occurs if and only if the other does not (AC9M8P03_E2) |
| | | discussing and sorting familiar events into those that are mutually exclusive and those that are not (AC9M8P03_E3) |

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| | | using Venn diagrams or two-way tables to demonstrate the difference between events that are mutually exclusive such as whether a boy or a girl is the next child born or those that are not mutually exclusive such as people who have blonde hair and people who have blue eyes (AC9M8P03_E4) |
| | | investigating Aboriginal and Torres Strait Islander children's instructive games, for example, *Koara* from the Jawi and Bardi Peoples of Sunday Island in Western Australia, exploring and identifying complementary and mutually exclusive events (AC9M8P03_E5) |

## Year 9

| Level description |
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| The Australian Curriculum: Mathematics focuses on the development of a deep knowledge and conceptual understanding of mathematical structures and fluency with procedures. Students learn through the approaches for working mathematically, including modelling, investigation, experimentation and problem solving, all underpinned by the different forms of mathematical reasoning. As students engage in learning mathematics in Year 9 they:<br>• apply scientific notation in measurement contexts, routinely consider accuracy in measurement and work with absolute, relative and percentage error in a range of different measurement contexts<br>• work with the real number line as a geometric model for real numbers that provides a continuous measurement scale. They locate different fractions exactly on the common scale of the real number line using scale and similarity and locate some irrational square roots of natural numbers using Pythagoras' theorem<br>• use linear and quadratic functions to model a broad range of phenomena and contexts, make predictions, and represent these using tables, graphs, and algebra, including with the use of digital tools<br>• manipulate algebraic expressions involving variables, exponents, and the expansion and factorisation of simple quadratic expressions using a variety of techniques including combinations of tables, diagrams, algorithms and digital tools<br>• formulate and solve related equations exactly or approximately using a combination of numerical, graphical, and algebraic approaches<br>• solve measurement problems about the surface area and volume of objects and apply formulas and inverse operations to solve problems calculating these and related dimensions of objects as required. They use similarity, scale, trigonometry, enlargement transformations, the triangle inequality and Pythagoras' theorem to solve practical problems given sets of information and investigate planar graphs and Euler's formula for planar graphs and polyhedrons<br>• investigate probabilities of compound events from two-step experiments and solve related problems. They explore the use of a variety of representations such as Venn diagrams, tree diagrams, two-way tables, and grids to assist in determining the probabilities for these events, design experiments to gather empirical data about relative frequencies and use these to check their reasoning<br>• compare multiple numerical data sets in context and analyse their distributions with consideration of symmetry and skew. They justify their choice of data representation with respect to data types and context and critically review the statistical presentation of data and related arguments of others. |

**Achievement standard**

By the end of Year 9, students use real numbers to solve problems. They extend and apply the exponent laws with positive integers to variables when factorising expressions. Students model situations involving change and solve linear and quadratic equations numerically, graphically and algebraically using inverse operations and by expanding and factorising algebraic expressions, using digital tools as appropriate. They describe the effects of variation of parameters on functions and relations and their graphical and algebraic representations, using computational thinking to generalise connections between them.

Students apply formulas to solve practical problems involving the surface area and volume of right prisms and cylinders. They solve practical problems involving ratio, similarity and scale in two-dimensional situations. Students apply Pythagoras' theorem and use trigonometric ratios to solve practical problems involving right angled triangles. They model situations and solve problems involving finance, measurement and direct proportion interpreting solutions in context. Students express small and large numbers in scientific notation and use this form in measurement contexts. They determine errors in measurements and interpret their effect on results. Students apply the enlargement transformation to images of shapes and objects and identify and describe attributes that change or are invariant. They apply Euler's formula to solve problems relating to planar graphs and polyhedrons. Students create and use algorithms to test spatial conjectures.

They compare and analyse the distributions of multiple univariate data sets, choosing representations with respect to the questions under investigation and describe features of these including consideration of summary statistics, symmetry and skew. Students obtain data from primary and secondary sources and explain how sampling techniques and representation can be used to support or question conclusions or to promote a point of view. They determine sets of outcomes for compound events and represent these in various ways and assign probabilities to these events. Students design and conduct experiments or simulations to gather empirical data.

| Strand | Content description<br>*Students learn to:* | Elaboration<br>*This may involve students:* |
|---|---|---|
| Number | recognise that the real number system includes all rational and irrational numbers and use real numbers to solve problems using digital tools as appropriate (AC9M9N01) | investigating the real number system by representing the relationships between irrationals, rationals, integers and natural numbers and discussing the difference between exact and approximate representations (AC9M9N01_E1) |
| | | using a real number line to represent the solution to inequalities of the form $ax + b < c$ and $ax + b > c$ (AC9M9N01_E2) |
| | | estimating the value of a surd irrational number by identifying which two whole numbers the square root of a number lies between, for example, as 132 is between the square number 121 and 144 so $\sqrt{132}$ is between $\sqrt{121}$ and $\sqrt{144}$ therefore between 11 and 12; reasoning that 132 is about halfway between 121 and 144 so $\sqrt{132}$ is a bit less than 11.5 (AC9M9N01_E3) |

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| | | solving problems involving the substitution of real numbers into formulas understanding that solutions can be represented in exact form or as an approximation when using digital tools, such as calculating the area of a circle using the formula $A = \pi r^2$ and specifying the answer to the calculation in terms of $\pi$ as an exact real number, for example, the circumference of a circle with diameter 5 units is $5\pi$ units, and its area is $\pi(\frac{5}{2})^2 = \frac{25}{4}\pi$ square units (AC9M9N01_E4) |
| | | investigating the position of rational and irrational numbers on the real number line, for example, using Pythagoras' theorem and geometric construction to locate real numbers, both rational and irrational, on a number line, for example, $\sqrt{2}$ is located at the intersection of an arc and the number line where the radius of the arc is the length of the diagonal of a 1 unit square (AC9M9N01_E5) |
| **Algebra** | apply the exponent laws to numerical expressions with integer exponents and extend to variables, using positive integer exponents (AC9M9A01) | representing decimal fractions in expanded form, for example, $0.475 = \frac{4}{10} + \frac{7}{100} + \frac{5}{1000} = 4 \times 10^{-1} + 7 \times 10^{-2} + 5 \times 10^{-3}$ (AC9M9A01_E1) |
| | | simplifying and evaluating numerical expressions, involving both positive and negative integer exponents, explaining why, for example, $5^{-3} = \frac{1}{5^3} = (\frac{1}{5})^3 = \frac{1}{125}$ (AC9M9A01_E2) |
| | | relating the computation of numerical expressions involving exponents to the exponent laws and the definition of an exponent, for example, $2^3 \div 2^5 = 2^{-2} = \frac{1}{2^2} = \frac{1}{4}$ ; $(3 \times 5)^2 = 3^2 \times 5^2 = 9 \times 25 = 225$ (AC9M9A01_E3) |
| | | choosing efficient strategies such as estimating and order of operation and applying them to exponent laws of numerical expressions with positive and negative integer exponents (AC9M9A01_E4) |
| | | recognising exponents in algebraic expressions, for example, $x^1 = x, r^2 = r \times r$, $h^3 = h \times h \times h$ and $y^4 = y \times y \times y \times y$ (AC9M9A01_E5) |
| | | relating simplification of expressions from first principles and counting to use of the exponent laws, for example, $(a^2)^3 = (a \times a) \times (a \times a) \times (a \times a) = a \times a \times a \times a \times a \times a = a^6$; $b^2 \times b^3 = (b \times b) \times (b \times b \times b) = b \times b \times b \times b \times b = b^5$; $\frac{y^4}{y^2} = \frac{y \times y \times y \times y}{y \times y} = \frac{y^2}{1} = y^2$ (AC9M9A01_E6) |

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| | | simplifying expressions involving combined application of the exponent rules where one or two variables are involved, for example, $\frac{x^2 \times x^3 \times y}{x^4 \times (y^2)^2} = \frac{x}{y^3}$ (AC9M9A01_E7) |
| | expand and factorise algebraic expressions including simple quadratic expressions (AC9M9A02) | recognising the application of the distributive law to algebraic expressions (AC9M9A02_E1) |
| | | using manipulatives such as algebra tiles or an area model to expand or factorise algebraic expressions with readily identifiable binomial factors, for example, $4x(x+3) = 4x^2 + 12x$ or $(x+1)(x+3) = x^2 + 4x + 3$ (AC9M9A02_E2) |
| | | recognising the relationship between expansion and factorisation and identifying algebraic factors in algebraic expressions including the use of digital tools to systematically explore factorisation from $x^2 + bx + c$ where one of $b$ or $c$ is fixed and the other coefficient is systematically varied (AC9M9A02_E3) |
| | | exploring the connection between exponent form and expanded form for positive integer exponents using all of the exponent laws with constants and variables (AC9M9A02_E4) |
| | | applying the exponent laws to positive constants and variables using positive integer exponents (AC9M9A02_E5) |
| | | investigating factorising non-monic trinomials using algebra tiles or strategies such as the area model or pattern recognition (AC9M9A02_E6) |
| | determine the gradient of a line segment passing through two given points on the Cartesian plane and the distance and midpoint between these points using a range of strategies, including graphing software and apply to spatial problems (AC9M9A03) | recognising that the gradient of a line is the same as the gradient of any line segment on that line (AC9M9A03_E1) |
| | | relating the gradient of a line to the tangent of the angle it makes with the positive direction of the horizontal axis (AC9M9A03_E2) |
| | | using digital tools to illustrate that parallel lines in the Cartesian plane have the same gradient (AC9M9A03_E3) |
| | | investigating graphical and algebraic techniques for finding the distance, midpoint and gradient of the line segment joining between two points (AC9M9A03_E4) |
| | | using dynamic graphing software and superimposed images, for example, playground equipment, ramps, escalators, to investigate gradients in context and their relationship to rule of a linear function, and interpret |

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| | | gradient as a constant rate of change in linear modelling contexts (AC9M9A03_E5) |
| | graph simple non-linear relations using graphing software where appropriate and solve linear and quadratic equations involving a single variable graphically, numerically and algebraically using inverse operations and digital tools as appropriate (AC9M9A04) | graphing quadratic and other non-linear functions using digital tools and comparing what is the same and what is different between these different functions and their respective graphs (AC9M9A04_E1) |
| | | using graphs to determine the solutions to linear and quadratic equations (AC9M9A04_E2) |
| | | representing and solving linear and quadratic equations algebraically using a sequence of inverse operations and comparing these to graphical solutions (AC9M9A04_E3) |
| | | graphing percentages of illumination of moon phases in relationship with Aboriginal and Torres Strait Islander Peoples' understandings that describe the different phases of the moon (AC9M9A04_E4) |
| | use linear and simple quadratic functions to model a variety of different situations involving change and represent these using tables, graphs on the Cartesian plane and algebra. Interpolate, extrapolate and solve equations, interpreting solutions in the modelling context (AC9M9A05) | representing linear functions including practical contexts such as flag fall fees, trade quotes involving a call out fee, cooking that includes resting or cooling times or water leakage from water tanks using tables and graphs or digital tools and algebraically, interpreting features of the graph such as symmetry, turning point, maximum and minimum values, and intercepts in context, and determining when values of the model lie within a given range (AC9M9A05_E1) |
| | | representing simple quadratic functions including modelling practical contexts such as paths of projectiles, parabolic mirrors, satellite dishes, profit/loss or optimisation in tables and graphs (hand drawn or digital tools) and algebraically interpreting features of the graphs such as the turning point and intercepts in context (AC9M9A05_E2) |
| | | exploring quadratic functions through hunting techniques of Aboriginal and Torres Strait Islander Peoples by increasing the number of hunters to increase the area/circumference to catch more prey (AC9M9A05_E3) |
| | apply computational thinking to investigate the effects of the variation of parameters on families of graphs of functions and relations using digital tools. Generalise emerging patterns and apply models to situations | investigating transformations of the graph of $y = x$ to the graph of $y = ax + b$ by systematic variation of $a$ and $b$ and interpretation of the effects of these transformations (AC9M9A06_E1) |
| | | investigating transformations of the graph (parabola) of $y = x^2$ in the Cartesian plane using digital tools to determine the relationship between graphical and algebraic representations of quadratic functions (AC9M9A06_E2) |
| | | experimenting with different types of functions, changing parameters to see what changes graphically, making conjectures and using empirical reasoning to recognise patterns and investigate relationships (AC9M9A06_E3) |

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| | or problems (AC9M9A06) | experimenting with digital tools by applying transformations, including translations and dilations to parabolas, and simple exponential functions, identifying patterns (AC9M9A06_E4) |
| Measurement | solve problems involving the volume of right prisms and cylinders in practical contexts and explore their relationship to right pyramids and cones (AC9M9M01) | investigating the volume and capacity of prisms and cylinders, to solve authentic problems (AC9M9M01_E1) |
| | | determining and describing how changes in the linear dimensions of a shape affect its surface area or volume, including proportional and non-proportional change (AC9M9M01_E2) |
| | | solving problems involving volume and capacity, for example, rain collection and storage, optimal packaging and production (AC9M9M01_E3) |
| | | experimenting with various open prisms, pyramids, cylinders and cones to develop an understanding that pyramids and cones are derived from prisms and cylinders respectively and that their volumes are directly related by a constant factor of $\frac{1}{3}$ (AC9M9M01_E4) |
| | solve problems involving the surface area of right prisms and cylinders (AC9M9M02) | analysing nets of objects to generate short cuts and establish formulas for surface area (AC9M9M02_E1) |
| | | determining the amount of material need to make can coolers for a class fundraising project and working out the most cost-efficient way to cut out the pieces (AC9M9M02_E2) |
| | | exploring different prisms that have the same volume but different surface areas making conjectures as to what type of prism would have the smallest or largest surface area (AC9M9M02_E3) |
| | | investigating objects and technologies of Aboriginal and Torres Strait Islander Peoples, analysing and connecting surface area and volume and exploring their relationship to capacity (AC9M9M02_E4) |
| | express number in scientific notation and solve problems involving very small and very large measurements, time scales and intervals using scientific notation and appropriate units (AC9M9M03) | representing extremely large and small numbers in scientific notation, and numbers expressed in scientific notation as whole numbers or decimals (AC9M9M03_E1) |
| | | using knowledge of place value and applying exponent laws operate with numbers expressed in scientific notation in applied contexts, for example, performing calculations involving extremely small numbers in scientific and other contexts (AC9M9M03_E2) |
| | | exploring different scales in fractals on-Country/Place, expressing their different attributes using scientific notation |

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| | | (AC9M9M03_E3) |
| | model situations involving scale and ratio in two-dimensions and solve related practical problems (AC9M9M04) | establishing the relationship between areas of similar figures and the ratio of corresponding sides (scale factor) (AC9M9M04_E1) |
| | | using images of proportional relationships to estimate actual measurements, for example, taking a photograph of a person standing in front of a tree and using the image and scale to estimate the height of the tree, discussing findings and ways to improve the estimates (AC9M9M04_E2) |
| | | investigating the use of scale and proportion in images used on social media, exploring the impact on image editing and how proportion may not be maintained resulting in distorted images (AC9M9M04_E3) |
| | | using everyday knowledge to help estimate the scale, such as given a picture of a man, measure the height and use average male height to work out the scale factor (AC9M9M04_E4) |
| | | investigating compliance with building and construction standards in design and construction such as the rise and tread of staircases and vertical and horizontal components of escalators (AC9M9M04_E5) |
| | | using knowledge of similar triangles, Pythagoras' theorem, rates and algebra to design and construct a Biltmore stick used to measure the diameter and height of a tree and calculate the density and dry mass to predict how much paper could be manufactured from the tree (AC9M9M04_E6) |
| | explore the relationship between graphs and equations corresponding to rate problems and solve problems involving direct proportion (AC9M9M05) | recognising situations involving direct proportion such as pay rates, exchange rates, multiple quotes for a job, conversion between scales or other appropriate science contexts (AC9M9M05_E1) |
| | | exploring the relationships in the situations graphically and commenting on the graph's features (AC9M9M05_E2) |
| | | describing the links between the graph and the equation including gradient, horizontal and vertical axis intercepts within the context of the problems (AC9M9M05_E3) |
| | | exploring fire techniques in land management practices used by Aboriginal and Torres Strait Islander Peoples that use direct and inverse proportion relationships including the rate of fire spread in different fuel types to wind speed, temperature, and relative humidity (AC9M9M05_E4) |
| | recognise that all | investigating error as a percentage of the exact value, for example, by comparing an estimation of the number of |

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| | measurements are estimates and calculate and interpret absolute, relative and percentage errors in measurements (AC9M9M06) | people expected to come to an event by subtracting the actual number that turned up to give an error then converting this into a percentage error (AC9M9M06_E1) |
| | | exploring the use of absolute value in a percentage error formula; when you would use absolute and when you would not, depending upon the context (AC9M9M06_E2) |
| | | calculating the percentage errors in expected budgets to actual expenditure (AC9M9M06_E3) |
| | | estimating the accuracy of measurements in practical contexts and giving suitable lower and upper bounds for measurement values (AC9M9M06_E4) |
| | apply angle properties, scale, similarity, Pythagoras' theorem and trigonometry in right angled triangles to solve practical problems (AC9M9M07) | investigating the applications of Pythagoras' theorem in authentic problems including applying Pythagoras' theorem and trigonometry to problems in surveying and design (AC9M9M07_E1) |
| | | establishing the formula for finding the distance between two points in the Cartesian plane using Pythagoras theorem (AC9M9M07_E2) |
| | | comparing the lengths of sides to develop an understanding of the relationship between the corresponding sides of similar right-angled triangles (AC9M9M07_E3) |
| | | applying the formula for calculation of distances between points on the Cartesian plane from their coordinates, emphasising the connection to vertical and horizontal displacements between the points (AC9M9M07_E4) |
| | | investigating the triangle inequality, and generalising links between the Pythagorean rule for right angled triangles, and related inequalities for acute and obtuse triangles (AC9M9M07_E5) |
| | | exploring minimal sets of information for a triangle from which other measures can all be determined (AC9M9M07_E6) |
| **Space** | recognise Euler's formula can be applied to different types of problems including problems | investigating Euler's formula and how it can be applied to different types of problems in different contexts and recognising how the relationships expressed within the formula transfer to these different contexts (AC9M9SP01_E1) |

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| | relating to planar graphs, platonic solids and other polyhedra (AC9M9SP01) | investigating various situations involving planar graphs (networks) and Euler's formula such as the 'The Seven Bridges of Königsberg' problem (AC9M9SP01_E2) |
| | | investigating the traversability of networks and the link to Euler's formula (AC9M9SP01_E3) |
| | | using Euler's formula to identify and describe platonic solids (AC9M9SP01_E4) |
| | | exploring geodesic design in Aboriginal and Torres Strait Islander building traditions and its relationship to Euler's formula and how this has influenced contemporary housing design (AC9M9SP01_E5) |
| | recognise the constancy of the sine, cosine and tangent ratios for a given angle in right-angled triangles using similarity (AC9M9SP02) | investigating patterns to reason about growing or nested similar figures that are aligned on a coordinate plane, connecting ideas of parallel sides and corresponding angles (AC9M9SP02_E1) |
| | | establishing an understanding that the sine of an angle is the length of the opposite side of a right-angled triangle with a hypotenuse of length one unit and similarly the cosine is the length of the adjacent side of the same triangle and as such, sine and cosine are proportional to corresponding lengths of similar right-angled triangles (AC9M9SP02_E2) |
| | | understanding the terms 'hypotenuse', 'adjacent' and 'opposite' sides in a right-angled triangle (AC9M9SP02_E3) |
| | apply the enlargement transformation to shapes and objects using dynamic geometric software as appropriate. Identify and explain aspects that remain the same and those that change (AC9M9SP03) | comparing the lengths of sides of triangles which have the same three angles (AC9M9SP03_E1) |
| | | using the properties of similarity and ratio, and correct mathematical notation and language, to solve problems involving enlargement (AC9M9SP03_E2) |
| | | investigating and generalising patterns in length, angle, area and volume when side lengths of shapes and objects are enlarged or dilated by whole and rational numbers, for example, comparing an enlargement of a square and a cube of side length 2 units by a factor of 3 increases the area of the square, $2^2$, to $(3 \times 2)^2 = 9 \times 2^2 = 9$ times the original area and the volume of the cube, $2^3$, to $(3 \times 2)^3 = 27 \times 2^3 = 27$ times the volume (AC9M9SP03_E3) |
| | apply computational thinking to construct, evaluate and refine | establishing and experimenting with the algorithm for determining the sum of the angles in an $n$-sided polygon (AC9M9SP04_E1) |

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| | algorithms designed to test spatial conjectures (AC9M9SP04) | creating an algorithm to generate Pythagorean triples (AC9M9SP04_E2) |
| | | creating and testing an algorithm that explores trigonometric ratios in right angle triangles, experimenting with changing parameters (AC9M9SP04_E3) |
| | | investigating visual proofs of spatial theorems and design an algorithm to produce a visual proof (AC9M9SP04_E4) |
| **Statistics** | investigate reports of surveys in digital media and elsewhere for information on how data was obtained to estimate population means and medians. Explain how different sampling methods can affect the results of surveys and how choice of representation could be employed to support a particular point of view (AC9M9ST01) | investigating and evaluating statistical reports in the media and other places by linking claims to displays, statistics and representative data (AC9M9ST01_E1) |
| | | investigating the use of statistics in reports regarding the growth of Australia's trade with other countries of the Asia region (AC9M9ST01_E2) |
| | | investigating and analysing different visualisations of data such as infographics found in the media and commenting on the strengths, weaknesses and possible biases of particular examples (AC9M9ST01_E3) |
| | | exploring the impact of decreased landline usage or an increased aversion to answering calls from unknown numbers on survey data (AC9M9ST01_E4) |
| | | exploring potential cultural bias relating to Aboriginal and Torres Strait Islander Peoples by critically analysing sampling techniques in statistical reports (AC9M9ST01_E5) |
| | represent the distribution of multiple numerical data sets using comparative representations (including back-to-back stem-and-leaf plots and grouped histograms). Compare data with consideration of centre, spread and shape (AC9M9ST02) | describing the shape of the distribution of data using terms such as ‘positive skew’, ‘negative skew’ and 'symmetric' and 'bi-modal' (AC9M9ST02_E1) |
| | | using stem-and-leaf plots to compare two like sets of data such as the heights of girls and the heights of boys in a class (AC9M9ST02_E2) |
| | | constructing grouped histograms which show trends in health issues such as lung cancer, leukemia, stroke and diabetes and using the graph to justify, verify or invalidate claims (AC9M9ST02_E3) |
| | | exploring comparative data presented in reports by National Indigenous Australians Agency in regard to *Closing the Gap*, discussing the comparative distributions within the context of the data, for example, comparative data presented in the *Closing the Gap - Prime Minister’s Report* (AC9M9ST02_E4) |

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| | choose appropriate forms of display or visualisation for a given type of data, justify selections and interpret displays with respect to statistical questions of interest for a given context (AC9M9ST03) | comparing data displays using mean, median and range to describe and interpret numerical data sets in terms of location (centre) and spread using histograms, dot plots, or stem and leaf plots (AC9M9ST03_E1) |
| | | exploring different visualisations of data (including non-standard representations such as infographics) and discussing their purpose, intended audience, evaluating how well they communicate responses to statistical questions of interest (AC9M9ST03_E2) |
| | | exploring the use of stacked bar charts, area charts and line graphs, discussing how they represent larger categories that can be subdivided into smaller categories and how information that can be obtained from these displays can be used for comparison (AC9M9ST03_E3) |
| | plan, conduct and review statistical investigations involving comparative analysis of multiple univariate data sets collected directly or from secondary sources (AC9M9ST04) | planning and conducting an investigation that investigates debatable questions and requires the analysis of secondary data set collected from online data bases such as the Australian Bureau of Statistics (AC9M9ST04_E1) |
| | | planning and conducting an investigation relating to consumer spending habits; modelling market research on what teenagers are prepared to spend on technology compared to clothing (AC9M9ST04_E2) |
| | | investigating where would be the best location for a tropical fruit plantation by conducting a statical investigation comparing different variables such as the annual rainfall in various parts of Australia, Indonesia, New Guinea and Malaysia, land prices and associated farming costs (AC9M9ST04_E3) |
| | | posing statistical questions, collecting, representing and interpreting data from different sources in relation to reconciliation (AC9M9ST04_E4) |
| **Probability** | list all outcomes for two-step chance events both with and without replacement using tree diagrams or arrays. Assign probabilities to outcomes and determine probabilities for events (AC9M9P01) | using systematic methods such as lists or arrays for outcomes of experiments to identify outcomes favourable to an event, such as a determining the chance of winning a game of heads and tails (AC9M9P01_E1) |
| | | conducting two-step chance experiments, using systematic methods to list outcomes of experiments and to list outcomes favourable to an event (AC9M9P01_E2) |
| | | conducting and discussing two-step chance experiments, such as the game of heads and tails, describing the different outcomes (AC9M9P01_E3) |

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| | | using repeated trials of Aboriginal and Torres Strait Islander children's instructive games, for example, *Gorri* from all parts of Australia, to calculate the probabilities of winning and not winning (AC9M9P01_E4) |
| | investigate and determine the probabilities of compound events using proportional reasoning and relate to the use of the language 'and', inclusive 'or', and exclusive 'or' (AC9M9P02) | understanding that relative frequencies from large data sets or long run experiments can provide reliable measures of probability and can be used to make predictions of decisions (AC9M9P02_E1) |
| | | using relative frequencies to find an estimate of probabilities of 'and', 'or' events (AC9M9P02_E2) |
| | | using Venn diagrams or two-way tables to calculate relative frequencies of events involving 'and', 'or' questions (AC9M9P02_E3) |
| | | calculating probabilities of winning and not winning using repeated trials of traditional Aboriginal and Torres Strait Islander children's instructive games (AC9M9P02_E4) |
| | design and conduct experiments or simulations that demonstrate the relationship between combined conditions for events and the probability of individual events (AC9M9P03) | using digital tools to conduct probability simulations that demonstrate the relationship between the probability of compound events and the individual probabilities (AC9M9P03_E1) |

## Year 10

| Level description |
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| The Australian Curriculum: Mathematics focuses on the development of a deep knowledge and conceptual understanding of mathematical structures and fluency with procedures. Students learn through the approaches for working mathematically, including modelling, investigation, experimentation and problem solving, all underpinned by the different forms of mathematical reasoning.<br>As students engage in learning mathematics in Year 10 they:<br>• investigate the accuracy of decimal approximations to irrational real numbers, consider the accuracy of computation with real numbers in context and explore the use of logarithmic scales to deal with phenomena involving small and large quantities and change<br>• apply numerical and graphical and algebraic approaches to analyse the behaviour of systems of two linear equations in two variables, and solve linear inequalities and represent solution sets as intervals on the real number line<br>• generalise and extend their repertoire of algebraic techniques involving quadratic and simple exponential algebraic expressions, model situations exhibiting growth or decay using linear, quadratic and simple exponential functions, and solve related equations, numerically, graphically and algebraically, with the use of digital tools as applicable<br>• solve measurement problems involving the surface area and volume of common objects, composite objects, and irregular objects, and use Pythagoras' theorem and trigonometry of right-angled triangles to solve spatial problems in two and three dimensions and manipulate images of their representations and images using digital tools. They apply geometric theorems to deduce results and solve problems involving plane shapes and use planar graphs and networks to investigate and model relations involving sets of points, connections, paths, and decisions<br>• investigate conditional probability and its relation to dependent and independent events, including sampling with and without replacement. They devise and use simulations to test intuitions involving chance events which may or may not be in dependent<br>• compare different ways of representing the distribution of continuous data including cumulative frequency graphs, and interpret key features of the distribution. They explore association between pairs of variables, decide the form of representation, interpret the data with respect to context and discuss possible conclusions. They use scatterplots to informally discuss and consider association between two numerical variables and informally consider lines of good fit by eye, interpolation, extrapolation and limitations. |

## Achievement standard

By the end of Year 10, students model situations and apply computational approaches to solving problems. They use digital tools to obtain and investigate and discuss the effect of approximations of exact irrational real numbers in combined and repeated calculations. Students use algebraic techniques to model phenomena, including financial applications, growth and decay and applying linear, quadratic and exponential functions as appropriate. They solve related algebraic equations, numerically, graphically and using computational thinking and digital tools. Students solve problems involving parallel and perpendicular lines. They formulate, solve, and interpret solutions to problems involving linear inequalities and simultaneous linear equations in two variables graphically.

Students use and interpret logarithmic scales representing small or large quantities or change in applied contexts. They solve practical measurement problems involving surface area and volumes of objects and composite solids. Students apply Pythagoras' theorem and trigonometry to solve spatial problems involving right angled triangles. They consider levels of accuracy and sources of error in measurement with instruments, and the possible impact of these when applying measurement formulas. Students describe and apply geometric theorems to solve problems, giving reason for solutions. They use networks to model relationships, interpret situations and describe connectedness.

Students design and conduct statistical investigations involving bivariate numerical data. They represent the distribution of data involving two variables using tables and scatter plots and discuss possible association. Students consider association between numerical variables including trend data when time is one of the variables. They critically analyse media in terms of the claims and conclusions, noting limitations and potential sources of bias. Students represent and compare the distribution of data for a continuous variable using various displays and discuss distributions in terms of summary statistics and their features. They apply conditional probability and independence to solve problems involving compound events, using diagrams. Students use computational thinking and reasoning to solve spatial problems and design and conduct simulations modelling phenomena involving compound events including conditional probability.

| Strand | Content description<br>*Students learn to:* | Elaboration<br>*This may involve students:* |
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| Number | recognise through experimentation and the use of technology, the effect of using approximations of real numbers in repeated calculations and compare the results when using exact representations (AC9M10N01) | comparing and contrasting the effect of truncation or rounding on the final result of calculations when using approximations of real numbers rather than exact representations (AC9M10N01_E1) |
| | | investigating the impact of approximation on multiple calculations in contexts that involve area of complex shapes involving circles, volume, surface area of complex objects involving circles and repeated calculations of simple interest where the solutions are not exact cents (AC9M10N01_E2) |

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| Algebra | use formulas involving exponents and real numbers to model practical problems (including financial contexts) involving growth and decay and solve using digital tools as appropriate (AC9M10A01) | investigating constant percentage change and constant ratio in terms of modelling growth and decay and contrast with linear growth or decay (AC9M10A01_E1) |
| | | determining doubling time and half-life in situations involving exponential growth and decay, and intervals for which the values of the model lie within a given range (AC9M10A01_E2) |
| | | working with authentic information, data and interest rates to calculate compound interest and solve related problems (AC9M10A01_E3) |
| | | substituting numerical values for variables when using formulas (AC9M10A01_E4) |
| | | calculating the value of any unknown within a formula using strategies such as rearranging the formula, substituting and calculating each side before rearranging, or using digital tools with symbolic manipulation functionality, supplying solutions in the context of the practical situation (AC9M10A01_E5) |
| | | investigating how exponential equations are used in carbon dating to estimate the age of Aboriginal and Torres Strait Islander Peoples' artefacts or material culture (AC9M10A01_E6) |
| | | formulating exponential equations in population growths of native animals on Country/Place with varying reproductive behaviour and critique their applicability to real world situations (AC9M10A01_E7) |
| | expand and factorise expressions and apply exponent laws involving products, quotients and powers of variables. Apply to solve equations algebraically (AC9M10A02) | reviewing and connecting exponent laws of numerical expressions with positive and negative integer exponents to exponent laws involving variables (AC9M10A02_E1) |
| | | using the distributive law and the exponent laws to expand and factorise algebraic expressions (AC9M10A02_E2) |
| | | explaining the relationship between factorisation and expansion (AC9M10A02_E3) |
| | | applying knowledge of exponent laws to algebraic terms, and simplifying algebraic expressions using both positive and negative integral exponents to solve equations algebraically (AC9M10A02_E4) |
| | solve problems involving parallel and perpendicular lines obtained from the graphs of | solving problems involving rail tracks, power lines, buildings, staircases, carparks, fencing, tree plantations or musical instrument strings using the relation that parallel lines have the same gradient and conversely that if two lines have the same gradient then they are parallel (AC9M10A03_E1) |

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| | linear functions (AC9M10A03) | using dynamic graphing software to investigate and describe the types of lines in in playground slides, bridges or scissor lifts (AC9M10A03_E2) |
| | | relating the product of the gradient of two perpendicular lines to the rotation of a right-angled triangle by 90°(AC9M10A03_E3) |
| | use linear inequalities to model situations, representing them graphically and interpret in the context of the situation. Verify solutions to other inequalities by substitution (AC9M10A04) | solving linear inequalities such as and $0 \leq 15 - 4x \leq 10$ and graphing the results on a number line (AC9M10A04_E1) |
| | | graphing regions corresponding to inequalities in the Cartesian plane, for example, graphing $2x + 3y < 24$ and verifying using a test point such as (0, 0) (AC9M10A04_E2) |
| | | identifying all the combinations of trips to the movies ($12) and ice-skating sessions ($21) as the integer solutions for an entertainment budget of up to $150 for the school holidays and expressing algebraically as $12m + 21s \leq 150$ (AC9M10A04_E3) |
| | | testing whether a point satisfies an inequality, for example, whether the point (3, 5) satisfies $2y < x^2$ (AC9M10A04_E4) |
| | recognise the connection between algebraic and graphical representations of exponential relations and solve simple related exponential equations using digital tools as appropriate (AC9M10A05) | investigating the links between algebraic and graphical representations of exponential functions using graphing software (AC9M10A05_E1) |
| | | using digital tools with symbolic manipulation functionality to explore exponential relations (AC9M10A05_E2) |
| | | investigating First Nations Ranger groups and other groups' programs that attempt to eradicate feral animals for survival of native animals on-Country/Place, exploring the competition between feral and native animals and their impact on natural resources by formulating exponential equations for population growth for each animal species (AC9M10A05_E3) |
| | model situations (including financial contexts) with simultaneous equations in two variables. Solve pairs of these equations and interpret solutions graphically in the | investigating situations such as torque and power in drag cars and high-performance cars, fermenting of wines, growth of diseases and effects of antibiotics, optimising packaging or positions of roads on bridges, that can be modelled graphically involving simultaneous equations; equations include but not limited to combinations of linear, quadratics, and exponential functions (AC9M10A06_E1) |
| | | investigating situations involving linear equations in context such as multiple quotes for a job, profit and loss, |

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| | modelling context (AC9M10A06) | solving it graphically; giving solutions in everyday language such as break-even point or point to change providers for the job (AC9M10A06_E2) |
| | | describing the solution of the simultaneous equations within the context of the situation using every day and mathematical language (AC9M10A06_E3) |
| | | investigating the strategies inherent in Aboriginal and Torres Strait Islander children's instructive games, for example, *Weme* from the Warlpiri Peoples of central Australia, and their connection to strategies to solve simultaneous linear equations in two variables (AC9M10A06_E4) |
| | apply computational thinking to model and solve algebraic problems graphically or numerically (AC9M10A07) | applying the graphing zoom functionality of digital tools and systematically refining intervals to identify approximate location of points of intersection of the graphs of two functions, such as $x^2 = 2^x$ (AC9M10A07_E1) |
| | | approximating the coordinates of the points of intersection of the graphs of two functions using systematic guess-check and refine algorithms (AC9M10A07_E2) |
| | | using a table of values to determine when an exponential growth or decay function exceeds or falls below a given value, such as monitoring the trend in value of a share price in a context of exponential growth or decay (AC9M10A07_E3) |
| | | applying a bisection algorithm to determine the approximate location of the horizontal axis intercepts of the graph of a quadratic function such as $f(x) = 2x^2 - 3x - 7$ (AC9M10A07_E4) |
| **Measurement** | solve problems involving the surface area and volume of composite objects including estimating the volume of irregular objects in practical contexts (AC9M10M01) | using authentic situations to apply knowledge and understanding of surface area and volume (AC9M10M01_E1) |
| | | investigating and determining the volumes and surface areas of composite solids by considering the individual solids from which they are constructed (AC9M10M01_E2) |
| | | using mathematical modelling to ascertain whether to hire extra freezer space for the amount of ice-cream required to make 'choc bombs' or similar for a large crowd at a fundraising event for the school or community (AC9M10M01_E3) |
| | | using mathematical modelling to ascertain the rainfall that can be saved from a roof top and the optimal shape and dimensions for rainwater storage based on where it will be located on a property (AC9M10M01_E4) |

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| | | modelling the design of beehives based on polygonal prisms to make decisions about what makes a good beehive (AC9M10M01_E5) |
| | interpret and use logarithmic scales to model phenomena involving small and large quantities and change (AC9M10M02) | understanding that the logarithmic scale is calibrated in terms of order of magnitude, for example, doubling or powers of 10 (AC9M10M02_E1) |
| | | investigating data representations (charts and graphs) that use logarithmic scales, interpret and discussing when it is appropriate to use this type of scale and when it is not appropriate (AC9M10M02_E2) |
| | | investigating how logarithmic scales are used in real world contexts, for example, Richter, decibel and sensitivity scales or growth in investments and describe reasons for choosing to use a logarithmic scale rather than linear scale (AC9M10M02_E3) |
| | | investigating the use of logarithmic scales to model growth, for example, spread of micro-organisms and disease (AC9M10M02_E4) |
| | | investigating dating methods of (geological) sites to provide evidence of Aboriginal human presence in Australia including the Madjedbebe dig in the Northern Territory that use logarithmic scales (scientific notation) and measurement accuracy in the dating (AC9M10M02_E5) |
| | model situations involving scale, ratios and rates relating to objects in two and three-dimensions and solve related practical problems (AC9M10M03) | using plans and elevation drawings to investigate making changes to building designs using appropriate scales and converting to actual measurements within the context to make decisions about changes (AC9M10M03_E1) |
| | | using a 3D printer to produce scaled versions of actual objects (AC9M10M03_E2) |
| | | solving proportional problems involving ratios making decisions about changing quantities whilst maintain the proportional relationships (AC9M10M03_E3) |
| | | understanding and generalising the effect of scaling one or more linear dimensions on surface areas and volumes (AC9M10M03_E4) |
| | | analysing and applying scale, ratios and rates in situations such as production prototypes and 3D printing (AC9M10M03_E5) |
| | | estimating the scale of an object, such as a model car, by measuring a linear dimension and using a typical car dimension to work out the scale factor (AC9M10M03_E6) |

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| | | investigating compliance with building codes and standards in design and construction such as for escalators in shopping centres (AC9M10M03_E7) |
| | identify levels of accuracy and the sources of measurement errors in practical contexts and investigate the impact of measurement errors on results (AC9M10M04) | investigating settings where measurement errors may impact on research results and how measurement data impacted by error can result in biased findings (AC9M10M04_E1) |
| | | analysing instruments and methods for measuring in investigations and modelling activities (AC9M10M04_E2) |
| | | investigating the impact that compounding errors have on financial calculations (AC9M10M04_E3) |
| | | investigating scientific measuring techniques including dating methods and genetic sequencing applied to Aboriginal Peoples and their artefacts and the social impact of measurement errors (AC9M10M04_E4) |
| | apply trigonometry of right angles triangles and Pythagoras' theorem to model and solve practical problems in two and three-dimensions including those involving direction and angles of elevation and depression (AC9M10M05) | applying right-angled trigonometry to solve navigation problems involving bearings, for example, determining the bearing and estimating the distance of the final leg of an orienteering course (AC9M10M05_E1) |
| | | applying Pythagoras' theorem and trigonometry to problems in surveying and design, where three-dimensional problems are decomposed into two-dimensional problems (AC9M10M05_E2) |
| | | using a clinometer to measure angles of inclination and applying trigonometry and proportional reasoning to determine the height of buildings in practical contexts (AC9M10M05_E3) |
| | | applying Pythagoras' theorem and trigonometry to investigate three-dimensional problems, for example, investigating the dimensions of the smallest box needed to package an object of a particular length (AC9M10M05_E4) |
| | | applying Pythagoras' theorem and trigonometry and using dynamic geometric software to design three-dimension models of practical situations involving angles of elevation and depression, for example, modelling a crime scene (AC9M10M05_E5) |
| | | exploring navigation, design of technologies or surveying by Aboriginal and Torres Strait Islander Peoples, investigating geometric and spatial reasoning and how these connect to trigonometry (AC9M10M05_E6) |

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| Space | model practical situations as a network and use network diagrams to specify relationships and connectedness (AC9M10SP01) | investigating the use of a graphs to represent a network, exploring and analysing connectedness, for example, investigating the 'The Seven Bridges of Königsberg' problem (AC9M10SP01_E1) |
| | | exploring efficient methods for traveling a network where there is a need to visit several specific points on the network one after each other, for example, postal delivery route (AC9M10SP01_E2) |
| | | investigating how an intranet, local area network (LAN) or social network can be represented as a network diagram to specify relationships (AC9M10SP01_E3) |
| | | representing the electrical wiring or wireless network of a home using network diagrams to investigate practical problems involving connections, power overload or the need for routers (AC9M10SP01_E4) |
| | | using maps as a network, investigating how Global Positioning System (GPS) based navigation systems determine the shortest path when recommending journeys (AC9M10SP01_E5) |
| | | exploring the use of networks to represent situations such rail or air travel between or within London, Paris, Hong Kong, and which connections, including inter-connection waits result in shortest travel time (AC9M10SP01_E6) |
| | | representing Aboriginal and Torres Strait Islander Peoples kinship systems using network diagrams and exploring the significance of relationships to Country/Place (AC9M10SP01_E7) |
| | apply logical reasoning (including the use of congruence and similarity) to proofs involving shapes in the plane and apply theorems to solve spatial problems (AC9M10SP02) | distinguishing between a practical demonstration and a proof, for example, demonstrating triangles are congruent by placing them on top of each other, as compared to using congruence tests to establish that triangles are congruent (AC9M10SP02_E1) |
| | | performing a sequence of steps to determine an unknown angle giving a justification in moving from one step to the next (AC9M10SP02_E2) |
| | | using dynamic geometric software to investigate the shortest path that touches three sides of a rectangle, starting and finishing at the same point and proving that the path forms a parallelogram (AC9M10SP02_E3) |
| | | investigate visual proof of geometric theorems and apply to solve spatial problems, using visual proof to justify solutions (AC9M10SP02_E4) |

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| | | formulating proofs involving congruent triangles and angle properties (AC9M10SP02_E5) |
| | apply computational thinking to solving spatial problems (AC9M10SP03) | designing, creating and testing an algorithm to determine whether shapes will tesselate and apply to practical contexts, for example, paving, tiling, creating mosaics (AC9M10SP03_E1) |
| | | applying a computational approach to solving problems involving networks, for example, connectedness, coverage and weighted measures, for example, exploring different routes and choosing the most efficient route to take when travelling by car using virtual map software (AC9M10SP03_E2) |
| | | using a three-dimensional printer to make components of a puzzle, planning and designing the puzzle using principles of tessellations (AC9M10SP03_E3) |
| | | using a three-dimensional printer to make scale models of three-dimensional objects (AC9M10SP03_E4) |
| | | exploring geospatial technologies used by Aboriginal and Torres Strait Islander communities to consider spatial problems including position and transformation (AC9M10SP03_E5) |
| **Statistics** | evaluate statistical reports in the media in terms of questions posed, data gathering and representation of distributions. Analyse claims and inferences, including ethical considerations and identification of potential sources of bias (AC9M10ST01) | evaluating whether graphs in a report could mislead, and whether graphs and numerical information support the claims (AC9M10ST01_E1) |
| | | evaluating the appropriateness of sampling methods in reports where statements about a population are based on a sample (AC9M10ST01_E2) |
| | | identifying potentially misleading data representations in the media such as graphs with broken axes, scales that do not start at zero or are nonlinear, data not related to the claim or representative of the population or deliberately misleading to support a claim or biased point of view (AC9M10ST01_E3) |
| | | investigating the source and size of the sample from which the data was collected and deciding whether the sample is appropriately representative of the population (AC9M10ST01_E4) |
| | | investigating population rates and discussing potential ethical considerations when presenting statistical data involving infection rates, and the number of cases per head of population (AC9M10ST01_E5) |

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| | | using secondary data to predict the number of people likely to be infected with a strain of flu or experience side effects with a certain medication discussing the ethical considerations of reporting of such data to the wider public, considering validity claims, samples sizes (AC9M10ST01_E6) |
| | | using the concept of Indigenous data sovereignty to critique and evaluate the Australian Government's Closing the Gap report (AC9M10ST01_E7) |
| | compare data distributions for continuous numerical variables using appropriate data displays (including boxplots). Discuss the shapes of these distributions in terms of centre, spread, shape and outliers in the context of the data (AC9M10ST02) | constructing and interpreting box plots and using them to compare data sets, understanding that box plots are an efficient and common way of representing and summarising data and can facilitate comparisons between data sets (AC9M10ST02_E1) |
| | | comparing shapes of box plots to corresponding histograms, cumulative frequency graphs and dot plots (AC9M10ST02_E2) |
| | | using digital tools to compare boxplots and histograms as displays of the same data in the light of the statistical questions being addressed and the effectiveness of the display in helping to answer the question (AC9M10ST02_E3) |
| | | finding the five-number summary (minimum and maximum values, median and upper and lower quartiles) and using its graphical representation, the box plot, as tools for both numerically and visually comparing the centre and spread of data sets (AC9M10ST02_E4) |
| | | comparing the information that can be extracted and the stories that can be told about numerical data sets which have been displayed in different ways including histograms, dot plots, box plots and cumulative frequency graphs (AC9M10ST02_E5) |
| | create and use scatterplots to investigate and comment on the relationships between two numerical variables. Describe the relationship and discuss any conclusions that may be drawn | discussing the difference between association and cause and effect and relating this to situations such as health, diversity of species, climate control (AC9M10ST03_E1) |
| | | using statistical evidence to make, justify and critique claims about association between variables, such as in contexts of climate change, migration, online-shopping, social media (AC9M10ST03_E2) |
| | | informally using a line of good fit by eye to discuss reliability of any predictions (AC9M10ST03_E3) |

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| | (AC9M10ST03) | investigating the relationship between two variables of spear throwers used by Aboriginal Peoples by using data to construct scatterplots, make comparisons, and draw conclusions (AC9M10ST03_E4) |
| | recognise and explore associations between categorical variables using two-way (contingency) tables and identify and discuss possible relationships (AC9M10ST04) | using two-way tables to investigate the relationships between categorical variables of data sets of authentic data (AC9M10ST04_E1) |
| | | recording data in contingency tables and using percentages and proportions to identify patterns and associations in the data (AC9M10ST04_E2) |
| | plan, conduct and review statistical investigations of association and trend in bivariate numerical data. Discuss association in terms of strength, direction and linearity (AC9M10ST05) | using statistical investigation to substantiate or invalidate anecdotal claims including those concerning climate, housing affordability, natural resources (AC9M10ST05_E1) |
| | | designing statistical investigations that collect bivariate data over time through observation, experiment or measurement, graph, interpret, analyse data and report on the data within the context of the statistical investigation question (AC9M10ST05_E2) |
| | | using a statistical investigation to address the question, '*Is there a relationship between vaccines and immunity from a virus'* (AC9M10ST05_E3) |
| | | investigating biodiversity changes in Australia before and after colonisation by comparing related bivariate numerical data, discussing and reporting on associations (AC9M10ST05_E4) |
| **Probability** | use the language of 'if .... then, 'given', 'of', 'knowing that' to investigate conditional statements and identify common mistakes in interpreting such language (AC9M10P01) | using two-way tables and Venn diagrams to understand conditional statements using the language of 'if ..then, 'given', 'of', 'knowing that' and identify common mistakes in interpreting such language (AC9M10P01_E1) |
| | | using arrays and tree diagrams to determine and compare probabilities of dependent and independent events (AC9M10P01_E2) |
| | use probability, random variables and simulations to | using samples of different sizes with and without replacement from a population to identify when the difference in methods becomes negligible (AC9M10P02_E1) |

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| | model phenomena, including sampling with and without replacement, and evaluate results (AC9M10P02) | recognising that an event can be dependent on another event and that this will affect the way its probability is calculated (AC9M10P02_E2) |
| | | using digital tools to simulate the capture-recapture method for estimating biological populations, for example, the population of mobile or elusive birds and animals or in fish farming and production (AC9M10P02_E3) |
| | design and use probability simulations to model and investigate situations including problems involving compound events and simulations that use conditional statements to produce different outcomes. Apply reasoning to evaluate and report on their effectiveness (AC9M10P03) | using simulations to gather data on frequencies for situations involving chance that appear to be counter-intuitive such as the three-door problem or the birthday problem (AC9M10P03_E1) |
| | | exploring situations in real-life where probability is used for decision making, such as supply and demand of product, insurance risk, queueing (AC9M10P03_E2) |
| | | using simulation to predict the number of people likely to be infected with a strain of flu or virus (AC9M10P03_E3) |
| | | identifying factors that may cause a simulation to no longer effectively model the real-world event (AC9M10P03_E4) |

## Year 10

### *Optional content that will support pathways to senior secondary mathematics (Mathematical Methods and Specialist Mathematics)*

In Year 10, students will consider possible pathways to senior secondary mathematics study. Preparation for subsequent study of Units 1 and 2 of Mathematical Methods and Specialist Mathematics can be strengthened by further exploring some aspects of mathematics content in Year 10 as a basis for building understanding that underpins formal treatment in Mathematical Methods and/or Specialist Mathematics subjects in senior secondary.

Suggestions for this content are provided below. Illustrative examples provide some suggestions of what might be appropriate for students to explore within the broad content showing links to relevant Year 10 content descriptions. Teachers may choose to draw on these suggestions to support students who may require additional content to enrich and extend their mathematical study whilst completing the Year 10 curriculum in preparation for senior secondary mathematics.

| Strand | Suggested content | Illustrative examples | Connected Year 10 content descriptions | Rationale for inclusion |
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| Number | operations on numbers involving surds and fractional exponents | explaining that *n*th root of *a*, is the same as the $\frac{1}{n}$ exponent i.e $\sqrt[n]{a} = a^{\frac{1}{n}}$ | expand and factorise expressions and apply exponent laws involving products, quotients and powers of variables. Apply to solve equations algebraically (AC9M10A02) | Surds and fractional exponents are representations used in both Methods and Specialist. Surd form provides exact answers when solving quadratic equations with irrational roots and in some measurement contexts in senior secondary mathematics.<br>Surds provide exact values for certain arguments of circular (trigonometric) functions<br>Fractional exponents arise in calculus where power functions with rational exponents are used in modelling contexts or in composition with other functions |
| | | simplifying expressions such as $\sqrt{96} = 96^{\frac{1}{2}}$, $\left(\sqrt{5}\right)^2 = (5^{\frac{1}{2}})^2 = 5^1 = 5$, $(\sqrt[3]{8})^2 = (8)^{\frac{2}{3}} = \sqrt[3]{8^2}$ | recognise the connection between algebraic and graphical representations of exponential relations and solve simple related exponential equations using digital tools as appropriate (AC9M10A05)<br>use formulas involving exponents and real numbers to model practical problems (including financial contexts) involving growth and decay and solve using digital tools as appropriate (AC9M10A01) | |

$$= 4,$$

$$(0.5)^{\frac{1}{2}} = (\frac{1}{2})^{\frac{1}{2}}$$
$$= \sqrt{\frac{1}{2}}$$
$$= \frac{\sqrt{1}}{\sqrt{2}}$$
$$= \frac{1}{\sqrt{2}}$$

performing the four arithmetic operations with both surds and fractional exponents including using the difference of two squares in creative ways to aid calculation

$$\left(3+\sqrt{7}\right)\left(3-\sqrt{7}\right) = 9-\left(\sqrt{7}\right)^2$$
$$= 2$$

recognising the effect of multiplying by 1 when its form is purposefully chosen

$$\frac{1}{\sqrt{2}} = \frac{1}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}}$$
$$= \frac{\sqrt{2}}{2},$$

$$\frac{\left(3+\sqrt{7}\right)}{\left(3-\sqrt{7}\right)} = \frac{\left(3+\sqrt{7}\right)}{\left(3-\sqrt{7}\right)} \times \frac{\left(3+\sqrt{7}\right)}{\left(3+\sqrt{7}\right)}$$

Fluency with working with these forms in numerical and algebraic contexts is a useful attribute for students on this pathway.

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| | | $= \frac{16+6\sqrt{7}}{2}$<br>$= 8+3\sqrt{7}$ | | |
| **Algebra** | numerical/tabular, graphical and algebraic representations of quadratic functions and their transformations in order to reason about the solutions of $f(x) = k$ | connecting the expanded and transformed representations | expand and factorise expressions and apply exponent laws involving products, quotients and powers of variables. Apply to solve equations algebraically (AC9M10A02)<br><br>apply computational thinking to model and solve algebraic problems graphically or numerically (AC9M10A07) | The first sub-topic of Topic 1 in Unit 1 of Mathematical methods is “Review of quadratic relationships”. Hence there is an expectation that students doing Mathematical methods will have had some experience with quadratics beyond what is in the F-10 curriculum |
| | | deriving and using the quadratic formula and discriminant to identify the roots of a quadratic function | | |
| | | identifying what can be known about the graph of a quadratic function by considering the coefficients and the discriminant to assist sketching by hand | | |
| | | solving equations and interpreting solutions graphically | | |
| | | recognising that irrational roots of quadratic equations of a single real variable occur in conjugate pairs | | |
| | the graphs of $y = \sin(x)$ and $y = \cos(x)$ as functions of a real variable and solve related equations | exploring the use of the unit circle and animations to show the periodic, symmetric and complementary nature of the sine and cosine functions | apply trigonometry of right angles triangles and Pythagoras’ theorem to model and solve practical problems in two and three-dimensions including those involving direction | A major shift in students’ study of trigonometry when they enter senior secondary school is defining and using trigonometric functions. Initial experience with |

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| | | establishing relationships between Pythagoras theorem, unit circle, trigonometric ratios, half square triangles and half equilateral triangles<br>solving equations of the form $\sin(x) = \frac{1}{\sqrt{2}}$ and $\cos(x) = -0.73$ over a specified interval graphically<br>graphing over different domains including negative values | and angles of elevation and depression (AC9M10M05)<br>apply computational thinking to model and solve algebraic problems graphically or numerically (AC9M10A07) | the graphs of the sine and cosine functions will provide some grounding for that.<br>There is a conceptual issue here, circular functions (including the trigonometric functions) provide the basis for modelling periodic behaviour. Trigonometric ratios are not the same thing. Unfortunately, given that trigonometry is introduced first (a common approach) this leads to complications. |
| | the inverse relationship between logarithmic and exponential functions | using the definition of a logarithm and the exponent laws to establish the logarithm laws and solve equations such as $5000 \times (1.01)^x = 9000$<br>solving exponential equations algebraically, using base 10 logarithms<br>connecting algebraic solutions obtained through the use of base 10 logarithms with graphical solutions | recognise the connection between algebraic and graphical representations of exponential relations and solve simple related exponential equations using digital tools as appropriate (AC9M10A05)<br>interpret and use logarithmic scales to model phenomena involving small and large quantities and change (AC9M10M02)<br>apply computational thinking to model and solve algebraic problems graphically or numerically (AC9M10A07) | Algebraic approaches that use logarithms to solve exponential equations in senior secondary subjects build on and complement the graphical approaches used in Year 10. Exploring content along these lines will provide some grounding for this shift. |

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| **Measurement** | the effect of increasingly small changes in the value of variables on the average rate of change and limiting values | using the gradient between two points as a measure of rate of change to obtain numerical approximations to instantaneous speed and interpreting 'tell me a story' piecewise linear position-time graphs | model situations involving scale, ratios and rates relating to objects in two and three-dimensions and solve related practical problems (AC9M10M03) | This extension of consideration of the gradient function exposes students to fundamental aspects of the calculus they will encounter in Methods and Specialist subjects. |
| **Space** | relationships between measures of different angles and various lines associated with circles (radiuses, diameters, chords, tangents) | exploring (including using dynamic geometric software) a range of situations that look at such concepts as angles between tangents and chords, angles subtended at the centre and circumference by a chord<br>exploring how deductive reasoning and proof is used in interpreting formal definitions and presenting logical arguments | apply logical reasoning (including the use of congruence and similarity) to proofs involving shapes in the plane and apply theorems to solve spatial problems (AC9M10SP02) | Introduces students to some of the relationships that they will encounter as the circle theorems in Unit 1 of Specialist mathematics. |
| **Statistics** | measures of spread and their effectiveness and interpretation with respect to different data distributions | comparing the use of quantiles/percentiles and cumulative frequency to analyse the distribution of data | compare data distributions for continuous numerical variables using appropriate data displays (including boxplots). Discuss the shapes of these distributions in terms of centre, spread, shape and outliers in the context of the data (AC9M10ST02) | Conceptually explores an important aspect of the analysis of key features of data distributions |

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| | | comparing mean or median absolute deviations with standard deviations as a robust measure of spread for different data distributions, and explore the effect of outliers | evaluate statistical reports in the media in terms of questions posed, data gathering and representation of distributions. Analyse claims and inferences, including ethical considerations and identification of potential sources of bias (AC9M10ST01) | |
| **Probability** | counting principles and factorial notation as a representation for efficient counting in multiplicative contexts including calculations of probabilities | applying the multiplication principle to problems involving combinations including probabilities related to sampling with and without replacement | use probability, random variables and simulations to model phenomena, including sampling with and without replacement, and evaluate results (AC9M10P02) | Factorial notation is a useful tool in Probability in senior secondary and beyond.<br>Fluency with working with these forms in numerical and algebraic contexts is a useful attribute for students on this pathway<br><br>The basic relation of interest is what happens to arrangements when there are sub-sets of identical elements.<br><br>That is if *n* elements are arranged in a row with a group of *p* identical elements, another group of *q* identical element (different from the first group) and similarly for another group of r identical elements. |
| | | understanding that a set with $n$ elements has $2^n$ subsets and that these can be systematically listed using a tree diagram or a table | | |
| | | using the definition of $n!$ to represent and calculate in contexts that involve choices from a set (e.g. How many different combinations of 3 playing cards from a pack? How many if we ignore the suits?), with and without replacement. | | |
| | | using $n! + 1$ to prove that there are infinitely many prime numbers | | |

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| | | performing calculations on numbers expressed in factorial form, such as $\frac{n!}{r!}$ to evaluate the number of possible arrangements of $n$ objects in a row, $r$ of which are identical | | Then the numbers of possible arrangements in a row is $\frac{n!}{p!q!r!}$<br><br>Once this is understood, then both the permutations $^nPr$ and the combinations $^nCr$ formulas are special cases. |