Australian CURRICULUM Review

MATHEMATICS

CONSULTATION CURRICULUM

All elements F–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.

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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.

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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.

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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

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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.

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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.

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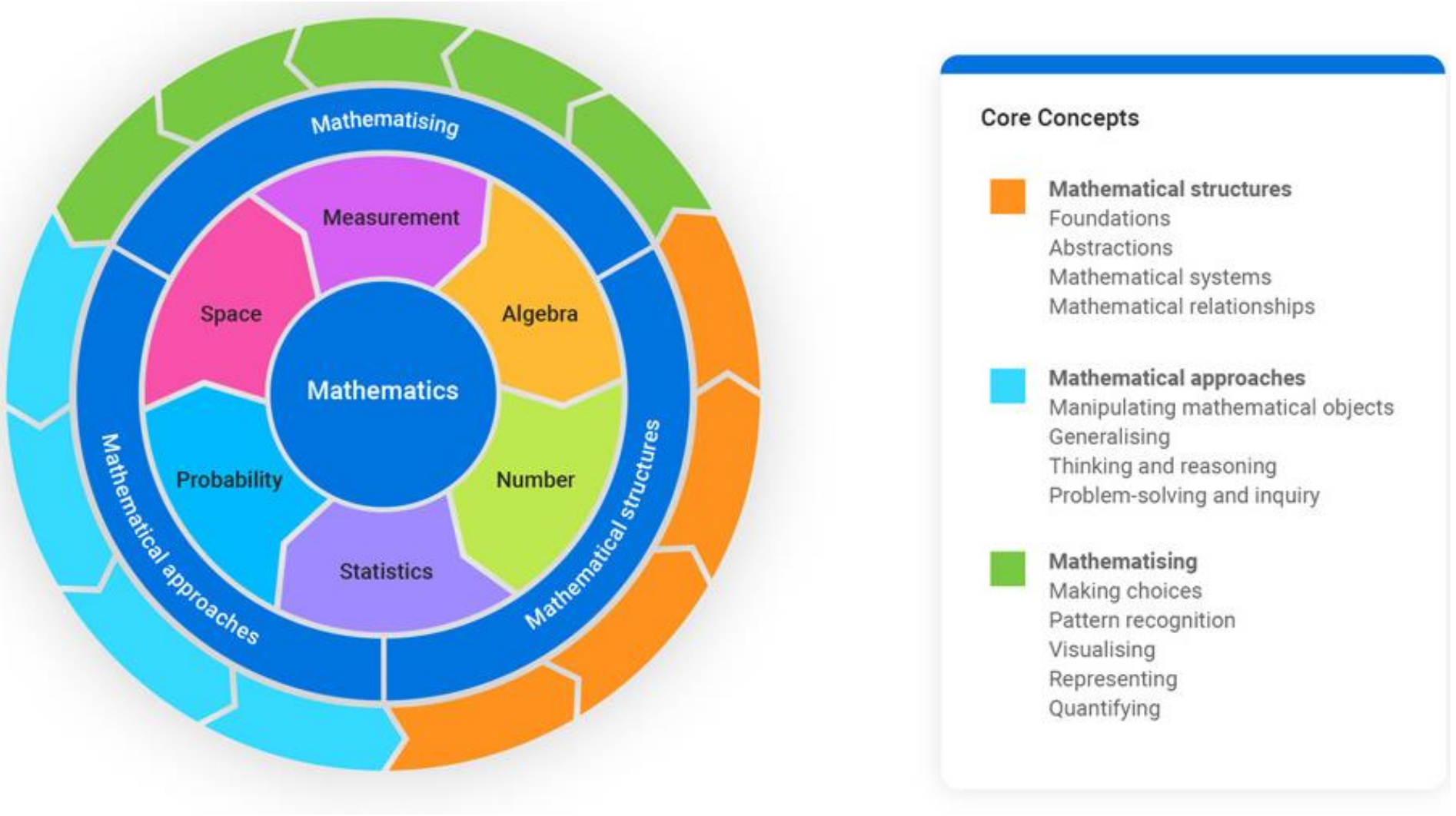

Figure 1: Relationship between the six strands and three core concept organisers

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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:

- *Foundation*s – 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:

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- *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.

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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

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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.

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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

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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

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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.

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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

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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.

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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.

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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.

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CURRICULUM ELEMENTS

Foundation

Level description

The Australian Curriculum: Mathematics focuses on the development of 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 Foundation year, they:

- explore situations, sparking curiosity to investigate and solve everyday problems using physical and virtual materials to model, sort, quantify and compare
- look for and make connections between number names, numerals and quantities and through active learning experiences, compare quantities and shapes, using elementary mathematical reasoning
- begin to bring some mathematical meaning to their use of familiar terms and language when they pose and respond to questions and explain their thinking and reasoning
- build confidence and autonomy in being able to make and justify mathematical decisions based on quantification and direct comparisons
- learn to recognise repetition and apply this to creatively build repeating patterns in a wide range of contexts
- begin to build a sense of chance and variability when they engage in play-based activities, imagine and think about familiar chance events.

Achievement standard

By the end of Foundation year, students can use subitising and counting strategies to demonstrate that numbers represent a quantity and have an order. They compare and match the size of collections to at least 20 for a purpose. Students make and describe connections between number names, numerals and position in the sequence of numbers. They identify numbers represented in different ways and demonstrate that numbers can be partitioned using two or more partitions or can be combined to make numbers up to10. Students model practical situations that involve equal sharing, adding to, and taking away from a collection to 10. They describe, continue and create repeating patterns using a variety of mediums.

Students distinguish between the attributes of mass, capacity and length when comparing objects, using appropriate direct comparison strategies. They directly compare the duration of events by starting events at the same time.Students identify, describe and sort familiar shapes and objects and explain their reasoning using everyday language. Theydescribe position and respond to instructions to move themself or objects to other locations within a familiar space and use

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everyday language to describe their movements in relation to other objects.

Students collect, sort, compare and quantify objects and images in response to given questions in familiar contexts. They discuss the outcomes of familiar activities and chance events.

Strand	Content description *Students learn to:*	Elaboration *This may involve students:*
Number	connect numbers (including zero) to their representative quantities, numerals, number names and position in the sequence, initially up to 10 and then beyond (AC9MFN01)	responding to a request to collect a quantity of objects or reading a numeral and selecting the associated quantity of items from a collection to match the number represented (AC9MFN01_E1)
		writing a number symbol on a container as a label to show how many objects it contains, for example, 9 paint brushes (AC9MFN01_E2)
		playing card games that involve reading and/or ordering number cards and identifying pairs (AC9MFN01_E3)
		understanding and using terms such as ‘first’ and ‘second’ to indicate ordinal position in a sequence (AC9MFN01_E4)
		reading and reciting stories and counting games/rhymes from Aboriginal and Torres Strait Islander cultures, connecting quantities to number names and numerals (AC9MFN01_E5)
		using body-tallying from Aboriginal counting systems, connecting quantities to number names and numerals (AC9MFN01_E6)
	instantly recognise and name the number of objects within collections of up to five items without counting (subitise). Quantify and compare collections of at least 10 objects by recognising and naming the partitions using part-part-whole	recognising how many objects in a collection or images on a card with a quick look, and without counting, saying the associated number (AC9MFN02_E1)
		recognising numbers represented in tens frames, including in manipulatives, images and digital apps, and describing their reasoning, ‘*I saw five counters across the top row and two counters underneath to make seven’* (AC9MFN02_E2)
		using subitising as the basis for ordering and comparing collections and saying who has more when sharing items in a game (AC9MFN02_E3)

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	relationships (AC9MFN02)	partitioning collections of up to ten objects into pairs in different ways and saying the part-part-whole relationship, for example, partitioning a collection of six counters into groups of four and two and saying '*four and two makes six*' then partitioning the same collection into five and one or three and three (AC9MFN02_E4)
		playing games like memory, matching pairs of quantities on ten frames, dominoes, dot cards or similar where the arrangement on each is different (AC9MFN02_E5)
		exploring groupings in an Aboriginal or Torres Strait Islander number system and the different ways of representing these groupings to compose and partition numbers, applying this to subitise collections of objects up to 10 or when using a five-frame (AC9MFN02_E6)
		naming and numbering objects in the environment on-Country/Place using subitising, connecting this to ways of quantifying and comparing collections in an Aboriginal or Torres Strait Islander number system (AC9MFN02_E7)
	establish understanding of the language and processes of counting to quantify, compare, order and make correspondences between collections, initially to 20, and explain reasoning (AC9MFN03)	using counting to compare two collections of like items to say which set is larger or smaller (AC9MFN03_E1)
		using counting songs and rhymes to establish the forwards counting sequence of numbers up to 10, then to 20 (AC9MFN03_E2)
		recognising, hearing and seeing the natural numbers 4 to 9 within the teen numbers from 14 to 19 (AC9MFN03_E3)
		saying the natural numbers in sequence while performing actions, for example, steps, jumps, claps or drumbeats (AC9MFN03_E4)
		understanding that each object must be counted only once, that the arrangement of objects does not affect how many there are, and that the last number counted answers the '*how many'* question (AC9MFN03_E5)
		using counting and one-to-one correspondence to quantify the number of items required for a purpose, for example, when asked to fetch enough scissors for each member of their group they count each member and then using the total count they fetch that number of scissors (AC9MFN03_E6)
		using counting to determine which collection of $1 coins contains the most money; laying out the two sets of coins side by side and matching them using one-to-one correspondence, to justify their conclusion (AC9MFN03_E7)

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	using body-tallying Aboriginal and Torres Strait Islander counting systems that involve body parts and one-to-one correspondence to count up to 20 (AC9MFN03_E8)
	considering how the making of shell necklaces by Aboriginal and Torres Strait Islander Peoples includes practices such as comparing and making correspondences between collections (AC9MFN03_E9)
	determining and reasoning about the size of sets of objects within Aboriginal and Torres Strait Islander instructive games, for example, *Segur etug* from Mer Island in the Torres Strait region (AC9MFN03_E10)
model practical situations and solve problems involving addition and subtraction with physical and virtual materials, using counting or subitising strategies to determine the total or the number of objects remaining (AC9MFN04)	modelling change problems, using role play and materials to show the action in a story, for example, '*if eight kangaroos were drinking at the river and three hopped away, how many would be left?*'; drawing a picture to show what they did with the materials, recording the result of the action with a number and explaining the result (AC9MFN04_E1)
	using a Think Board after solving a problem with materials; connecting a drawing and a number with the action they used to find an answer (AC9MFN04_E2)
	explaining the counting or subitising strategy used to solve an addition or subtraction problem, for example, role playing using $1 coins to pay for items in a shop where items are priced in whole dollars (AC9MFN04_E3)
	exploring Aboriginal and Torres Strait Islander Peoples' stories, such as *Tiddalick, the greedy frog,* that describe additive situations and their connections to Country/Place (AC9MFN04_E4)
	using leaf games involving sets of objects that tell stories, such as games from the Warlpiri Peoples of Yuendumu in the Northern Territory, to investigate addition and subtraction situations (AC9MFN04_E5)
model practical situations and solve problems that involve equal sharing, through role play and games using physical and virtual materials (AC9MFN05)	using materials to role play equal sharing, for example, sharing pieces of fruit or a bunch of grapes between four people (AC9MFN05_E1)
	counting a number of items, for example, nine beads or six $1 coins, and then sharing them equally between three people by subitising or counting each group by ones to decide how many beads or coins each person will get (AC9MFN05_E2)
	playing card games where each player is dealt the same number of cards (AC9MFN05_E3)

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		using instructive games of Aboriginal and Torres Strait Islander Peoples that involve sharing, for example, playing *Yangamini* of the Tiwi Peoples of Bathurst Island to investigate and discuss equal sharing (and hence equal chances) (AC9MFN05_E4)
Algebra	describe, copy, continue and create repeating patterns using different elements including movement, sounds, colours, objects, shapes, and numbers (AC9MFA01)	interpreting a repeating pattern sequence and choosing the appropriate number of items to copy or continue a pattern created by someone else explaining how they know which comes next in the sequence (AC9MFA01_E1)
		exploring repeating patterns during art or craft activities, for example, making a bead necklace; describing the pattern they have created such as '*one red, three blue, two green; one red, three blue, two green;'* (AC9MFA01_E2)
		examining arrangements of shapes, labelling those that are patterns and those that are not patterns, and justifying their decisions using phrases to describe the patterns (AC9MFA01_E3)
		recognising, continuing and creating pattern sequences during music activities, such as a repeating pattern of drum beats or dance moves, saying the sequence as they move, for example, 'clap clap step, clap clap step' (AC9MFA01_E4)
		exploring weaving, shell necklaces or dances and songs of Aboriginal and Torres Strait Islander Peoples to identify, describe and create repeating patterns (AC9MFA04_E5)
		exploring instructive children's games of Aboriginal and Torres Strait Islander Peoples such as *'Walbiri'* from the Warlpiri Peoples of central Australia that involve repeating patterns of objects, observing and describing patterns (AC9MFA01_E6)
Measurement	explore and identify attributes of objects and events including length, capacity, mass and duration. Use direct comparisons and everyday language to compare pairs of objects and events, using these attributes and communicating reasoning (AC9MFM01)	directly comparing pairs of everyday objects from the kitchen pantry to say which is heavier/lighter, for example, hefting a tin of baked beans and a packet of marshmallows; comparing the same pair of objects to say which is longer/shorter and discussing comparisons (AC9MFM01_E1)
		using language to describe the measurement attributes of length, mass, capacity and duration and connecting the words with the appropriate attribute, for example, using tall, short, wide, long, high, to describe the attribute of length (AC9MFM01_E2)
		directly comparing pairs of objects to say which is longer/shorter, and explaining how they know, for example, choosing to line up the bases of a spoon and fork to decide which is longer (AC9MFM01_E3)

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		starting two events at the same time to decide which takes longer, for example, putting on a pair of sandals with buckles or Velcro, and describing the duration using everyday language, '*I took a longer time because I'm still learning to do up my buckles'* (AC9MFM01_E4)
		exploring the attributes of spinning tops used by Aboriginal and Torres Strait Islander Peoples including length, size and mass and how these influence their duration of spin, for example, spinning tops used by the Yidinjdji Peoples of the Cairns region of far north Queensland and referred to as *bunbuja* (AC9MFM01_E5)
		investigating situations where Aboriginal and Torres Strait Islander Peoples use direct comparisons for identifying animal tracks such as shorter-longer, lighter-heavier (tread) (AC9MFM01_E6)
	connect days of the week and times of day (morning, lunchtime, afternoon, evening) to familiar events and actions (AC9MFM02)	choosing events and actions that make connections with students' everyday family routines (AC9MFM02_E1)
		ordering images of daily events on a string line across the room, and justifying the placement by referring to morning, lunchtime, afternoon or night (AC9MFM02_E2)
		creating classroom rosters, for example, a roster for watering the classroom garden (AC9MFM02_E3)
		creating a pictorial diary to show the important events that happen on the various days of the week (AC9MFM02_E4)
Space	sort, name and make familiar shapes and objects. Recognise and describe familiar shapes and objects within the environment using everyday language (AC9MFSP01)	making a shape picture using a range of materials, including precut shapes and objects to trace around, toothpicks and string, describing the shapes and objects they used to trace around and sharing why they chose each shape in their picture (AC9MFSP01_E1)
		sorting a collection of shapes to create a shape and name chart by attaching cards with words such as sides, corners, curved, straight, closed and open to describe common features of each category in the sort (AC9MFSP01_E2)
		recognising and naming shapes that are (close to) rectangles, squares, triangles and circles in component parts of everyday things, for example, on bicycles, toy vehicles or kitchen pantry items (AC9MFSP01_E3)
		making objects of interest, for example making a rocket, selecting from an assortment of recycled objects, boxes and containers, and justifying their choice of component parts (AC9MFSP01_E4)

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		exploring, describing and naming shapes and objects that can be observed on Country/Place, recreating and sorting into sets based on their shape (AC9MFSP01_E5)
	describe position and movement of self and objects in relation to other objects and locations within a familiar space (AC9MFSP02)	following and giving directions to guide another student around an obstacle path (AC9MFSP02_E1)
		following simple algorithms (sets of instructions) that describe the movement of an object from one location to another, for example, roleplaying being a robot and following step-by-step instructions given by another classmate to move from one place to another only moving as instructed (AC9MFSP02_E2)
		exploring Aboriginal and Torres Strait Islander children's instructive games, for example, *Thapumpan* from the Wik-Mungkan Peoples of Cape Bedford in north Queensland, describing position and movement of self in relation to other participants, objects or locations (AC9MFSP02_E3)
Statistics	collect, record, sort and compare data represented by objects and images in response to investigative questions relating to familiar contexts (AC9MFST01)	collecting, and sorting data through everyday activities or events, for example, collecting data about favourite toys and sorting and labelling them into two categories, such as *'Toys you can make things with*' and '*Other toys'* then subdividing the '*Other toys'* category and creating two more labels (AC9MFST01_E1)
		collecting and deciding how to organise data to answer questions, for example, '*Do more people in our class today have shoes with laces or without*?'; explaining that lining up, matching shoes with and without laces one-to-one will answer the question (AC9MFST01_E2)
		creating classroom charts and rosters using stickers to represent data; comparing and interpreting representations (AC9MFST01_E3)
		investigating statistical contexts after reading a story then asking and responding to questions like '*What different things did you see?*' or '*What were the different types of …*' and '*How many were there*?' (AC9MFST01_E4)
		exploring how information from the environment is collected and used by Aboriginal and Torres Strait Islander Peoples to predict weather events (AC9MFST01_E5)

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Probability	discuss and explore the outcomes of games and familiar events involving chance (AC9MFP01)	exploring familiar games that involve chance and discussing the outcomes, for example, playing games that involve making decisions about where to stand '*corners*' or what to do '*captains coming',* then discussing their choices and sharing what happened during the game (AC9MFP01_E1)
		creating a weather chart for the class and discussing what the possible weather events might be, for example, sunny, rainy, hot, cold, cloudy or windy (AC9MFP01_E2)
		playing guessing games that involve guessing what the outcome will be and discussing results, for example, holding up a number of fingers behind their back and asking a classmate to guess how many they are holding up, then discussing what happened and what could have been the outcome (AC9MFP01_E3)
		exploring Aboriginal and Torres Strait Islander children's instructive games that involve chance, for example, *Kolap* from Mer Island in the Torres Strait region, that involve chance to investigate and reason about outcomes (AC9MFP01_E4)

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Year 1

Level description

The Australian Curriculum: Mathematics focuses on the development of 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 1 they:

- use their curiosity and imagination to explore situations, recognise patterns in their environment and choose ways of representing their thinking to communicate to others
- understand demonstrate that numbers can be represented, partitioned and composed in various ways. They recognise patterns in numbers and extend their knowledge of natural numbers beyond two digits
- use physical or virtual materials and diagrams to model authentic problems through active learning experiences, recognise existing patterns, explore and employ different strategies and discuss the reasonableness of answers
- explain ways of making direct and indirect comparisons and begin to use uniform informal units to measure some attributes
- begin to reason spatially and use spatial features to classify shapes and objects. They recognise these shapes and objects in their environment and use simple transformations, directions and pathways to move the positions of shapes and objects within a space
- use simple surveys to collect and sort data, recognise that data can be represented differently, and justify and explain patterns that have been created
- discuss outcomes of chance events and make decisions about the likelihood of these using everyday language.

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Achievement standard

By the end of Year 1, students connect number names, numerals and quantities. They describe how numbers can be partitioned in different ways and use multiple representations of these numbers. Students demonstrate that numbers are composed in groups of tens and ones and into other number groupings. Students identify the 0–9 repeating sequence in and between the decades and can skip count from different starting points. They partition collections into groups and use skip counting and other quantifying strategies to quantify the number of objects in collections to at least 100. They use materials, including money, and a variety of strategies to model situations and solve everyday problems involving addition, subtraction, equal sharing and grouping. Students identify, describe and create repeating patterns using shapes, objects and number patterns formed by skip counting from different starting points.

They compare and order objects based on their attributes of length, mass and capacity, and events based on their duration. Students make direct and indirect comparison of lengths, masses, capacities and durations and explain their strategies. They measure the length of shapes and objects using uniform informal units. Students sort and classify shapes and objects using obvious features. They use directions to move objects within a familiar space.

Students collect and record data, create one-to-one displays and compare and discuss the data using total frequencies. They can list and describe the outcomes of familiar chance events using everyday language.

Strand	Content description *Students learn to:*	Elaboration *This may involve students:*
Number	recognise, read, write and order natural numbers to at least 100 and represent them using physical and virtual materials (including Australian coins and notes), number lines and charts (AC9M1N01)	reading, writing and ordering two-digit numbers, using patterns within the number system, including zeros and numbers that look and sound similar, for example, 16, 60, 61, 66 (AC9M1N01_E1)
		positioning a set of numbered cards in the correct order and relative location by pegging on an empty number line (AC9M1N01_E2)
		collaboratively building a hundreds chart on the floor using cards numbered from 0 to 100 (AC9M1N01_E3)
		using the constant function on a calculator to add ten to single digit numbers, recording the numbers to make, show and explore the patterns in a 0 – 100 chart (AC9M1N01_E4)
		recognising, sorting and ordering a collection of Australian coins and notes according to their value (AC9M1N01_E5)
	recognise that two-digit numbers are composed of	using physical or virtual materials and drawings partition numbers into tens and ones, for example, recognise 35 as 30 and 5 and represent it as 3 groups of ten and 5 ones (AC9M1N02_E1)

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	groups of tens and ones and can be partitioned into other number groupings (AC9M1N02)	exploring how many ways a number of objects can be placed into two groups, for example, 23 sheep placed into two paddocks; systematically recording partitions using diagrams or numbers to ensure they have found all possibilities and justifying their result (AC9M1N02_E2)
		using part-part-whole reasoning to group numbers into different number groupings (AC9M1N02_E3)
		playing money-trading games, exchanging ten $1coins for one $10 note and keeping track of the value of their money by counting tens and ones (AC9M1N02_E4)
		using part-part-whole reasoning to partition the 365 days of the year into the seasons of an Aboriginal and Torres Strait Islander seasonal calendar, saying how many days are in each of the seasons (AC9M1N02_E5)
	quantify larger sets of objects, to at least 100, by partitioning collections into groups to facilitate more efficient counting. Continue the count, using knowledge place value and skip-counting, recognising that the last number said in the count represents the total quantity of objects, (AC9M1N03)	estimating how many objects are in a large collection, such as how many counters are in a jar, and discussing counting strategies to decide which skip count to use to give an efficient count (AC9M1N03_E1)
		partitioning a large collection such as a handful of pencils into groups of fives or tens and skip counting to work out how many there are; recording the amount and connecting the digits in the number to the grouped materials (AC9M1N03_E2)
		counting collections of objects such as pencils or images of birds in a tree, by grouping them in tens to enable efficient counting and connecting the digits in the number to the groups of tens and ones (AC9M1N03_E3)
		counting a large collection of Australian $1 coins by stacking them into piles of ten and skip counting in tens to determine the total value (AC9M1N03_E4)
	model situations (including money transactions) and solve problems involving one-digit and two-digit addition and subtraction using physical or virtual materials, diagrams and a range of strategies	using counting-on or counting-back by tens and ones using bundled materials and a 0 – 100 chart to solve addition or subtraction problems, for example, to solve 23 + 36 = ?, skip counting by tens 36, 46, 56 and then ones 57, 58, 59 (AC9M1N04_E1)
		modelling addition and subtraction story problems on a Think Board, to show and explain the connections between the materials, the diagram and the numbers within the story problem (AC9M1N04_E2)
		partitioning numbers to mentally solve addition or subtraction problems involving money, for example, *'I had $14 and was given $15 for my birthday';* $10 plus $10 is $20, $4 plus $5 is the same as $4 plus $4 plus $1 which equals $9,

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	(AC9M1N04)	and $20 plus $9 is $29 (AC9M1N04_E3)
		using play-money to role play addition and subtraction problems, for example, setting up a shop and role-playing buying and selling goods with play money representing whole dollar amounts (AC9M1N04_E4)
		modelling a variety of different additive situations using effective strategies, for example, keeping track of the number of people on a bus as it stops to pick up and drop off passenger or role-playing financial transactions at a play store (AC9M1N04_E5)
		creating and performing addition and subtraction stories through Aboriginal and Torres Strait Islander dances to explore the relationship between addition and subtraction (AC9M1N04_E6)
	model situations and solve problems that involve equal sharing and grouping using physical or virtual materials (including money) and diagrams, counting or subitising to find the number in each share or the combined total of the groups (AC9M1N05)	creating equal groups to solve problems, for example, grouping a collection of pencils into threes or fours to decide how many triangles or squares they can make (AC9M1N05_E1)
		modelling repeated equal group situations, such as, '*how many wheels are needed for three cars?*', using materials and drawing a picture to show what they did, recording the results with a number and explaining whether the answer refers to cars or wheels (AC9M1N05_E2)
		modelling equal sharing situations, for example, sharing a set of dominoes between the two players in a game, and then counting or subitising to ensure they both have the same number (AC9M1N05_E3)
		sharing out a set of $10 notes between three people and skip counting by tens to ensure they have equal amounts (AC9M1N05_E4)
		sorting a collection of coins according to their value and sharing the coins equally between four people, using counting or subitising to ensure they have equal amounts of each denomination (AC9M1N05_E5)
		exploring Aboriginal and Torres Strait Islander Peoples' instructive games, for example, *Yangamini* from the Tiwi Peoples of Bathurst Island to investigate and discuss how and why equal sharing and grouping is used (AC9M1N05_E6)
Algebra	recognise, describe, continue and create growing number patterns formed by skip-counting, initially by twos,	using songs and rhymes to establish skip-counting sequences, initially twos, fives and tens and exploring other sequences later (AC9M1A01_E1)
		recognising the patterns in skip-counting sequences, for example, that skip counting in fives starting from zero always

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	fives and tens starting from zero (AC9M1A01)	results in either a five or zero as the final digit (AC9M1A01_E2)
		with the use of a calculator, exploring skip-counting sequences that start from different numbers, discussing patterns (AC9M1A01_E3)
		modeling skip counting sequences using the constant function on a calculator, while saying, reading and recording the numbers as they go (AC9M1A01_E4)
		counting by twos, fives, or tens to say how much money is in a collection of $2 coins, $5 notes, 5 cent coins, $10 notes or 10 cent coins (AC9M1A01_E5)
		exploring repeating patterns that can be observed on-Country/Place, such as animal tracks, identifying if the patterns fit or do not fit a skip-counting model that is additively growing by a fixed amount (AC9M1A01_E6)
	recognise, describe, continue and create repeating pattern sequences with numbers and objects, identifying the unit of repeat, including recognising the 0-9 repeating sequence within and between the decades (AC9M1A02)	interpreting a repeating pattern sequence created by someone else; noticing the repeating part of the pattern and describing what part of the pattern is being repeated (AC9M1A02_E1)
		recognising the elements that are repeating and continuing the pattern describing the unit of repeat (AC9M1A02_E2)
		identifying missing elements in a repeating pattern from any position within the pattern unit (AC9M1A02_E3)
		recognising within the sequencing of natural numbers that 0 – 9 digits are repeated both in and between the decades and using this pattern to continue the sequence and recognise larger numbers (AC9M1A02_E4)
		describing a repeating pattern by generalising its elements within the pattern unit; representing the same pattern in different contexts, for example, RGGBRGGBRGGB… or 122312231223… (AC9M1A02_E5)
		exploring the structure of an Aboriginal and Torres Strait Islander number system and identifying the repeating patterns in the system, exploring different ways of representing number including oral and gestural language (AC9M1A02_E6)
Measure-ment	measure and compare objects and events using familiar attributes including length, mass, capacity and duration	indirectly comparing the length of several objects using a piece of string to decide which will fit within a space; using comparative language to describe the order, shortest, short, longer, longest (AC9M1M01_E1)
		ordering the weight of three or more objects such as rocks, using hefting and balance scales; using comparative language to explain the order, lightest, light, heavier, heaviest, and how they decided on the order (AC9M1M01_E2)

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	and order objects and events using direct and indirect comparisons, communicating reasoning for strategies (AC9M1M01)	pouring sand/rice/water from one container to another to compare and order the capacity of three or more containers; describing the order; in terms of which holds the most/least, and those in between (AC9M1M01_E3)
		creating sand timers from recycled material and comparing them to order the duration of time required for the sand to run through (AC9M1M01_E4)
		investigating situations where Aboriginal and Torres Strait Islander Peoples estimate, compare and communicate measurements, for example, seasons or material culture (AC9M1M01_E5)
	recognise that units need to be uniform and used end to end for consistency when measuring. Explore informal ways to measure, compare and communicate the length of objects using informal units (AC9M1M02)	using two different units, for example, pop sticks and pencils, to measure the length of an object such as a desk, and explaining why the number of units used may be different (AC9M1M02_E1)
		comparing the length of two objects such as a desk and a bookshelf by laying multiple copies of a unit and counting to say which is longer and how much longer; explaining why they shouldn't have gaps or overlaps between the units as this will change the size of the unit (AC9M1M02_E2)
		measuring the distance between two locations using footsteps, comparing the results and explaining why there may be different results, referring to the size of the units (footsteps) (AC9M1M02_E3)
		investigating measurable attributes that are interpreted by Aboriginal and Torres Strait Islander Peoples to understand animal behaviour such as turn, size and length of animal tracks (AC9M1M02_E4)
	compare sequences and cycles of events and describe their duration using familiar units of time including years, months, weeks, days and hours (AC9M1M03)	naming and listing familiar units to time, such as hours, days, weeks, years, ordering them from the shortest to the longest duration of time (AC9M1M03_E1)
		investigating the months of the year, comparing how the number of days vary and explaining how the months are cyclic across the year (AC9M1M03_E2)
		sequencing familiar events including the representation of time with pictorial timelines (AC9M1M03_E3)
		discussing types of events and activities and deciding whether it would take closer to an hour, a day, a week, a month or a year for its duration, for example, it takes a day for the sun to rise and fall and rise again, it takes less than an hour for me to walk to school (AC9M1M03_E4)
		investigating durations of time represented in the cycles of an Aboriginal and Torres Strait Islander Peoples' seasonal calendar (AC9M1M03_E5)

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Space	recognise, compare and classify familiar shapes and objects in the environment, using obvious features. Identify the similarities and differences between them (AC9M1SP01)	classifying a collection of shapes, including different sized circles, ovals, regular and irregular triangles and quadrilaterals into like piles, saying what is the same about the shapes in a pile and what is different between piles (AC9M1SP01_E1)
		making four-sided shapes by cutting and threading straws with string then deciding which are squares, which are rectangles or which are neither, giving reasons for their decisions (AC9M1SP01_E2)
		selecting a shape from a small collection of shapes inside a bag or box and describing the shape by feel, in order that others can name the shape and give reasons for their choice (AC9M1SP01_E3)
		recognising and describing the different shapes and sizes of Australian coins and ordering them according to their value (AC9M1SP01_E4)
		exploring string games used in story telling by Aboriginal and Torres Strait Islander Peoples, for example, *karda* from the Yandruwandha Peoples of north-east South Australia, recognising, comparing, describing and classifying the shapes made by the string and their relationship to shapes and objects on Country/Place (AC9M1SP01_E5)
	give and follow directions to move people and objects to different locations (AC9M1SP02)	interpreting and following directions around familiar locations and understanding the meaning and importance of the words when giving and following directions, for example, 'clockwise', 'anticlockwise', 'forward' and 'under' (AC9M1SP02_E1)
		creating and following an algorithm consisting of a set of instructions to move an object to a different location (AC9M1SP02_E2)
		describing a familiar journey across Country/Place using directional language (AC9M1SP02_E3)
Statistics	explore various types of investigative questions used to collect data. Discuss the type of data they produce and the sorts of decisions that could be made) (AC9M1ST01)	investigating the difference between a question that is statistical, for example, '*Are most flowers red*?' and a question that isn't, for example, '*Are there flowers that are red?*' (AC9M1ST01_E1)
		investigating different types of questions by selecting them based on the data that the response will generate, such as, 'yes/no' questions, for example, '*Do you like bananas*?', multiple choice, for example '*Which of these fruits do you like best*?' or open-ended questions, for example, '*What is your favourite fruit?'*, comparing the types of responses the questions generate and discussing and selecting ways of recording the responses (AC9M1ST01_E2)
		exploring the use of data to make predictions, using the results of questions, for example, asking '*Which month has the most birthdays of students in the class*?' and speculating if these results would be the same if they asked the class

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		next door or the whole school (AC9M1ST01_E3)
		modelling a situation to answer a question, for example, asking '*How can we clean up our art room?*', and choosing to collect and sort art supplies into categories such as throw away, recycle and reuse; modelling the process with images of objects (AC9M1ST01_E4)
	acquire data and record in various ways (objects, images, drawings, lists, tally marks and symbols) using digital tools where appropriate (AC9M1ST02)	discussing methods of collecting data to answer a question, such as 'What types of rubbish are found in the playground?', sharing ideas and trying out one or two of the suggested methods (AC9M1ST02_E1)
		reviewing the data collected and explaining how they might change the way they collect data next time (AC9M1ST02_E2)
		collecting and recording information on a topic of interest using lists, for example, '*how many people barrack for a football team' or 'what colour eyes each person has'*. Considering the data, to generate some questions that it could answer, then rearranging the data or collecting different data to answer the question (AC9M1ST02_E3)
		creating a tally to record data while observing events such as the year level of students using the bike shed; deciding on the possible categories before the observations are taken, then reviewing the data afterwards to notice whether the tally was effective (AC9M1ST02_E4)
		using star charts with stickers or emojis to represent class data, for example, using emojis on a personal feeling chart to represent how they are feeling each day or using emojis to represent activities on the class calendar (AC9M1ST02_E5)
		representing data with objects and drawings where one object or drawing represents one data value; describing the displays and explaining patterns that have been created using counting strategies to determine the frequency of responses (AC9M1ST02_E6)
		exploring ways of representing, sharing and communicating data through story and symbols used by First Nations Peoples (AC9M1ST02_E7)
	represent collected categorical data using one-to-one displays (including	creating a pictograph with objects or drawings using a base line to ensure one-to-one matching of values; discussing the possible categories for the pictograph and arranging the objects or drawings into the categories then reflecting on the chosen categories and deciding whether they were helpful (AC9M1ST0_E1)

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	pictographs and tally charts) using digital tools where appropriate. Quantify and compare the data using total frequencies and discuss the findings (AC9M1ST03)	translating data from a list or pictorial display into a tally chart to make counting easier; describing what the data in the tally chart is showing, by referring to the categories; using skip counting by fives to compare the numbers within each category and explaining how the tally chart answers the question (AC9M1ST03_E2)
		making generalisations about data sets, for example, using classroom data to compare different ways of travelling to and from school, discussing results and finding patterns in modes of travel (AC9M1ST03_E3)
		deciding on a good time of the year to visit the zoo and explaining the choice in terms of the likelihood of good weather (AC9M1ST03_E4)
		exploring ways Aboriginal and Torres Strait Islander Peoples represent, share and communicate data through story and symbols (AC9M1ST03_E5)
Probability	identify outcomes of familiar events involving chance and describe them using everyday language such as 'will happen', 'won't happen' or 'might happen' (AC9M1P01)	sorting cards showing different events such as playing in a park, eating an ice cream, reading a book, going to school, riding a bike, watching television or playing in the rain, as to whether they could, will or won't happen tomorrow, justifying their decisions (AC9M1P01_E1)
		exploring uncertainty by sorting activity cards into two piles of '*I know for sure what will happen'*, (certain of the outcome) and *'I am not sure what will happen'* (uncertain of the outcome) (AC9M1P01_E2)
		creating a list of things they are certain will happen tomorrow and considering whether they should change their mind by responding to questions like '*Are you sure?'*, '*Can you be really certain?'* (AC9M1P01_E3)
		predicting outcomes of an activity, for example, predicting whether they will or won't throw a beanbag through a hoop; then after one attempt, either changing their prediction or considering how to change the game so that they will be more certain (make it easier) or less certain (make it more challenging) to get it in (AC9M1P01_E4)
		predicting what might, will or won't happen next, during different parts of a story, for example, when reading a story discuss what the main character could do, will do or won't do next (AC9M1P01_E5)
		exploring Aboriginal and Torres Strait Islander children's instructive games, for example, Kolap from Mer Island in the Torres Strait region, identifying and describing chance events and likelihood of outcomes (AC9M1P01_E6)

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Year 2

Level description

In the Australian Curriculum: Mathematics students develop a deep knowledge and conceptual understanding of mathematical structures and fluency with procedures. They 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 2 they:

- partition and combine numbers flexibly, recognising and describing the relationship between addition and subtraction and employing part-whole reasoning to solve additive problems
- formulate problems from authentic situations, using physical and virtual materials, diagrams and number sentences to represent the situation and use different strategies to solve problems
- compare and contrast related operations and use known addition and subtraction facts to derive strategies for unfamiliar calculations
- recognise types of patterns and translate them to different contexts
- partition collections, shapes and objects into equal parts and build a sense of fractions as a measure, connecting this to measures of turn and representations of time. Using uniform units to measure, compare and discuss the attributes of shapes, objects and the duration of events
- describe spatial relationships such as the relative position of objects represented within a two-dimensional space and the resulting image after a shape has been transformed
- choose questions based on their interests to collect, represent and interpret data and recognise features of different representations building the foundations for statistical inquiry
- use the language of chance to describe and compare the outcomes of familiar chance events and develop an understanding of the meaning of chance.

Achievement standard

By the end of Year 2, students apply knowledge of place value to group, partition, rearrange and rename two-digit and three-digit numbers in terms of their parts and regroup partitioned numbers to enable more efficient computation. They formulate situations, including financial contexts and solve practical problems involving addition and subtraction, using number sentences and efficient strategies. Students represent practical situations involving multiplication and division using equal groups, arrays, repeated addition and subtraction and solve practical problems using physical and virtual materials. They identify part-whole relationships and interpret common uses of halves and quarters of shapes, objects and collections applied in practical contexts. Students estimate the size of

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large collections applying their knowledge of place value. They describe and continue patterns formed by increasing or decreasing additively by a fixed amount and connect patterns represented in different contexts.

Students use consistent informal units repeatedly to compare different measurements of shapes and objects. They explain the effects of one-step transformations and compare shapes and objects describing features and properties using spatial terms. Students identify relative positions, locate things on two-dimensional representations and move within a space by giving and following directions and pathways.

They use a range of methods, including digital tools, to collect and record categorical data, representing and interpreting the data in response to investigative questions. Students describe and order the likelihood of outcomes for everyday events and explain their reasoning.

Strand	Content description *Students learn to:*	Elaboration *This may involve students:*
Number	recognise, read, write and order natural numbers to at least 1000 and represent them using physical or virtual materials, number lines and charts, recognising the place value of each digit (AC9M2N01)	collecting large quantities of materials for the purpose of recycling, for example, ring pulls, bottle tops and bread tags, and grouping them into ones, tens and hundreds, using the materials to show different representations of two-digit and three-digit numbers (AC9M2N01_E1)
		reading, writing and ordering two-digit, three-digit and four-digit numbers, using patterns in the number system, including numbers with zeros in different places, and numbers that look and sound similar such as 808, 880, 818, 881 (AC9M2N01_E2)
		locating numbers on different number lines, for example, a number line with 50 on one end and 200 on the other, and the intermediary lines not numbered, or with every decade numbered (AC9M2N01_E3)
		playing money trading games using $1 coins and $10 and $100 notes. Exchanging ten $1 coins for one $10 note and exchanging ten $10 notes for one $100 note and recording the total value of money as the game progresses (AC9M2N01_E4)
	group, partition, rearrange and rename numbers up to 1000 according to their place value and into other number groupings. Explain the role of a zero digit in place value notation (AC9M2N02)	comparing the digits within a written number with materials grouped into hundreds, tens and ones, and explaining the meaning of each of the digits in the materials (AC9M2N02_E1)
		renaming numbers in different ways using knowledge of place value, for example, renames 245 as 24 tens and 5 ones or 2 hundreds and 45 ones (AC9M2N02_E2)
		comparing numbers written with Roman numerals with numbers written using the base 10 place value system and explaining why the place value system is easier to use (AC9M2N02_E3)

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		counting a collection of mixed coins and notes, arranging them into different groups, for example, equal height stacks then changing the count to accommodate the different denominations (AC9M2N02_E4)
		exploring a base 5 number system used by Aboriginal and Torres Strait Islander Peoples and the many ways whole numbers in the base 10 system can be rearranged and partitioned to this base 5 system, finding similarities and differences with the base 10 number system (AC9M2N02_E5)
	estimate the quantity of objects in large sets using knowledge of the size of numbers to make and justify reasonable estimates (AC9M2N03)	estimating the number of people in a large gathering, for example, school assembly, using known numbers, such as how many students per class (AC9M2N03_E1)
		grouping the number of animals in part of an image, for example, grouping seagulls in an image by the beach into tens or ten groups of ten, to efficiently estimate how many are in the full image (AC9M2N03_E2)
		estimating how many informal units, for example, washers or marbles are required to compare the mass of two or three objects, grouping the materials into tens and ones to compare their estimate with the actual measure (AC9M2N03_E3)
	model situations (including money transactions) and solve problems involving addition and subtraction of two-digit numbers using part-whole reasoning, number sentences, physical or virtual materials, diagrams and efficient strategies. Explain the results in terms of the situation (AC9M2N04)	using physical or virtual materials, and diagrams to model additive situations, applying part-whole reasoning to find and discuss a solution and explaining how they solved the problem (AC9M2N04_E1)
		using mental strategies and informal written jottings to help keep track of the numbers when solving addition and subtraction problems involving two-digit numbers (AC9M2N04_E2)
		using strategies such as doubles, near doubles, combinations to ten, bridging tens and partitioning to mentally solve problems involving 'friendly' two-digit numbers, for example, 56 + 37 could be solved by thinking 50 + 30 = 80, 6 + 7 is the same as 6 + 6 + 1 = 13, 80 + 13 = 93 (AC9M2N04_E3)
		modelling addition and subtraction problems by writing a number sentence and explaining how each number in the sentence is connected to the situation (AC9M2N04_E4)
		interpreting an everyday situation, for example, shopping or a story and deciding whether to use addition or subtraction to solve the problem; justifying the choice of operation and an appropriate number sentence to input into a calculator to solve it, for example '*I used subtraction to solve this problem as I knew the total and one of the parts, so I needed to subtract to find the missing part'* (AC9M2N04_E5)
		using a physical or mental number line or hundreds chart to solve addition or subtraction problems, by moving along

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	or up and down in tens and ones, for example, '*I had some money in my wallet and spent $75 now I have $57 left. How much did I have to start with?'* (AC9M2N04_E6)
	using addition and a calendar to model and solve the problem '*How many days there are in left in this year?*' using the calendar to identify the number days left in this month and in each of the remaining months, and using addition to model and solve the problem (AC9M2N04_E7)
	using Aboriginal and Torres Strait Islander Peoples' stories and dance to understand the balance and connection between addition and subtraction representing relationships as number sentences (AC9M2N04_E8)
model situations (including money transactions) and solve problems involving multiplication and division, representing the situation as repeated addition, equal groups and arrays. Use a range of efficient strategies to find a solution. Explain the results in terms of the situation (AC9M2N05)	modelling a range of different types of multiplication and division problems, involving repeated equal quantities, sharing and grouping (AC9M2N05_E1)
	using materials or diagrams, and skip counting to solve repeated equal quantity problems or stories, for example, '*Granny baked 4 trays of biscuits with 12 on each tray, how many biscuits did she have*?; writing a repeated addition number sentence after they solved it and connecting each number in the sentence to the situation (AC9M2N05_E2)
	using a Think Board to solve partition division problems, for example, sharing a prize of $36 between 4 people, using materials, a diagram and skip counting to find the answer; explaining whether the answer (9) refers to people or dollars (AC9M2N05_E3)
	forming arrays to solve combination problems, for example, '*how many outfits can be made from four shirts and four shorts?'* (AC9M2N05_E4)
	covering rectangles and squares using an array of paper tiles and skip counting (where appropriate) to decide which has the largest area (AC9M2N05_E5)
	deciding how many people should be in each team for a game or sports event, or how to share out some food or money, including deciding what to do if there is a remainder (AC9M2N05_E6)
	investigating Aboriginal and Torres Strait Islander Peoples instructive games, for example, *Yangamini* from the Tiwi Island Peoples, that model equal grouping and sharing situations, representing these with a repeated addition number sentence (AC9M2N05_E7)

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	recognise and describe one-half as one of two equal parts of a whole. Connect halves, quarters and eighths through repeated halving and interpret common uses of halves, quarters and eighths of shapes and collections (AC9M2N06)	creating halves of a range of collections by sharing into two equal groups; comparing half of a set, for example, 12 washers, with half of a set of 8 bolts to say how they are the same and how they both represent one-half (AC9M2N06_E1)
		creating halves by equally dividing by measurement attributes, for example, a length of paper tape, a lump of play dough, a cup of water into two parts, then selecting one of the parts and naming it '*one-half*' and explaining that '*a half is one part out of two equal parts of a whole*'(AC9M2N06_E2)
		comparing half of a collection of objects to half of a measurement attribute and explaining that they are each representing one-half of a different whole, for example, comparing half of a collection of 10 sausages, with half of a carton of milk and explaining how each shows one half of their respective wholes (AC9M2N06_E3)
		subdividing representations of one-half to make quarters and explaining how the word '*quarter*' is connected to the 4 subdivided parts (AC9M2N06_E4)
		using repeated halving to subdivide shapes and objects in different ways to make different shaped halves, quarters and eighths; naming the pieces and comparing the size of them to notice that they are all the same size (amount) even though they are different shapes (AC9M2N06_E5)
		splitting an object into equal pieces and relating the number of parts to the size of a fraction, for example, if there are 4 pieces then each piece is a quarter and if there are 8 pieces then each is one-eighth (AC9M2N08_E6)
Algebra	recognise, identify, describe, and continue additive patterns that increase or decrease by fixed amounts and identify missing elements in the pattern (AC9M2A01)	creating a pattern sequence with materials such as counters or Pattern Blocks and writing the sequences as numbers, for example, creating a fish pattern and recording the number of fins; 2, 4, 6, ... and using the pattern to work out how many fins would be on 4 fish, 8 fish (AC9M2A01_E1)
		creating a shape pattern using digital drawing software and using numbers to describe the pattern for someone else to replicate (AC9M2A01_E2)
		exploring patterns in the built environment to locate additive pattern sequences, for example, '*how many windows in one room, two rooms, three rooms…?*'or '*How many wheels on one car, two cars, three cars*…?'and recording the results in a diagram or table (AC9M2A01_E3)
		exploring additive pattern sequences and recognising and using the constant term being added or subtracted to identify missing elements in the sequence (AC9M2A01_E4)

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		exploring additive patterns in Aboriginal and Torres Strait Islander Peoples material culture such as in weaving technologies and describing their connections to mathematical expressions (AC9M2A01_E5)
	recognise and connect number patterns from one context to a pattern of the same form in another context (AC9M2A02)	creating repeating patterns, for example, using a bead string creating a pattern red, blue, green, black, orange, black, green, blue, red and explaining how the pattern is the same as a pattern in another context, such as in letters ABCDEDCBA or numbers 123454321 (AC9M2A02_E1)
		recording repeating patterns such as walking – left foot, right foot, left foot, right foot – and recognising the same pattern in a different context, such as a pendulum on a clock – tick, tock, tick, tock. Connecting and explaining the repeating nature of these patterns (AC9M2A02_E2)
		creating a repeating pattern using digital drawing software and using numbers to describe the sequence; creating a different repeating pattern with the same number sequence, justifying how the pattern is the same for each arrangement (AC9M2A02_E3)
		recognising additive and repeating pattern in the environment and representing it using drawings, coloured counters and numbers (AC9M2A02_E4)
		understanding that cycles are repeating patterns by exploring Aboriginal and Torres Strait Islander Peoples' seasonal calendars (AC9M2A02_E5)
Measurement	select attributes and appropriate uniform informal units to measure, compare and order objects and events based on length, capacity, mass and duration, using units without gaps or overlaps and smaller units for accuracy when necessary (AC9M2M01)	measuring and comparing the duration of events using informal units of time, such as pendulum swings, a metronome or a sundial (AC9M2M01_E1)
		using balance scales to compare the weight of several objects, such as rocks, and selecting an appropriate informal unit from a range of objects; counting the number of units to say which is heavier and how much heavier; explaining why the units chosen should be all the same weight (AC9M2M01_E2)
		comparing the capacity of several containers using units such as a spoon or cup of sand, to say which container will hold the most and how much more one container will hold as compared to another; recording the results and writing an explanation of their measurement process, including using smaller units to be more accurate justifying the result (AC9M2M01_E3)

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		choosing suitable units from a range of objects to measure the length of a range of objects; justifying their choice of a longer unit to measure things that are long, such as the width of a room, and a shorter unit to measure shorter things or when they need to be more accurate (AC9M2M01_E4)
		investigating capacity through Aboriginal and Torres Strait Peoples' water management techniques, such as traditional water carrying vessels and rock holes (AC9M2M01_E5)
		investigating Aboriginal and Torres Strait Islander Peoples' use of body parts, such as hands, as uniform informal units of measurement to manufacture nets for a particular purpose (AC9M2M01_E6)
	use a calendar to identify the date and determine the number of days in each month and the total number of days in a year (AC9M2M02)	using calendars to locate specific dates and identify what day it is, to determine the date two weeks prior to or after a given date (AC9M2M02_E1)
		creating a class calendar to enter specific dates relevant to the class, for example, students' birthdays, school assemblies, sports carnivals or class excursions (AC9M2M02_E2)
		using addition and a calendar to model and solve the problem '*How many days there are in left in this year?*' using the calendar to identify the number days left in this month and in each of the remaining months, and using addition to model and solve the problem (AC9M2M02_E3)
		identifying and locating specific days or dates on a calendar, for example, sports days, ANZAC Day, Easter, Diwali or Ramadan (AC9M2M02_E4)
	recognise and tell time to the hour, half hour and quarter-hour (AC9M2M03)	creating an analogue clock from a paper plate, showing the placement of the numbers and the two hands; explaining how long it takes for the two hands to move around the clock face and what time unit each is showing (AC9M2M03_E1)
		investigating the relationship between the movement of the hands on an analogue clock and the duration of time it represents (AC9M2M03_E2)
		dividing a clockface into halves and quarters and connecting the subdivisions with telling the time to the half and quarter hour; explaining the meaning of 'quarter past' and 'quarter to' referring to the hour (AC9M2M03_E3)
	identify and describe measures	exploring the immediate environment to identify things that turn, for example, the handle on a tap, a door or

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	of turn (quarter, half, three-quarters and full turns) in everyday situations (AC9M2M04)	computer screen on a hinge; identifying a half turn and a full turn, drawing a diagram and labelling it with arrows to show the direction and amount of turn (AC9M2M04_E1)
		giving and following directions to move during an activity, for example, moving a toy car along a model road, describing half, quarter and full turns in a choreographed dance (AC9M2M04_E2)
		creating or following an algorithm that will move an object along a pathway, for example, programming a robot, referring to half, quarter and three-quarter turns, left or right (AC9M2M04_E3)
		exploring how seasons are represented in an Aboriginal and Torres Strait Islander Peoples' seasonal calendar recognising how they relate to measurements of turn (AC9M2M04_E4)
Space	recognise, compare and classify regular and irregular shapes and objects describing features and properties using spatial terms (including parallel sides) (AC9M2SP01)	attaching name cards to different parts of an object to distinguish between objects and their faces, for example, knowing that a box (rectangular prism) is not a rectangle and a cube is not a square (AC9M2SP01_E1)
		sorting a collection of shapes that include both regular and irregular shapes into different groups based on their features such as number of sides, having all sides equal, having pairs of parallel sides (AC9M2SP01_E2)
		dismantling a number of boxes for example cereal box, tissue box, shoe box and laying them out flat along the edges to see and name the component shapes of the package (AC9M2SP01_E3)
		investigating the shapes of different sporting fields, describing and labelling their features including parallel goal posts and side lines, centre circles and goal squares (AC9M2SP01_E4)
		creating regular shapes using digital tools and observing what happens when you drag or push vertices to produce irregular shapes (AC9M2SP01_E5)
		exploring patterns, shapes and objects on-Country/Place and discussing their features and how they might have been formed (AC9M2SP01_E6)
	locate positions and identify relative positions of key features of a familiar space represented in two-dimensions. Move	interpreting drawings of familiar locations and identifying the relative positions of key features (AC9M2SP02_E1)
		understanding that we use representations of objects and their positions, such as on maps, to allow us to receive and give directions and to describe place (AC9M2SP02_E2)

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	positions following directions and pathways (AC9M2SP02)	using a classroom seating plan to locate a new seating position and giving directions to other classmates to find their seat (AC9M2SP02_E3)
		following and creating movement instructions that need to be carried out in order to move through a 4 × 4 grid mat on the classroom floor (or on a computer screen), for example, one forward, two to the right and one backwards and so on to reach a target square (AC9M2SP02_E4)
		exploring programming using, for example, a robotic toy to follow a path on a street scene on a floor mat adjusting their directions as they consider the order of their instructions, the direction and how far they want the toy to travel (AC9M2SP02_E5)
		interpreting drawings of familiar locations and identify the relative positions of key features (AC9M2SP02_E6)
	recognise and explain the effect of one-step transformations (including translation, reflection and rotation) on shapes using dynamic geometric software where appropriate (AC9M2SP03)	using a mirror to reflect shapes and images, describing the resulting image; using reflections to draw symmetrical pictures and images (AC9M2SP03_E1)
		using dynamic geometric software to explore transforming shapes recognising what changes and what stays the same (AC9M2SP03_E2)
		using the insert as shape feature of a word processing document to create a shape, observing and discussing what happens to this shape when it is moved around the page, flipped under a reflection and rotated (AC9M2SP03_E3)
		investigating how animal tracks can be interpreted by Aboriginal and Torres Strait Islander Peoples using transformation of their shapes to help determine and understand animal behaviour (AC9M2SP03_E4)
Statistics	identify a question of interest involving one categorical variable. Gather data relevant to the question and use the variation in data to reason and respond to these questions	posing a question of interest about favourite things, for example, types of fruit, football teams, days of the week, asking classmates for responses to the question and recording responses using a table; using counting strategies to determine the number of different responses and the most popular and least popular responses (AC9M2ST01_E1)
		investigating questions, such as '*How much rubbish is really rubbish*?' by gathering data about objects in categories, for example, throw away, recycle, and reuse; after gathering data against these categories and deciding whether the data answers the question (AC9M2ST01_E2)

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	(AC9M2ST01)	using classroom data to compare different ways of travelling to and from school, discussing results and finding patterns in modes of travel (AC9M2ST01_E3)
		exploring and creating graphs to represent classroom data, for example, collecting data on the country of birth of each student and presenting the results as a picture graph (AC9M2ST01_E4)
	acquire categorical data sets through surveys, observation or experiment using digital tools to assist where appropriate. Sort into relevant categories and display data for summary using lists and tables (AC9M2ST02)	determining the variety of birdlife in the playground, and using a prepared table to record observations (AC9M2ST02_E1)
		using a software survey tool to construct a survey to collect class data; sorting and interpreting responses and considering the questions asked and whether they need to be modified to reuse the survey (AC9M2ST02_E2)
		observing events prior to creating a table or list to gather data and using these observations to decide on what categories to use, for example, observing students arriving at school prior to creating a table to use to collect data investigating a question about '*the different ways students get to school*' (AC9M2ST02_E3)
		exploring the ways Aboriginal and Torres Strait Islander Peoples observe, collect, sort and record data (AC9M2ST02_E4)
	create different graphical representations of data sets using software to assist where appropriate. Compare the different representations, identify and describe common and distinctive features (AC9M2ST03)	using graphics tools to generate different graphs of the same data set, comparing and discussing the different representations, for example, using the graphics function of a spreadsheet to explore different representations (AC9M2ST03_E1)
		exploring and comparing the usefulness of different data displays, for example, using lists, tally charts and jointly creating column graphs and picture graphs to represent different types of items; describing the difference between them and saying which is easiest to interpret and why (AC9M2ST03_E2)
		using digital tools to create picture graphs to represent data using one-to-one correspondence, deciding on an appropriate title for the graph and considering whether the categories of data are appropriate for the context (AC9M2ST03_E3)
		comparing picture graphs with one-to-one column graphs of the same data, interpreting the data in each and saying how they are the same and how they are different, for example, collecting data on the country of birth of each student and creating different pictographs to represent classroom data (AC9M2ST03_E4)

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		comparing dot plots, sticker charts, picture graphs, bar charts and column graphs of the same data set and recognising the use of a common baseline to determine the most popular response and comparing these to other representations including pie charts (AC9M2ST03_E5)
Probability	identify practical activities and everyday events that involve chance. Describe outcomes in terms of their relative likelihood and recognise that while a chance event may occur, it may also not occur and there is no way of knowing which will be the case in advance (AC9M2P01)	classifying a list of everyday events or a set of outcomes for a practical activity according to how likely they are to happen, using the language of chance and explaining reasoning, for example, sorting cards that list an event or outcome into piles of likely to happen, unlikely to happen, certain to happen and impossible, then comparing and discussing these with other groups, giving reasons for classifications (AC9M2P01_E1)
		playing games that require a particular number to come up on a die in order to start the game and predicting who will start; discussing whether you can make sure that the number you need will come up (AC9M2P01_E2)
		exploring the likelihood of weather-related outcomes and discussing that it is impossible to snow during a 40℃ heatwave but highly unlikely to snow in Uluru (AC9M2P01_E3)
		predicting and testing what would happen if ten names were put in a box, drawn out and then replaced after each selection, discussing how even though there is a chance all names will be drawn, there is also a chance not all names will be drawn from the box (AC9M2P01_E4)
		exploring chance events associated with games and activities like drawing a coloured ball out of a bag. Using a *'pop-o-matic*' dice roller or games that use a spinner, to try and predict what the outcome will be (AC9M2P01_E5)
		discussing how even when you are sure something will happen there is always a chance that it won't happen, for example, discussing that although yesterday was a regular school day, you didn't have school as the temperature was too hot and school was cancelled (AC9M2P01_E6)
		sorting a set of event cards according to whether they are impossible, certain to happen or uncertain, discussing how impossible events cannot happen and certain events must happen, so they are not affected by chance whereas uncertain events are affected by chance (AC9M2P01_E7)
		using the language of chance to predict colours of cubes as they are drawn from a bag and using reasoning to predict the subsequent cubes as they are drawn, for example, the next cube could be green or red, but it is impossible that it is yellow as there are no yellow cubes in the bag (AC9M2P01_E8)

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		investigating Aboriginal and Torres Strait Islander Peoples' seasonal calendars, identifying the order of likelihood of environmental indicators (AC9M2P01_E9)

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Year 3

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 3 they:

- are increasingly aware that mathematics has conventions and language enabling the unambiguous communication of ideas and results
- experience the power of being able to manipulate numbers using range of strategies that are based on knowledge of single-digit addition facts and their understanding of place value/base 10, partitioning and regrouping
- begin to apply their understanding of algorithms to experiment, explore and investigate mathematical relationships and recognise patterns
- extend the repertoire of patterns they identify and work with to include growing patterns based on multiplying and dividing
- can determine key features of objects and spaces and use these when they create spatial representations
- undertake, with guidance, meaningful statistical investigations, making decisions about their use and representation of data and reporting their findings
- are increasingly able to understand how outcomes are generated through random processes.

Achievement standard

By the end of Year 3 students apply an understanding of place value and the structure of numbers when partitioning, rearranging, regrouping and renaming numbers to at least 10 000 in different ways. They use addition and subtraction as inverse operations. Students establish and use single-digit addition and related subtraction facts to construct equivalent number sentences and to develop additive strategies for modelling and solving problems involving two-digit and three-digit numbers. They round numbers to make estimates for financial and other calculations. Students model situations and solve problems involving single-digit multiplication and division using diagrams, equal groups and arrays. They apply part-whole understanding to represent unit fractions and their multiples in different ways. Students identify, create and continue patterns formed by multiplying or dividing by two. They create and use algorithms to investigate the properties of odd and even numbers and to identify patterns and develop facts for single-digit multiplication of two, three, five and ten.

Students use known measurements of familiar items to compare and make estimates and use familiar metric units when measuring attributes of objects and events. They identify angles as measures of turn. Students communicate estimates and measures of duration using formal units of time. They identify key features of objects and connect them to how the objects are used and classified. Students create two-dimensional representations of environments that show the positions of objects relative to each other. They identify and describe line symmetry in the environment.

Students communicate with reasons, results and conclusions from guided statistical investigations involving categorical and discrete numerical data. Students

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record, represent and compare collected data using appropriate methods. Students identify all possible outcomes of chance events and report on variation observed when chance events are repeated.

Strand	Content description *Students learn to:*	Elaboration *This may involve students:*
Number	represent, read, write, rename and order natural numbers to at least 10 000 using naming and writing conventions for larger numbers and relate these representations to place value in the base 10 number system (AC9M3N01)	moving materials from one place to another on a proportional place value model to show the renaming of numbers, for example, 1574 can be shown as one thousand, five hundreds, seven tens and four ones, or as fifteen hundreds, seven tens and four ones (AC9M3N01_E1)
		using the cyclical nature of the place value names and spaces between sets of three digits to read and write larger numbers: ones, tens, hundreds, ones of thousands, tens of thousands, hundreds of thousands, one of millions, tens of millions … (AC9M3N01_E2)
		using the constant function on a calculator to explore the effect of adding or subtracting ones, tens, hundreds, thousands or tens of thousands to/from numbers that include nines or zeros in different places, for example, 49 999 add 1 or add 100, 500 000 subtract 10 or 100 (AC9M3N01_E3)
		throwing three dice, nominating the value, for example, tens, hundreds or thousands of each digit and adding or subtracting the three-digit number to reach a target amount (AC9M3N01_E4)
		comparing, reading and writing the numbers involved in the more than 60 000 years of Aboriginal Peoples' presence on the Australian continent through time scales relating to pre-colonisation and post-colonisation (AC9M3N01_E5)
	apply place value to partition, rearrange and regroup numbers to at least 10 000 to assist in calculations when solving problems (AC9M3N02)	recognising that 10 000 is equivalent to 10 thousands, 100 hundreds, 1000 tens and 10 000 ones (AC9M3N02_E1)
		using grouped materials or diagrams to make proportional models (material grouped into ones, tens, hundreds, thousands) and face value models (abacus) of large numbers to assist in calculations (AC9M3N02_E2)
		justifying choices about partitioning and regrouping numbers in terms of their usefulness for particular calculations when solving problems (AC9M3N02_E3)

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	applying knowledge of place value to assist in calculations when solving problems involving larger numbers, for example, calculating the total crowd numbers for an agricultural show that lasts a week (AC9M3N02_E4)
round natural numbers to the nearest multiple of five or ten to make estimates for financial transactions and to solve other practical problems (AC9M3N03)	estimating how much paper will be required and how much space a grid paper model of a large number, for example, 20 200 will take up on the wall (AC9M3N03_E1)
	estimating how many items they can buy with, for example, $100 using shopping catalogues, and explaining why they should round everything up to the nearest dollar, five or ten dollars before completing their estimated calculation (AC9M3N03_E2)
	estimating how much change they should get after buying several of the same item and explaining whether their estimate will be lower or higher than the actual amount (AC9M3N03_E3)
recognise and use different models to represent the unit fractions $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}$ and their multiples. Combine fractions with the same denominator to complete the whole using part-whole understanding (AC9M3N04)	recognising that unit fractions represent equal parts of a whole, for example, one third is one of three equal parts of a whole (AC9M3N04_E1)
	representing unit fractions and their multiples in different ways, for example, using a Think board to represent one-quarter using a diagram, concrete materials, a situation and the notation (AC9M3N04_E2)
	sharing or dividing measurement attributes such as mass or capacity and comparing them to say what is the same and what is different, for example, between $\frac{1}{4}$ of a lump of playdough and $\frac{1}{4}$ of a cup of rice, explaining what the parts of the fraction they refer to in each model (AC9M3N04_E3)
	cutting objects such as oranges, sandwiches or playdough into halves, quarters or fifths and reassembling them to show, for example, two-halves make a whole, four-quarters make a whole, counting the fractions as you go (AC9M3N04_E4)
	sharing collections of objects, for example, pop sticks or sultanas between three, four or five people and connecting division with fractions, for example, sharing between three people gives $\frac{1}{3}$ of the collection each and sharing between five people gives $\frac{1}{5}$ of the collection each (AC9M3N04_E5)
	exploring hunting circles used by Aboriginal and Torres Strait Islander Peoples to catch prey to investigate and represent different models of unit fractions based on different numbers of hunters between 1 and 5

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		(AC9M3N04_E6)
	model situations and solve problems (including representing money in different ways) involving addition and subtraction of two-digit and three-digit numbers, applying knowledge of partitioning, place value and basic facts. Explain results in terms of the situation (AC9M3N05)	using materials to represent an additive situation, choosing whether to use an addition and/or subtraction number sentence, and explaining how each number in their number sentence is connected to the situation (AC9M3N05_E1)
		identifying a problem and applying effective strategies to solve using a Think Board or a bar model to represent an additive situation (AC9M3N05_E2)
		using partitioning and part-part-whole models to mentally solve addition or subtraction problems, making informal written 'jottings' to keep track of the numbers, and the inverse relationship between addition and subtraction as needed (AC9M3N05_E3)
		choosing between standard and non-standard place value partitions to assist with calculations, for example, to solve 485 + 365, thinking of 365 as 350 + 15, then adding the parts, 485 + 15 = 500, 500 + 350 = 850 (AC9M3N05_E4)
		solving subtraction problems efficiently by changing both numbers to create a 'friendlier' calculation, for example, 534 – 395 adding 5 to both numbers to make 539 – 400 = 139 (AC9M3N05_E5)
		using a physical or mental number line and jumping along forwards or backwards in hundreds, tens and ones to solve a range of addition or subtraction problems including with different unknowns, for example, '*I had 75 tomatoes and then picked some more, now I have 138. How many did I pick*?' (AC9M3N05_E6)
		recognising the relationship between dollars and cents and representing money amounts in different ways using knowledge of part-part-whole relationships, for example, knowing that $1 is equal to 100 cents; representing $1.85 as $1 + 50c + 20c + 10c + 5c or 50c + 50c + 50c + 10c + 10c + 10c + 5c; calculating change from $2 starting from $1.30 is 20c + 50c = $2 (AC9M3N05_E7)
		choosing to represent a situation with an open subtraction number sentence and using the inverse relationship to solve the problem with addition on a calculator, for example, '*I had some money and then spent* $375*, now I have* $158 *left. How much did I have to start with?* □ – $375 = $158, could be solved by $375 + $158 = □ (AC9M3N05_E8)

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	model situations (including financial contexts) and solve problems involving multiplication and division using diagrams, equal groups and arrays. Represent the situation as a number sentence and solve using digital tools where appropriate. Explain the results in terms of the situation (AC9M3N06)	using materials, a bar model or a Think Board to model a multiplication problem, for example, if 4 tomato plants each has 6 tomatoes, decide whether to use an addition or multiplication number sentence, explaining how each number in their number sentence is connected to the situation (AC9M3N06_E1)
		interpreting a multiplication situation using a diagram or array model to say what is unknown, for example, the number of groups, the number per group, or the total amount; writing a number sentence to represent the situation, for example, '*If beans cost* $3 *per kilo, how much does it cost for five kilos?,* writing 3 x 5 = 15 and saying, '*Three is the cost per kilo, five is how many kilos and* $15 *is the total cost* (AC9M3N06_E2)
		solving division problems involving unknown numbers of groups or finding how much is in each group by representing the problem with both division and multiplication number sentences; explaining how the two number sentences are connected to the problem (AC9M3N06_E3)
		representing and solving shopping problems involving buying a number of the same item, for example, buying five tablets for $496 each, choosing to solve the problem efficiently by rounding up to $500 and subtracting 5 X 4 = $20, 5 x $500 = $2500, 2500 – 20 = $2480 (AC9M3N06_E4)
		deciding how to share an amount evenly, for example, 48 horses into two, four, six, or eight paddocks, representing the shares with a division and a multiplication number sentence, and counting the number in each share to solve the problem (AC9M3N06_E5)
Algebra	identify, continue and create extended number sequences formed by doubling and halving using technology to assist where appropriate. Identify and describe emerging patterns (AC9M3A01)	connecting halving with dividing by two and using this to create a pattern sequence by continuous halving, for example, *'I started with* $24 *and gave away half, then another half, and another…*' Writing and explaining the sequence, 24, 12, 6, 3 as '*I started with $24 and halved it 3 times'* (AC9M3A01_E1)
		creating and investigating doubling patterns made with everyday items, such as shoes….*'one person, two shoes, two people, four shoes'* …, recording the sequence two ways (with addition and multiplication) and explaining the patterns they notice (AC9M3A01_E2)
		exploring and identifying similarities in growing patterns formed by doubling and halving and identifying these on-Country/Place including branching in trees and river systems (AC9M3A01_E3)
	recognise and explain the connection between addition	exploring partitioning using materials, part-part-whole diagrams or bar models and recording addition and subtraction facts for each representation, explaining how each fact is connected to the materials, diagrams or

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	and subtraction as inverse operations and apply to partition numbers when generating equivalent number sentences (AC9M3A02)	models, for example, 16 + 8 = 24, 24 – 8 = 16, 8 = 24 – 16 (AC9M3A02_E1)
		exploring and explaining the inverse relationship between addition and subtraction, using this to find unknown values on a calculator, for example, solving 27 + □ = 63 using subtraction, □ = 63 – 27 (AC9M3A02_E2)
		exploring Aboriginal and Torres Strait Islander Peoples' stories and dance to explain the connection and balance between addition and subtraction, connecting this to a number sentence and discussing how this conveys important information about processes on-Country/Place (AC9M3A02_E3)
	recognise and explain patterns in basic addition facts up to 10 + 10 and related subtraction facts. Extend apply these patterns to develop efficient mental strategies for computation with larger numbers (AC9M3A03)	using tens frames or materials such as unifix cubes to develop and record addition and subtraction strategies such as doubles, near doubles and combinations to ten, explaining patterns noticed within the facts (AC9M3A03_E1)
		using function machines to model addition and subtraction, recognising and describing the patterns between input and output using digital tools to assist where appropriate (AC9M3A03_E2)
		exploring partitioning using materials and part-part-whole diagrams to develop subtraction facts related to addition facts, such as 8 + 7 = 15 therefore, 15 – 7 = 8 and 15 – 8 = 7 (AC9M3A03_E3)
		exploring partitioning to develop and record facts systematically, for example, 'How many ways can 12 monkeys be in two trees?', 12 = 12 + 0, 12 =11 + 1, 12 = 10 + 2, 12 = 9 + 3, …; explaining how they know they have found all possible partitions (AC9M3A03_E4)
		understanding basic addition and related subtraction facts and using extensions to these facts, for example, 6 + 6 = 12, 16 + 6 = 22, 6 + 7 = 13, 16 + 7 = 23, 60 + 60 = 120, 600 + 600 = 1200 (AC9M3A03_E5)
	describe, follow and create algorithms involving a sequence of steps and decisions to investigate numbers including odd and even numbers and multiples of 2, 3, 5 and 10 using computational thinking to recognise, describe	following an algorithm consisting of a flowchart with a series of instructions and decisions to determine whether a number is even or odd; using the algorithm to determine if a set of numbers are divisible by two (AC9M3A04_E1)
		using an algorithm designed to determine whether a number is a multiple of 2, 5 or 10 to explore a set of numbers, identifying and discussing emerging patterns (AC9M3A04_E2)
		exploring algorithms used for repeated addition, comparing and describing what is happening, and using them to establish the multiplication facts for two, three, five and ten, for example, following the sequence of steps, the decisions being made and the resulting solution, recognising and generalising any emerging patterns

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	and explain emerging patterns (AC9M3A04)	(AC9M3A04_E3)
		creating an algorithm as a set of instructions that a classmate can follow to generate multiples of 3 using the rule '*to multiply by 3 you double the number and add on one more of the number*', for example, for 3 threes you double 3 and add on 3 to get 9, for 3 fours you double 4 and add one more 4 to get 12... (AC9M3A04_E4)
		creating a sorting algorithm that will sort a collection 5 cent and 10 cent coins and provide the total value of the collection applying knowledge of multiples of 5 and 10 (AC9M3A04_E5)
Measurement	measure, order and compare objects using familiar metric units of length, mass and capacity to solve practical problems (AC9M3M01)	making a measuring tape using metric units of length and using it to measure and compare things, for example, the girth of a tree; explaining that the lines on a ruler show the beginning and end of each unit (AC9M3M01_E1)
		using a strip of centimetre grid paper to measure and compare the length of objects, connecting this with centimetre units on a ruler and using fractions of a grid to give an accurate measure (AC9M3M01_E2)
		discussing how the capacity of a container or object is the internal volume and usually refers to the amount of liquid it can hold, measured in millilitres and litres; comparing the capacity of different sizes of familiar drinks, for example, 600 millilitres, 1 litre, 2 litre and 3 litre milks containers (AC9M3M01_E3)
		measuring and comparing the capacity or mass of objects or containers using measuring jugs or kitchen scales and standard metric units, millilitres, litres, grams and kilograms; interpreting and explaining what the lines on the measuring jugs or scale mean (AC9M3M01_E4)
		deciding which attribute to measure and which standard unit to use to compare the size of things, for example, the size of a mouse and a cat, or the capacities of a fish tank and water tank (AC9M3M01_E5)
	recognise which metric units are used to measure everyday items and use known measures and related units as a benchmark to make, improve and check the reasonableness of estimates (AC9M3M02)	examining items in the kitchen pantry to identify which metric unit is used to describe the size of the items (AC9M3M02_E1)
		identifying things that have a mass of one kilogram, 500 kilograms, one litre, or 500 millilitres; using these benchmarks, estimate the mass or capacity of other things, explaining their reasoning (AC9M3M02_E2)
		estimating the weight of a range of packages to decide how much postage will cost, using tables from the post office, for example, a package between 500 grams and 1 kilogram will cost $14.65 (AC9M3M02_E3)

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	communicate estimates and measures of duration using formal units including days, hours, minutes and seconds (AC9M3M03)	estimating how long it would take to read a set passage of text, and sharing this information to demonstrate understanding of formal duration units (AC9M3M03_E1)
		planning a sequence of events based on estimates of the duration of each event, for example, planning a set of activities for a class party by estimating how long each game or activity will take (AC9M3M03_E2)
		reading and connecting digital time with analogue time, interpreting times such as 12:15 as a quarter past 12, or 15 minutes past 12, 12:45 as a quarter to one or 15 minutes before 1 o'clock, and reading time to the minute on both devices (AC9M3M03_E3)
		reading analogue clocks throughout the day, and noticing and connecting the position of the hour hand and the distance the minute hand has travelled (AC9M3M03_E4)
		using sand timers and digital timers to estimate and measure short durations of time, one minute, three minutes and five minutes (AC9M3M03_E5)
		exploring how cultural accounts of Aboriginal and Torres Strait Islander Peoples explain cycles of time that involve the sun, moon and stars (AC9M3M03_E6)
	identify angles as measures of turn such as a right angle (quarter turn) and compare angle sizes in everyday situations (AC9M3M04)	investigating hands turning on a clock and connecting half, quarter and full hours to angles; using this to give or follow directions to locate an object in the room, or a pathway through a grid, such as programming a robot, referring to half, quarter, three-quarter and full turns, clockwise or anti-clockwise (AC9M3M04_E1)
		exploring the built environment to identify angles that are bigger than, smaller than and the same size as a right angle (AC9M3M04_E2)
		exploring Aboriginal and Torres Strait Islander children's instructive games to investigate angles as measures of turn, for example, the game *Waayin* from the Datiwuy People in the northern part of the Northern Territory (AC9M3M04_E3)
		exploring Aboriginal and Torres Strait Islander Peoples methods of weaving, identifying and comparing fractional turns to make patterns, and explaining why the patterns are different for the different fractions (AC9M3M04_E4)

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Space	analyse, classify and make models of objects, identifying key features and explaining why these features make them suited to their uses (AC9M3SP01)	classifying a collection of geometric objects, including cylinders spheres, prisms and pyramids and refer to some key features such as the shape and number of surfaces, edges and vertices (AC9M3SP01_E1)
		identifying and naming cubes, rectangular prisms, cylinders, cones and spheres in common objects found in the environment (AC9M3SP01_E2)
		making a geometric object in solid form, for example, with playdough, hollow form with provided plastic or card shapes and skeleton form with straws and discussing the features of the object they had to focus on for each different material (AC9M3SP01_E3)
		investigating and explaining how Aboriginal and Torres Strait Islander Peoples' dwellings are orientated in the environment to accommodate climatic conditions (AC9M3SP01_E4)
		exploring the designs of nets of Aboriginal and Torres Strait Islander Peoples, investigating key features and purpose of the shapes within the designs (AC9M3SP01_E5)
	create, use and interpret models of familiar environments positioning representations of key landmarks and objects relative to each other (AC9M3SP02)	designing the layout of a space, for example, a proposed games room or the classroom using a blank sheet of paper as the boundary and cut outs of shapes to represent furniture from a top view perspective (AC9M3SP02_E1)
		locating themselves within a boundary such as a basketball court, an oval, stage or assembly hall, guided by a simple hand-held plan indicating the different positions of the participants in the activity (AC9M3SP02_E2)
		sketching a map within the classroom indicating where they have hidden an object, swapping maps with a partner and then providing feedback about what was helpful and what was confusing in the map (AC9M3SP02_E3)
		identifying differences in the representation of a place on a map, in an aerial photo and in a satellite image and discussing how different methods of representation give different information about the relative positioning of key landmarks and objects (AC9M3SP02_E4)
		exploring land maps or cultural maps used by Aboriginal and Torres Strait Islander Peoples to locate, identify and position important landmarks such as waterholes (AC9M3SP02_E5)

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	identify line symmetry in the environment, using terms such as vertical, horizontal and diagonal to describe the lines (AC9M3SP03)	walking around the playground or taking a nature walk to explore their environment looking for examples of symmetry, such as, school buildings, trees and using a tablet, capture images to bring back to the classroom and share (AC9M3SP03_E1)
		exploring digital images, recognising and discussing those that possess line symmetry, for example, water reflections, human and animal features, images of nature and architecture (AC9M3SP03_E2)
		exploring line symmetry in the natural environment on-Country/Place such as in plants and flowers, identifying and describing observations (AC9M3SP03_E3)
Statistics	acquire categorical or discrete numerical data by observing, collecting and accessing existing data sets. Record and represent it using appropriate methods (including frequency tables and spreadsheets) and use total frequencies to compare data (AC9M3ST01)	exploring meaningful and increasingly efficient ways to collect and record data, for example, written surveys, online surveys, polling the class using interactive digital mediums and representing and reporting the results of investigations (AC9M3ST01_E1)
		using surveys, observations or experiments to collect categorical, discrete numerical or qualitative (text) data sets and discussing what kind of data can be used in a statistical investigation (AC9M3ST01_E2)
		using lists, tallies, symbols, digital data tables to record and display data collected during an experiment to be interpreted (AC9M3ST01_E3)
		exploring different online sources to access data, for example, using online query interfaces to select and retrieve data from an online database such as weather records, Google Trends or the World Health Organization (AC9M3ST01_E4)
		exploring the use of the sum function in spread sheets to calculate total frequencies of collected data (AC9M3ST01_E5)
		investigating seasonal calendars of Aboriginal and Torres Strait Islander Peoples by collecting data and creating frequency tables and spreadsheets based on environmental indicators that can be found for the current season (AC9M3ST01_E6)
	interpret and compare various displays using software to	comparing various student-generated data representations and describing their similarities and differences (AC9M3ST02_E1)

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	construct graphs where appropriate. Interpret, describe and explain them in the context they represent (AC9M3ST02)	using digital tools and graphing software to construct different graphs of data acquired through experiments of observations interpreting the data and making inferences, for example graphing data from a science experiment and interpreting the results (AC9M3ST02_E2)
		using newspapers or magazines to find examples of different displays of data, interpreting and describing the data they are representing (AC9M3ST02_E3)
		collecting data and creating one-to-one data displays about the frequency of environmental indicators in seasonal calendars of First Nations Peoples (AC9M3ST02_E4)
	use the statistical investigation process to conduct guided statistical investigations involving the collection of categorical or discrete numerical data with respect to contexts and problems of interest (AC9M3ST03)	creating a poster or infographic that describes the process of statistical investigation, describing the components, the tools and the types of data that can be collected, represented and interpreted (AC9M3ST03_E1)
		collaboratively working through a whole class investigation choosing a question of interest, using an efficient collection method and recording collected data then representing, interpreting and reporting the data in terms of the question and context (AC9M3ST03_E2)
		planning investigations that involve collecting data, and carrying out the investigation, for example, narrowing the focus of a question such as '*which is the most popular breakfast cereal*?' to '*which is the most popular breakfast cereal among Year 3 students in our class*?' (AC9M3ST03_E3)
Probability	conduct chance experiments, involving repetitions of an activity, experiment or game. List and describe the set of all possible outcomes, recognising and recording variation in results using digital tools as appropriate (AC9M3P01)	identifying the possible outcomes of tossing a coin, predicting the outcome of 10 tosses, then carrying out a few trials and tallying the results for each trial. Responding to questions '*Was your prediction correct*?', '*How did your results vary for each trial*?' and '*How do the results vary across the class*?' (AC9M3P01_E1)
		conducting repeated trials of chance experiments such as tossing a coin, throwing a die or drawing a ball from a bag and identifying the variations between trials (AC9M3P01_E2)
		predicting the outcomes then testing and tallying the results of about ten trials using chance tools that have equally likely outcomes, noticing the variation in outcomes between the trials (AC9M3P01_E3)
		comparing the results of drawing counters from a bag with and without replacement (AC9M3P01_E4)

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	using Aboriginal and Torres Strait Islander children's instructive games, for example, *Jillora* from the Yurlayurlanya Peoples in South Western Queensland, to conduct repeated trial chance experiments, recognising and explaining variation in results (AC9M3P01_E5)

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Year 4

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 4 they:

- draw on their facility with patterns in whole number facts, fractions and decimals to deepen their appreciation of how numbers work
- develop and use strategies for multiplication that are based on their appreciation of multiplication as an operation and their knowledge of laws for arithmetic operations
- become increasingly conscious of context and purpose when they make judgements and reflect on the reasonableness of results and how they choose to represent mathematics and mathematical information
- measure and estimate common attributes of objects using conventional instruments and appropriate metric units
- draw on stochastic reasoning to analyse, categorise and order chance events by carefully considering the features of the means for generating random outcomes
- develop and use surveys to obtain data that is directly relevant to their statistical investigations.

Achievement standard

By the end of Year 4, students use their understanding of the structure of place value to efficiently multiply natural numbers by multiples of 10, and to represent tenths and hundredths in decimal form. They model situations, including financial contexts, and use addition and multiplication facts to add and subtract four-digit numbers and multiply and divide numbers efficiently. Students develop and use rounding and estimation strategies to reason and determine whether results are reasonable. They identify patterns in the multiplication facts and use their knowledge of these patterns in efficient strategies for mental calculations. Students solve problems using the properties of odd and even numbers. They locate common fractions on a number line and use fraction notation and other representations to demonstrate equivalence within families of fractions. Students identify and explain emerging patterns in sequences involving multiples and generated by algorithms using computational approaches and digital tools. They use the properties of operations and the structure of numbers to find unknown values in equivalent number sentences involving addition and subtraction.

Students use common scaled instruments to measure length, mass, capacity and temperature, using units that are appropriate for purpose. They measure and approximate the perimeter of shapes and enclosed boundaries and use square units to measure and approximate area. Students convert between units of time when solving problems involving duration. They compare angles relative to a right or straight angle and use formal angle names to communicate their results.

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Students apply spatial reasoning to model more complex shapes and objects with simpler ones. They create, use and interpret grid reference maps as two-dimensional representations of objects and spaces. Students identify rotational symmetry in plane shapes and create symmetrical patterns.

They use surveys and other means to generate categorical data in statistical investigations and communicate their findings in the context of the data. Students create displays, including column graphs and many-to-one pictographs, to represent and show the spread and variability of a data set. They assess the suitability of displays for representing data and discuss the shape of data distributions and the variation in data. Students use experience and the results of experiments to order the likelihood of the outcomes of chance events and identify whether events are independent or dependent.

Strand	Content description *Students learn to:*	Elaboration *This may involve students:*
Number	recognise, explain and extend the application of place value to tenths and hundredths and use the conventions of decimal notation to name, rename and represent decimal numbers (AC9M4N01)	using a bar to represent the whole, dividing it into ten equal pieces, with each piece representing 0.1 or a tenth of the whole length, two pieces are 0.2 or two-tenths of the whole (AC9M4N01_E1)
		using materials to show the multiplicative relationship between the whole, tenths and hundredths, for example, using a bundle of ten straws as the whole, one straw as the tenth and cutting the tenth into ten parts to show the hundredths (AC9M4N01_E2)
		recognising that one is the same as ten-tenths and one-tenth is the same as 10 hundredths and using this relationship to rename decimals, for example, renaming 0.25 as two-tenths and five-hundredths or twenty-five hundredths (AC9M4N01_E3)
		making models of measurement attributes to show the relationship between the base unit and parts of the unit, for example, 1.5 metres is one metre and five tenths of the next metre (AC9M4N01_E4)
		counting large quantities of mixed notes and coins, writing the total using dollars and cents, and recognising the cents as parts of the next dollar (AC9M4N01_E5)
		comparing the way money and measures are read and said, explaining how they are the same and different, for example, $2.75 is said '*two dollars seventy-five*' and 2.75 m is said '*two point seven five metres*', the 7 means 7 tenths and the 5 means 5 hundreds in both (AC9M4N01_E6)
	recognise the multiplicative relationship between the place	using materials to explore and explain why multiplying by ten moves the digits one place to the left and why dividing by ten moves digits one place to the right (AC9M4N02_E1)

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value of digits and apply to solve problems involving multiplying or dividing natural numbers by multiples of ten (AC9M4N02)	using a calculator to explore the effect of multiplying or dividing numbers by tens, hundreds and thousands, recording sequences in a place value chart and explaining patterns noticed (AC9M4N02_E2)
	using a calculator or other computational tool to explore the effect of multiplying numbers by multiples of ten, recording results in a table or spread sheet and explaining the patterns noticed, for example, multiplying 5 x 10, 5 x 20, 5 x 30, 5 x 40, 5 x 50, 5 x 60, 5 x 70, 5 x 80, 5 x 90, 5 x 100 and recognising the pattern of 5 x the first digit (AC9M4N02_E3)
	applying knowledge of the multiplicative relationship between the place value of digits to determine the unit cost for items that come in packs of ten (AC9M4N02_E4)
use estimation and rounding to check and explain the reasonableness of solutions to problems (including purchases and the calculation of change to the nearest five cents) by recalling and applying number facts and rounding results of calculations where appropriate (AC9M4N03)	using basic facts to estimate the result of a calculation and say what the answer will be between, for example, 5 packets of biscuits at $2.60 each will cost between $10 and $15 (AC9M4N03_E1)
	using rounded amounts to complete an estimated budget for a shopping trip or an excursion, explaining why overestimating the amounts is appropriate (AC9M4N03_E2)
	exploring the effect of rounding in addition and multiplication calculations, rounding both numbers up, both numbers down and one number up and one number down; explaining which estimation is the best approximation and why (AC9M4N03_E3)
apply the properties of odd and even numbers when solving problems (AC9M4N04)	identifying even numbers using skip counting by twos or by grouping even collections of objects in twos (AC9M4N04_E1)
	explaining why all numbers that end in the digits 0, 2, 4, 6 and 8 are even and that numbers ending in 1, 3, 5, 7 and 9 are odd (AC9M4N04_E2)
	using the four operations with pairs of odd or even numbers or one odd and one even number, then using the relationships established to check the accuracy of calculations (AC9M4N04_E3)
	exploring and explaining why some materials can be shared evenly between two people and some cannot (AC9M4N04_E4)

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	exploring and explaining the patterns involved in adding and subtracting odd and even numbers, for example, even + even = even, odd + even = odd, odd + odd = even and using this to decide whether answers to addition and subtraction problems are correct or not (AC9M4N04_E5)
recognise the relationships between families of fractions (halves, quarters and eighths; fifths and tenths; thirds, sixths and twelfths) including equivalence. Use different representations (including fraction notation) to designate parts of a whole (AC9M4N05)	exploring and extending fraction families within collections of materials , for example, by seeing $\frac{3}{4}$ as 3 in each 4, showing this within related fractions like $\frac{6}{8}$ or that $\frac{2}{5}$ means 2 in each 5 so it can be shown within $\frac{4}{10}$ (AC9M4N05_E1)
	creating models of equivalent fractions by subdividing capacity measures into smaller fractions, for example, half a cup of flour could be shown as two quarters or four eighths of a cup of flour (AC9M4N05_E2)
	subdividing materials such as play dough into fifths and tenths to show equivalence between different fractions, recording as both fractions and decimals (AC9M4N05_E3)
	exploring the connection between fractions of metres and decimals for example, finding $\frac{1}{2}$ of a metre, and connecting this to 0.5 m or 50 cm, $\frac{1}{4}$ of a metre and connecting this with 0.25 m or 25 cm (AC9M4N05_E4)
	using array diagrams to show the relationship between fractions, division and multiplication, for example, 3 x 4 = 12, 12 ÷ 4 = 3, $\frac{1}{4}$ of 12 is 3, $\frac{1}{3}$ of 12 is 4 (AC9M4N05_E5)
count by fractions (including quarters, halves, thirds and mixed numerals). Locate and represent these fractions on number lines (AC9M4N06)	cutting objects, for example, oranges or sandwiches into quarters and counting by quarters to find the total number, saying the counting sequence, one quarter, two quarters, three quarters, four quarters or one whole, five quarters or one and one quarter, six quarters or one and two quarters… eight quarters or two wholes... (AC9M4N06_E1)
	subdividing the sections between whole numbers on parallel number line so that one shows halves, another shows quarters and another shows thirds. Counting the fractions by jumping along the number lines, noticing when the count is at the same position on the parallel lines (AC9M4N06_E2)
model situations (including financial contexts) and solve problems involving addition and	representing a range of additive situations involving larger numbers using materials, part-whole diagrams and/or a bar model, and writing addition and/or subtraction number sentence, based on whether a part or the whole is missing; explaining how each number in their number sentence is connected to the situation (AC9M4N07_E1)

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subtraction of numbers to at least 10 000, by formulating expressions and choosing efficient strategies, including digital tools where appropriate. Justify choices and explain results in terms of the situation (AC9M4N07)	choosing between a mental calculation or a calculator to solve addition or subtraction problems, using a calculator when the numbers are difficult or unfriendly and a mental calculation when the numbers can be connected to a familiar mental calculation strategy; reflecting on their answer in relation to the context to ensure it makes sense (AC9M4N07_E2)
	choosing an efficient mental calculation strategy, for example, place value partitioning, inverse relationship, compatible numbers, bridging tens, splitting one or more numbers, extensions to basic facts etc, and using informal written jottings to add or subtract larger '*friendly*' numbers (AC9M4N07_E3)
	interpreting everyday situations involving money, such as a budget for a large event, as requiring either addition or subtraction and solving using a calculator; recording the number sentence used on the calculator and justify the choice of operation in relation to the situation (AC9M4N07_E4)
model situations (including financial contexts) and solve problems involving multiplication and division where there is no remainder, using diagrams, arrays and number sentences choosing efficient strategies and using digital tools where appropriate. Explain results in terms of the situation (AC9M4N08)	representing a range of multiplicative situations using materials, array diagrams and/or a bar model, and writing multiplication and/or division number sentences, based on whether the number of groups, the number per group or the total is missing, and explaining how each number in their number sentence is connected to the situation (AC9M4N08_E1)
	interpreting a division situation using a diagram or array model to say what is unknown – the number of groups, or the number per group and writing a division number sentence to represent the situation (AC9M4N08_E2)
	using an array to model a multiplication problem, and connecting the idea of how many groups and how many in each group, with the rows and columns of the array, and writing an associated number sentence (AC9M4N08_E3)
	using materials or a diagram to solve a multiplication or division problem, writing a number sentence, and explaining what each of the numbers within the number sentence refers to, for example, I rode 36 km in 3 hours, how fast was I going? 36 ÷ 3 = 12, the 36 refers to km, the 3 refers to hours and the 12 refers to kilometres travelled in one hour (AC9M4N08_E4)
	using place value partitioning, basic facts and an array model to solve multiplication problems, such as 16 × 4, thinking 10 × 4 and 6 × 4, 40 + 24 = 64 (AC9M4N08_E5)
	solving multiplication problems involving money, such as buying a number of the same item, for example, 5 garden pots for $96 each, using efficient mental strategies, and written jottings to keep track if needed, for example,

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		rounding $96 up to $100 and subtracting 5 x $4 = $20, 5 x $100 = $500, $500 – $20 = $480 (AC9M4N08_E6)
		exploring Aboriginal and Torres Strait Islander Peoples' cultural stories and dances and how they convey important environmental information including processes on-Country/Place such as turtle egg gathering, formulating connected multiplication or division mathematical expressions to model these situations (AC9M4N08_E7)
Algebra	continue and create extended number sequences involving multiples of 3, 4, 6, 7, 8, and 9 using technology to assist where appropriate. Identify and explain emerging patterns (AC9M4A01)	creating multiples of 3 on grid paper and doubling to find multiples of 6; recording and explaining the connections to the x3 and x6 multiplication facts., 3, 6, 9, … doubled is 6, 12, 18, … (AC9M4A01_E1)
		investigating doubling patterns and connecting the sequences created with multiplying by 2 (double), 4 (double, double) and 8 (double, double, double) (AC9M4A01_E2)
		using function machines to model multiplication creating a sequence of numbers using digital tools to assist where appropriate; recognising, describing and explaining emerging patterns (AC9M4A01_E3)
		creating and investigating patterns involving multiplies, made with materials such as pop sticks or straws, for example, 1 triangle needs 3 sticks, 2 triangles need 6 sticks…; recording and explaining the sequence of numbers and the patterns they notice, making connections to multiplication facts (AC9M4A01_E4)
		identifying and describing fractal patterns on-Country/Place, creating number sequences using technology to describe them and exploring their connections to Aboriginal and Torres Strait Islander Peoples' artworks (AC9M4A01_E5)
	find unknown values in equivalent number sentences applying an understanding of associative and commutative properties of addition and the inverse property of addition and subtraction (AC9M4A02)	exploring the associative and commutative properties of addition using materials, diagrams and number lines, for example, using number lines to demonstrate that 5 + 2 = 2 + 5, demonstrating that 2 + 2 + 3 = 7 and 2 + 3 + 2 = 7 and 3 + 2 + 2 = 7 (AC9M4A02_E1)
		using balance scales and informal uniform units to create addition (or subtraction) number sentences showing equivalence, for example, 7 + 8 = 6 + 9, and to find unknowns in equivalent number sentences, for example, 6 + 8 = □ + 10 (AC9M4A02_E2)
		constructing equivalent number sentences involving addition, demonstrate an understanding of the associative property and explaining what they did, for example, '*If I start with 3 + 8, I know 8 = 3 + 5 and so 3 + 8 = 3 + 3 + 5 then 3 + 8 = 6 + 5 as I can add the 3 + 3 first*' (AC9M4A02_E3)

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	exploring the fact that addition is associative but subtraction is not using physical or virtual materials, for example, using counters to show that 3 + 2 + 5 = (3 + 2) + 5, or 3 + 2 + 5 = 3 + (2 + 5) as they both equal 10 but (10 – 3) – 2 = 5 and 10 – (3–2) = 9 so it is not the same, and 2 + 5 = 5 + 2 but 5 – 2 does not equal 2 – 5 because 5 is greater than 2 and you cannot take more than you have (AC9M4A02_E4)
	using part-part-whole diagrams or bar models to explore and explain the inverse relationship between addition and subtraction, using this to make calculations easier, for example, solving 27 + □ = 63 using subtraction, □ = 63 – 27 (AC9M4A02_E5)
recognise, recall and explain patterns in basic multiplication facts up to 10 x 10 and related division facts. Extend and apply these patterns to develop increasingly efficient mental strategies for computation with larger numbers (AC9M4A03)	using arrays on grid paper or created with blocks/counters to develop and explain patterns in the basic multiplication facts; using the arrays to explain the related division facts (AC9M4A03_E1)
	using materials or diagrams to develop and record multiplication strategies such as skip counting, doubling, commutativity, and adding one more group to a known fact (AC9M4A03_E2)
	using known multiplication facts for 2, 3, 5 and 10 to establish multiplication facts for 4, 6 ,7 ,8 and 9 in different ways, for example, using multiples of ten to establish the multiples 9 as '*to multiply a number by 9 you multiply by 10 then take the number away*'; 9 x 4 = 10 x 4 – 4 , 40 – 4 = 36 or using multiple of three as *'to multiply a number by 9 you multiply by 3, and then multiply the result by 3 again'* (AC9M4A03_E3)
	using the materials or diagrams to develop and explain division strategies, such as halving, using the inverse relationship to turn division into a multiplication (AC9M4A03_E4)
	using known multiplication facts up to 10 x 10 to establish related division facts (AC9M4A03_E5)
describe, follow and create algorithms that generate a sequence of numbers resulting from performing multiplication and use computational thinking to recognise, describe and explain emerging patterns (AC9M4A04)	using materials or diagrams to develop and record multiplication strategies such as skip counting or doubling, creating an algorithm that describes the strategies as a series of instructions for another to follow (AC9M4A04_E1)
	creating a basic flowchart that represents an algorithm that will generate a sequence of numbers using multiplication by a constant term, including decisions, input/output and processing symbols; using a calculator to model the processing function, follow the algorithm and record the sequence of numbers generated, describing any emerging patterns (AC9M4A04_E2)
	using a spreadsheet and the 'fill down' function and a multiplication formula to generate a sequence of numbers, for

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		example, enter the number 1 in the cell A1, 'fill down' to cell A100, enter the formula ' = A1*5 ' in the cell B1 and use the 'fill down' function to generate a sequence 100 numbers; describing any emerging patterns (AC9M4A04_E3)
		using function machines to model multiplication using digital tools to assist where appropriate; recognising, describing and explaining emerging patterns (AC9M4A04_E4)
Measurement	use scaled instruments and appropriate units to measure and compare attributes of length, mass, capacity and temperature and solve practical problems (AC9M4M01)	reading and interpreting the mass measurement on digital and analogue kitchen scales including spring scales, explaining what unit of mass, the lines on the analogue scales refer to (AC9M4M01_E1)
		deciding on which attribute, unit and measuring instrument to use to compare the length and mass of various things, such as the size of animals or the distance travelled by a model in a science investigation; explaining the use of units, such as grams or millimetres to give accurate measures when needed (AC9M4M01_E2)
		using scaled instruments such as tape measures, measuring jugs, kitchen scales and thermometers, recording measures using whole units (560 millimetres) or whole and part units, for example, 5.25 metres, 1.75 litres, 2.5 kilograms, 28.5° C (AC9M4M01_E3)
		exploring the different types of scaled instruments used by First Nations Ranger Groups and other groups to make decisions about caring for Country/Place, modelling these in local contexts (AC9M4M01_E4)
	recognise ways of measuring and use appropriate units to measure and approximate the perimeter of shapes and enclosed spaces (AC9M4M02)	recognising that perimeter is the sum of the lengths that form the boundary of a shape or enclosed space (AC9M4M02_E1)
		choosing suitable units from a range of objects to measure around the edge of a shape such as a garden bed; comparing the results to say which unit was an appropriate choice for the context (AC9M4M02_E2)
		using a piece of string or rope to measure the perimeter of irregular shapes including those that have curved sections and enclosed spaces (AC9M4M02_E3)
		creating a range of rectangular 'paddocks' on grid paper and exploring methods of working out the length of the boundary fences; explaining that the more efficient methods involve adding the sides rather than counting squares (AC9M4M02_E4)

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	exploring the distance of country and state boarders using online map tools, relating this to perimeter (AC9M4M02_E5)
recognise and describe area as a measure of two-dimensional space and use square units to measure and approximate the area of regular and irregular shapes (AC9M4M03)	choosing suitable units from a range provided, including appropriate things such as paper tiles, mosaic squares, blocks, and inappropriate things such as string, counters, cotton wool balls, to measure the area of regular and irregular shapes, for example, tabletop or a paint spill, writing an explanation of their measurement process and justifying their choice of unit (AC9M4M03_E1)
	measuring and comparing the area of shapes, using an array of paper tiles or mosaic squares and part units to fill gaps at the edge of the shapes, compare the total areas by combining the fractional parts to make whole units (AC9M4M03_E2)
	investigating how to use one unit repeatedly to measure the area of a shape, for example, using one paper square to measure and compare the area of a rectangle and a triangle; recording and explaining how they used part units to give an accurate measure, and why they needed to ensure there were no gaps or overlaps (AC9M4M03_E3)
	investigating the ways First Nations Ranger Groups and other groups measure area of land to make decisions about fire burns to care for Country/Place (AC9M4M03_E4)
solve everyday problems involving the duration of time including situations involving references to ‘am’ and ‘pm’ and conversions between units of time (AC9M4M04)	calculating the amount of time between two events, such as the between the start and finish of a movie, a bus journey or a flight (AC9M4M04_E1)
	determining the time spent at an event where the starting and finishing times are written in ‘am’ and ‘pm’ notation (AC9M4M04_E2)
	converting units of time using relationships between units, like 60 minutes in an hour, 60 seconds in a minute, to solve problems such as creating a daily timetable for an event, such as an athletics carnival (AC9M4M04_E3)
	exploring the passing of time in Aboriginal and Torres Strait Islander Peoples’ explanations through cultural accounts about cyclic phenomena involving sun, moon and stars (AC9M4M04_E4)
estimate, compare and describe angles using angle names	exploring and classifying the interior angles of a range of shapes, using examples of angles to identify acute, obtuse, right and reflex angles (AC9M4M05_E1)

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	where appropriate (including acute, obtuse, straight angle, reflex and revolution) and their relationships to a right angle (AC9M4M05)	identifying angles within the environment and estimating whether they are acute, (less than 90 °), obtuse, (more than 90° and less than 180°) right (90°) or reflex (more than 180° and less than 360°) (AC9M4M05_E2)
		creating a right-angle template using cardboard or paddle pop sticks and using it to compare angles in the environment, commenting on whether they are smaller than or greater than a right angle (AC9M4M05_E3)
		using a different measuring tools such as a spirit level or set squares to determine whether a line or objects are straight, square or perpendicular (at right angles) (AC9M4M05_E4)
Space	use combinations of shapes and objects to make or approximate more complex shapes and objects in the environment (AC9M4SP01)	identifying common shapes that form part of a composite shapes by re-creating these shapes using physical or virtual materials (AC9M4SP01_E1)
		approximating complex shapes and objects in the environment with familiar shapes and objects, for example, drawing cartoon animal made out of familiar shapes (AC9M4SP01_E2)
		exploring how familiar shapes and objects are used in logos and other graphics to represent more complex shapes and creating logos using graphic design software (AC9M4SP01_E3)
	create and interpret grid maps using grid references and directions to locate and describe positions and pathways (AC9M4SP02)	interpreting a grid reference map of interest, such as a map of the showgrounds, a food festival or a botanical garden and writing instructions for a friend, who is located at the entrance, to find you at a location (AC9M4SP02_E1)
		identifying grid references to communicate a location, for example, the closest train station, or use a grid reference, for example, to locate a park on a grid map of the local area (AC9M4SP02_E2)
		comparing and contrasting, describing and locating landmarks, people or things in a bird's eye picture of a busy scene, such as people in a park, firstly without a transparent grid reference system overlaid over the picture, and then with the grid overlaid; noticing how the grid helps to pinpoint things quickly and easily (AC9M4SP02_E3)
		using the grid as a tool to enlarge or transform an image or artwork (AC9M4SP02_E4)
		exploring scale and direction in two-dimensional maps used by First Nations Ranger Groups and other groups to care for Country/Place (AC9M4SP02_E5)

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	recognise rotational symmetry of shapes and create symmetrical patterns, and pictures using dynamic geometric software where appropriate (AC9M4SP03)	identifying rotational symmetry of shapes by tracing around various shapes and using the image, investigating and recording the different rotations that result in the same image (AC9M4SP03_E1)
		using dynamic geometric software to manipulate shapes and create symmetrical patterns, for example, creating tessellation patterns that are symmetrical (AC9M4SP03_E2)
		using stimulus materials such as the motifs in Central Asian textiles, Tibetan artefacts, Indian lotus designs and Islamic artwork (AC9M4SP03_E3)
		exploring the natural environment on-Country/Place to investigate and discuss patterns and rotational symmetry of shapes and objects such as in flowers (AC9M4SP03_E4)
Statistics	construct, interpret and compare many-to-one pictographs, column graphs and other displays or visualisations suited to the data set(s) using software to construct graphs where appropriate and identify and discuss the information that has been created (AC9M4ST01)	investigating many-to-one data displays using digital technologies and graphical software, interpreting and discussing key features (AC9M4ST01_E1)
		understanding that data can be represented with one symbol representing more than one piece of data, and that it is important to read all information about a representation before making judgements (AC9M4ST01_E2)
		constructing graphs of data collected through observation during science experiments, recording, interpreting and discussing the results in terms of the scientific study (AC9M4ST01_E3)
		using secondary data of fire burns to care for Country/Place by First Nations Ranger Groups and other groups to construct data displays (AC9M4ST01_E4)
	evaluate the effectiveness of different displays or visualisations in illustrating and comparing features of data distributions. Discuss and communicate the shape of the distribution and variation in the data (AC9M4ST02)	suggesting questions that can be answered by a given data display and using the display to answer questions (AC9M4ST02_E1)
		interpreting data representations in the media and other forums in which symbols represent more than one data value (AC9M4ST02_E2)
		comparing different student generated diagrams, tables and graphs, describing their similarities and differences and commenting on the usefulness of each representation for interpreting the data (AC9M4ST02_E3)

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	plan and conduct statistical investigations, collecting and recording categorical data through survey responses and other means using digital tools (including spreadsheets) as appropriate. Interpret, compare and communicate findings within the context of the investigation (AC9M4ST03)	creating a survey to collect class responses to a preferred movie choice, recording data responses using spread sheets; graphing data using a column graph or other appropriate representation and interpreting results of the survey reporting findings back to the class (AC9M4ST03_E1)
		planning a statistical investigation and acquiring data from different online sources, for example using online query interfaces to select and retrieve data from an online database such as weather records, Google Trends or the World Health Organization (AC9M4ST03_E2)
		exploring different contexts in which statistical investigations can take place and the types of questions to ask in order to collect data relevant to the context, for example, investigating supermarket customer complaints that breakfast cereals with the most sugar are positioned at children's eye level, discussing what questions you would need to answer (AC9M4ST03_E3)
Probability	use experience and experiments to order chance events based on their likelihoods of occurring (AC9M4P01)	experimenting with tossing two coins at the same time, recording and commenting on the likelihood of outcomes after a number of tosses (AC9M4P01_E1)
		using lists of events familiar to students and ordering them from 'least likely' to 'most likely' to occur, considering and discussing why the order of some events might be different for different students (AC9M4P01_E2)
		recording and ordering the outcomes of experiments using random generators such as coins, dice and a variety of spinners (AC9M4P01_E3)
		predicting the likelihood, from most likely to least likely, of selecting a red ball from a bag with 10 red balls and 5 white balls, a bag with 20 of each, or one that has 25 red balls and 20 white balls, justifying their decision (AC9M4P01_E4)
		exploring Aboriginal and Torres Strait Islander Peoples' seasonal calendars, identifying relationships and order of relative likelihoods between events and how these are used to make decisions about caring for Country/Place (AC9M4P01_E5)
	explore the relationships between outcomes in games	exploring games such as tic-tac-toe or rock-paper-scissors and deciding if it makes a difference who goes first or if you can use a particular strategy to win (AC9M4P02_E1)

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	and other chance situations and identify whether the chance of one outcome occurring will or will not be affected by the occurrence of other outcome(s) (AC9M4P02)	explaining why the chance of a new baby being either a boy or a girl does not depend on the gender of the previous baby (AC9M4P02_E2)
		predicting the outcome of a coin toss after 5 heads have been flipped in a row, discussing the assumption that because so many heads came up, '*is it more likely that a tail rather than a head will come up next?*'; discussing with reasons why the assumption is correct or incorrect (AC9M4P02_E3)
		identifying school events where the chance of them taking place is affected by the chance of other events occurring, for example, given that there is a high chance of a storm on Friday, there is only a small chance that the coastal dune planting project will go ahead (AC9M4P02_E4)
		investigating Aboriginal and Torres Strait Islander children's instructive games to explore and explain probability relating to dependent and independent events (AC9M4P02_E5)

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Year 5

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 5 they:

- begin to make and use proportional comparisons of quantities
- use their increasing awareness of relationships to convert between forms of numbers, units and spatial representations
- use appropriate instruments and digital tools to construct and measure angles in degrees
- plan, conduct and report findings from statistical investigations that involve an increasing range of types of data and means for representation
- model real situations with guidance using natural numbers and operations and report on insights and conclusions they reach about the context
- further develop their stochastic reasoning when they consider relationships between events and connect long-term frequency over many trials to the probability of an event occurring
- create and use maps with coordinates
- recognise what stays the same and when changes and when shapes undergo transformations.

Achievement standard

By the end of Year 5, students use natural numbers and arithmetic operations in expressions that model financial and other practical situations. They write natural numbers as products of factors and use to identify multiples and related rules for division. Students use place value to write, rename, compare and order decimals including decimals greater than one. They compare, order and represent fractions with the same or related denominators. Students connect common percentages to their fraction and decimal equivalents and use percentages to represent, describe and compare relative size. They apply knowledge of multiplication facts and efficient strategies to multiply large numbers by one-digit and two-digit numbers and divide by single-digit numbers, interpreting any remainder in the context of the problem. Students add and subtract fractions with the same denominator. They check the reasonableness of their results using estimation and interpret their findings in relation to the situation being modelled. Students identify, extend and create patterns that involve natural numbers, fractions and decimals. They apply properties to manipulate and identify equivalent number sentences and solve numerical equations. Students use a computational thinking approach to identify and explain patterns in the factors and multiples of numbers.

They consider the accuracy required when choosing metric units to solve practical problems involving perimeter and area and convert between 12-hour and 24-

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hour time. Students use appropriate spatial terms when constructing, measuring and comparing angles in degrees. They use grid coordinates to locate and move positions and create two-dimensional nets for objects. Students use their knowledge of the properties of, and the relationships between shapes and objects to develop and use algorithms to categorise them. They identify and describe differences and similarities between a shape and the image produced when transformations are applied and any rotational symmetries.

Students plan and conduct statistical investigations that collect ordinal categorical and discrete numerical data and use dot plots and the mode, to discuss the distribution of data. They construct and interpret line graphs and identify and discuss the relationships represented. Students list the outcomes of chance events, estimate likelihoods and make comparisons between those with equally likely outcomes and those without.

Strand	Content description *Students learn to:*	Elaboration *This may involve students:*
Number	use place value understanding to interpret, write, name and rename numbers with more than two decimal places (including numbers greater than one). Compare, order, locate and represent these on a number line (AC9M5N01)	making models of one-digit, two-digit and three-digit decimals by subdividing materials or grids, and explaining the multiplicative relationship between consecutive places, for example, thousandths are ten times smaller than hundredths, writing the numbers into a place value chart to compare and order them (AC9M5N01_E1)
		renaming decimals to assist with mental computation, for example, when asked to solve 0.6 ÷ 10 they rename 6 tenths as 60 hundredths and say '*if I divide 60 hundredths by 10, I get 6 hundredths'* and writes 0.6 ÷ 10 = 0.06 (AC9M5N01_E2)
		using a number line to show decimals between consecutive numbers, for example, 2.335 between 2.33 and 2.34, that is 2.33 < 2.335 < 2.34, and justifying the placement (AC9M5N01_E3)
		ordering a set of decimals with varying numbers of decimal places and numbers greater than one, on a string line across the room (AC9M5N01_E4)
		interpreting and comparing the digits in decimal measures, for example, length or weight measures of animals or plants, for example, an echidna weighing 1.77 kg and a platypus weighing 1.708 kg (AC9M5N01_E5)
		interpreting informal plans or diagrams showing length measures as decimals, placing the numbers into a decimal place value chart to connect the digits to their value (AC9M5N01_E6)
	decompose natural numbers into products of factors and recognise multiples using	exploring factors using a number of blocks to form rectangles, listing all possible factors for each number, for example, 12 blocks can form the following rectangles, 1 x 12, 2 x 6, 3 x 4 (AC9M5N02_E1)
		exploring multiples using materials to make multiple copies of two-dimensional shapes; triangles to explore

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divisibility rules to determine if one number is divisible by another (AC9M5N02)	multiples of three, squares to explore multiples of four, pentagons to explore multiples of five, recording the multiples in a 0 – 100 chart to notice the patterns (AC9M5N02_E2)
	investigating and researching divisibility rules and explaining each rule using materials (AC9M5N02_E3)
use estimation strategies appropriate to the context (including financial contexts) when making decisions about approaches to solving problems and to check the reasonableness of solutions (AC9M5N03)	interpreting a series of contextual problems to decide whether an exact answer or an approximate calculation is appropriate; explaining their reasoning in relation to the context and the numbers involved (AC9M5N03_E1)
	exploring the effect of rounding addition, subtraction and multiplication and division calculations, rounding both numbers up, both numbers down and one number up and one number down; explaining which estimation is the best approximation and why (AC9M5N03_E2)
	considering the type of rounding that is appropriate when estimating the amount of money required, for example, rounding up or rounding down when buying one item from a store using cash, compared to rounding up the cost of every item when buying groceries to estimate the total cost and not rounding when the financial transactions are digital (AC9M5N03_E3)
	investigating the use of estimating strategies by Aboriginal and Torres Strait Islander Peoples to make decisions about steam cooking in ground ovens including catering for large groups of people and the required amounts of resources needed for cooking (AC9M5N03_E4)
apply knowledge of factors and multiples to compare and order fractions with the same and related denominators (including numbers greater than one) and represent them on number lines explaining any equivalences and the order (AC9M5N04)	exploring equivalent fractions with pattern blocks, selecting one block, or a combination of blocks to represent one whole, and making a design with shapes to equal six (or ten) wholes; recording the fractions to justify the total (AC9M5N04_E1)
	creating a fraction wall from paper tape to model and compare a range of different fractions with related denominators; using the model to play fraction wall games (AC9M5N04_E2)
	connecting a fraction wall model and a number line model of fractions to say how they are the same and how they are different, for example, explaining $\frac{1}{4}$ on a fraction wall represents the area of one-quarter of the whole whereas on the number line $\frac{1}{4}$ is identified as a point that is one-quarter of the distance between zero and one (AC9M5N04_E3)
	using an understanding of factors and multiples and equivalence to explore efficient methods for the location of

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	fractions with related denominators on parallel lines, for example, explaining on parallel number lines that $\frac{2}{8}$ is located at the same position on a parallel number line as $\frac{1}{4}$ because $\frac{1}{4}$ is equivalent to $\frac{2}{8}$ (AC9M5N04_E4)
	converting between mixed and improper fractions to assist with locating them on a number line (AC9M5N04_E5)
use percentages to describe, represent and compare relative size and recognise that 100% represents the complete whole. Connect familiar percentages to their decimal and fraction equivalents (AC9M5N05)	exploring applications of percentages used in everyday contexts, for example, the bar model used for charging devices indicating the percentage of power remaining; advertising in retail contexts relating to discounts or sales (AC9M5N05_E1)
	creating a model by subdividing a whole, for example, subdividing a sheet of newspaper into 100 parts to represent various percentage amounts, and connecting them to commonly used fractions $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{3}{4}$ and their decimal equivalents (AC9M5N05_E2)
	creating a model by subdividing a collection of materials, for example, blocks or money, into $\frac{1}{2}$ and $\frac{1}{10}$, and connecting these with decimal and percentage equivalents; one tenth of 40 is 4 so 10% of 40 is 4, one half of 40 is 20, so 50% of 40 is 20 and therefore 60% of 40 must be 24 (AC9M5N05_E3)
	investigating the relationship between decimal notation, fractions and percentages, for example, 0.1 is the same as $\frac{1}{10}$, which is the same as 10%; connecting representations to a model (AC9M5N05_E4)
solve problems involving addition and subtraction of fractions with the same denominator, investigating different strategies, including using different representations (AC9M5N06)	exploring ways of adding/subtracting fractional amounts by subdividing different models of measurement attributes, for example, adding half an hour and three quarters of an hour using a clock face, adding a $\frac{3}{4}$ cup of flour and a $\frac{1}{4}$ cup of flour, subtracting $\frac{3}{4}$ of a metre from 2 $\frac{1}{4}$ metres (AC9M5N06_E1)
	modelling and solving addition and subtraction problems involving fractions by using jumps on a number line, or making diagrams of fractions as parts of shapes (AC9M5N06_E2)
	using materials, diagrams, number lines or arrays to show and explain that fraction number sentences can be rewritten in equivalent forms without changing the quantity, for example, $\frac{1}{2}+\frac{1}{4}$ is the same as $\frac{2}{4}+\frac{1}{4}$ (AC9M5N06_E3)

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		creating bar models to represent the fractions within addition or subtraction story problems (AC9M5N06_E4)
	choose efficient strategies to represent and solve problems involving multiplication of large numbers by one-digit or two-digit numbers using basic facts, place value, properties of operations and digital tools where appropriate, explaining the reasonableness of the answer (AC9M5N07)	interpreting and solving everyday division problems such as, '*How many buses are needed if there are 436 passengers, and each bus carries 50 people?*', deciding whether to round up or down in order to accommodate the remainder (AC9M5N07_E1)
		solving division problems mentally like 72 divided by 9, 72 ÷ 9, by thinking, '*how many 9 makes 72*', ? x 9 = 72 or '*share 72 equally 9 ways'* (AC9M5N07_E2)
		investigating the use of digital technologies to solve multiplicative situations managed by First Nations Ranger Groups and other groups to care for Country/Place including population growth of native and feral animals such as comparing rabbits or cane toads with platypus or koalas, or the monitoring of water volume usage in communities (AC9M5N07_E3)
	choose efficient strategies to represent and solve division problems, using basic facts, place value, the inverse relationship between multiplication and division and digital tools where appropriate. Interpret any remainder according to the context and express results as a mixed fraction or decimal (AC9M5N08)	developing and choosing efficient strategies and using appropriate digital technologies to solve multiplicative problems involving multiplication of large numbers by one- and two-digit numbers (AC9M5N08_E1)
		solving multiplication problems such as 253 x 4 using a doubling strategy, for example, 253 + 253 = 506, 506 + 506 = 1012 (AC9M5N08_E2)
		solving multiplication problems like 15 x 16 by thinking of factors of both numbers, 15 = 3 x 5, 16 = 2 x 8; rearranging the factors to make the calculation easier, 5 x 2 = 10, 3 x 8 = 24, 10 x 24 = 240 (AC9M5N08_E3)
		using an array model to show place value partitioning to solve multiplication, such as 324 x 8, thinking 300 x 8 = 2400, 20 x 8 = 160, 4 x 8 = 32 then adding the parts, 2400 + 160 + 32 = 2592; connecting the parts of the array to a standard written algorithm (AC9M5N08_E4)
		investigating the use of digital tools to solve multiplicative situations managed by First Nations Ranger Groups and other groups to care for Country/Place including population growth of native and feral animals such as comparing rabbits or cane toads with platypus or koalas, or the monitoring of water volume usage in communities (AC9M5N08_E5)
	model situations (including financial contexts) formulating	interpreting an everyday situation to determine which operation can be used to solve it using a calculator; recording the number sentence input into a calculator and justify their choice of operation in relation to the situation

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	expressions using addition, subtraction, multiplication and/or division. Choose efficient strategies using the properties of operations and digital tools where appropriate. Justify choices and explain results in terms of the situation (AC9M5N09)	(AC9M5N09_E1)
		interpreting a series of contextual problems to decide whether an exact answer or an approximate calculation is appropriate; explaining their reasoning in relation to the context and the numbers involved (AC9M5N09_E2)
		using materials, diagrams, arrays and/or a bar models to choose which operation is required to solve a problem; formulating and writing an appropriate number sentence, and explaining how each number and operation is connected to the situation (AC9M5N09_E3)
		choosing between a mental calculation, the use of a calculator or spreadsheet (or similar) to solve a wide range of problems, for example, using a calculator or spreadsheets when the numbers are difficult, justifying their choice of operation and calculation method; reflecting on their answer in relation to the context to ensure it makes sense (AC9M5N09_E4)
		creating financial plans, for example, creating a budget for a class fundraising event (AC9M5N09_E5)
		investigating how song, story, and/or dance of Aboriginal and Torres Strait Islander Peoples can be represented through mathematical models using combinations of two or more of the four operations (AC9M5N09_E6)
Algebra	continue and create extended number sequences with fractions, decimals and natural numbers resulting from addition and subtraction using technology to assist where appropriate. Recognise and explain emerging patterns (AC9M5A01)	creating a pattern sequence with materials, writing the associated number sequence, and then describing the sequence so someone else can replicate it with different materials, for example, using matchsticks or toothpicks to create a growing pattern of triangles using three for one triangle, five for two triangles, seven for three triangles and describing the pattern as '*Start with three and add two each time'* (AC9M5A01_E1)
		investigating and continuing pattern sequences with materials such as blocks and writing the associated number sequence, for example, a staircase design could be represented with the number sequence, 1, 4, 9, …; using the number sequence to predict how many blocks are needed for the next staircase, or the eighth or tenth (AC9M5A01_E2)
		connecting halving with dividing by 2 and using this to create a pattern sequence by continuous halving, for example, starting with $24 and giving away half, then another half, and another; writing and explaining the sequence 24, 12, 6, 3, 1.50, 0.75 '*I started with $24 and halved it 5 times*' (AC9M5A01_E3)
		using the constant function on a calculator to create and record a decimal pattern, for example, '*If 0.4 m of material is required to make one cushion, how much is needed to make two, three, four or more*?'; explaining the pattern

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		and using it to say how much material is needed for six or more cushions (AC9M5A01_E4)
		investigating Aboriginal and Torres Strait Islander Peoples methods in making coil mats or baskets and how patterns are made on the coil, creating designs using combinations of fractions on the coil such as $\frac{1}{4}$ turn + $\frac{1}{4}$ turn +$\frac{1}{3}$ turn + $\frac{1}{6}$ turn = 1 full turn (AC9M5A01_E5)
	find unknown values in equivalent number sentences involving multiplication and division applying an understanding of the associative, distributive, commutative and inverse properties, using factors and multiples. Identify and use equivalent number sentences involving multiplication and division to form numerical equations (AC9M5A02)	exploring multiplicative partitioning using materials, diagrams or arrays and recording 2 multiplication and 2 division facts for each grouping; 4 x 6 = 24, 6 x 4 = 24, 24 ÷ 4 = 6 and 24 ÷ 6 = 4; explaining how each is different from and connected to groups in the materials, diagrams or arrays (AC9M5A02_E1)
		forming numerical equations using equivalent number sentences, for example, given that 3 x 5 = 15 and that 30 ÷ 2 = 15 then 3 x 5 = 30 ÷ 2 (AC9M5A02_E2)
		using materials, diagrams or arrays to explore and explain the inverse relationship between multiplication and division; using the inverse to make calculations easier, for example, solving □ x 17 = 221 using division, □ = 221 ÷ 17 (AC9M5A02_E3)
		exploring that multiplication is associative and commutative but division is not, using materials, diagrams and arrays, for example, using arrays to demonstrate that 2 x 3 = 3 x 2 but 6 ÷ 3 does not equal 3 ÷ 6; demonstrating that 2 x 2 x 3 = 12 and 2 x 3 x 2 = 12 and 3 x 2 x 2 = 12; 8 ÷ 2 ÷ 2 = (8 ÷ 2) ÷ 2 = 2 but 8 ÷ (2 ÷ 2) = 8 ÷ 1 = 8 (AC9M5A02_E4)
		using materials, diagrams or arrays to explore and explain the distributive property, for example, where 4 x 13 = 4 x 10 + 4 x 3 (AC9M5A02_E5)
		constructing equivalent number sentences involving multiplication to form a numerical equation, applying knowledge of factors, multiples and the associative property, for example, using 3 x 4 = 12 and 2 x 2 = 4 then 3 x 4 = 3 x (2 x 2) and 3 x 4 = (3 x 2) x 2 so 3 x 4 = 6 x 2 (AC9M5A02_E6)
	use algorithms and digital tools to explore factors and multiples and apply computational thinking	creating algorithms that use multiplication and division facts to determine if a number is a multiple or factor of another number (AC9M5A03_E1)
		using a calculator or other computational tool and the relationship between factors and multiples to explore numbers, making and investigating conjectures (AC9M5A03_E2)

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	to recognise, interpret and explain emerging patterns (AC9M5A03)	using the 'fill down' function of a spreadsheet and a multiplication formula to generate a sequence of numbers that represent the multiples of any number you enter into the cell; describing and explaining the emerging patterns (AC9M5A03_E3)
Measurement	recognise the relationship between the prefixes for metric units and choose to use smaller units or a combination of units to obtain a more accurate measure when measuring the length, mass and capacity of objects (AC9M5M01)	researching the metric unit names for each of the attributes, length, mass and capacity and ordering them from the largest unit to the smallest, for example, kilometre, hectometre, decametre, metre, decimetre, centimetre, millimetre; explaining the relationship between the prefix names across the units and the times ten relationship between the adjacent units (AC9M5M01_E1)
		measuring and comparing jumps or throws using a metre length of string, for example, then measuring the part metre with centimetres and/or millimetre; explaining which unit of measure is most appropriate to give the accurate measure (AC9M5M01_E2)
		deciding on the unit required to estimate the amount of paint or carpet for a room or a whole building, justifying the choice of unit in relation to the context and the degree of accuracy required (AC9M5M01_E3)
	model situations and solve practical problems involving the perimeter of common shapes and the area of rectangles using appropriate metric units (AC9M5M02)	investigating problem situations involving perimeter, for example, '*How many metres of fencing is required around a paddock, or around a festival event?*' (AC9M5M02_E1)
		using a physical or a virtual geoboard app to explore the relationship between area and perimeter and solve problems, for example, investigating what is the largest and what is the smallest area that has the same perimeter (AC9M5M02_E2)
		exploring efficient ways of calculating the perimeters of rectangles such as adding the length and width together and doubling the result (AC9M5M02_E3)
		solving measurement problems, for example, '*What area can be painted when you have one 10 L can and one 4 L can of the same paint?'* by modelling and calculating the possible dimensions of the walls and providing a range of solutions (AC9M5M02_E4)
		creating a model of a permaculture garden, dividing the area up to provide the most efficient use of space for gardens and walkways, labelling the size of each area, and calculating the amount of resources needed, for example, compost to cover the vegetable garden (AC9M5M02_E5)
		exploring the designs of fishing nets and dwellings of Aboriginal and Torres Strait Islander

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		Peoples, investigating perimeter, area and purpose of the shapes within the designs (AC9M5M02_E6)
	compare 12-hour and 24-hour time systems and solve practical problems involving the conversion between them (AC9M5M03)	using timetables written in 24-hour time, such as flight schedules, to convert between 24- and 12-hour time (AC9M5M03_E1)
		converting between digital representation of 24-hour time and analogue clock matching the same times represented in both systems (AC9M5M03_E2)
	estimate, construct, measure and compare angles in degrees, using appropriate tools (including a protractor) using conventional language to describe angles (AC9M5M04)	exploring the size of angles within shapes that do and do not tesselate, measuring the angles and using the sum of angles to explain why some shapes will tesselate and other shapes do not (AC9M5M04_E1)
		estimating the size of angles in the environment using a clinometer and describing the angles using conventional language (AC9M5M04_E2)
		constructing triangles using a rule and protractor and given the angles and side lengths (AC9M5M04_E3)
		using a protractor to measure angles using degrees, to create a pattern or string design within a circle (AC9M5M04_E4)
Space	connect and construct objects from their nets and create nets for objects using spatial and geometric reasoning (AC9M5SP01)	designing and constructing exact nets for packaging particular shaped items or collections of interest, taking into consideration how the faces will be joined and how the package will be opened (AC9M5SP01_E1)
		visualising folding some possible nets for a range of prisms and pyramids, predicating which will work and which cannot work, justifying their choices, based on the number, size and position of particular shapes in each diagram (AC9M5SP01_E2)
		sketching nets for a range of prisms and pyramids considering the number, shape and placement of the faces and test by cutting and folding (AC9M5SP01_E3)
		investigating objects designed and developed by Aboriginal and Torres Strait Islander Peoples such as those used in fish traps and instructive toys, identifying the shape and relative position of each face to determine the net of the object (AC9M5SP01_E4)
	construct a grid coordinate system that uses coordinates	understanding how the numbers on the axes on a grid coordinate system are numbers on a number line and are used to pinpoint locations (AC9M5SP02_E1)

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	to locate positions within a space. Use coordinates and directional language to describe position and movement (AC9M5SP02)	discussing the conventions of indicating a point in a grid coordinate system, for example, by writing the horizontal axis number first and the vertical axis number second, using brackets and commas (AC9M5SP02_E2)
		comparing a grid reference system to a grid coordinate system (first quadrant only) by using both to play strategy games involving location, for example, '*Battleships*', deducing that in a grid coordinate system you number the lines (starting from zero), not the spaces (AC9M5SP02_E3)
		placing a coordinate grid over a contour line drawing and listing the coordinates of each point in the picture; asking a peer to re-create the drawing using only the list of coordinates, and discussing the reasons for the potential similarities and differences between the two drawings (AC9M5SP02_E4)
	describe and perform translations, reflections and rotations of shapes, using dynamic geometric software where appropriate. Recognise and describe what changes and what remains the same under the transformation and identify any rotational symmetries (AC9M5SP03)	using pattern blocks and paper tracing around a shape and conducting a series of a one-step transformations; continuing to trace each resulting image then copying the original position and end position on a new sheet of paper (AC9M5SP03_E1)
		exploring how different combinations of transformation can produce the same resulting image (AC9M5SP03_E2)
		using dynamic geometric software construct images and use the editing function to rotate (turns of 90 degrees), reflect and translate the image recording the different transformations; experimenting with different transformations to produce the same final image identifying any symmetries (AC9M5SP03_E3)
		challenging classmates to select a combination of transformations to move from an original image to the final image, noting the different combinations using different colours to trace images (AC9M5SP03_E4)
	use computational thinking to create algorithms involving decisions to sort and classify shapes and objects. Experiment with	using an algorithm, represented as a flow chart, to sort a collection of shapes and objects into two and three-dimensional groups; recognising key features and distinctive properties of each group (AC9M5SP04_E1)
		following a sorting algorithm, separate a list of objects and shapes into two and three-dimensional groups; discussing why particular shapes and objects have been sorted into each category (AC9M5SP04_E2)

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	different shapes and objects, sorting into categories and recognising any emerging patterns (AC9M5SP04)	identifying what would be the key elements of an algorithm that sorted shapes and objects into two and three-dimensional categories; discussing and providing examples of how it might work (AC9M5SP04_E3)
Statistics	acquire, validate and represent ordinal and discrete numerical data in different ways, using software (including spreadsheets and graphs). Discuss and report on data distributions in terms of highest frequency (mode) and shape, in the context of the data (AC9M5ST01)	recognising that ordinal data is categorical and not numerical even though the data being collected might be numbers, for example, a rating scale using numbers 1 – 5 to represent the categories people can choose from when asked 'What rating would you give this film out of 5?' (AC9M5ST01_E1)
		recognising when the mode of a data set may (may not) be useful as a representative measure (AC9M5ST01_E2)
		identifying the best methods of presenting data to illustrate the results of investigations and justifying the choice of representations (AC9M5ST01_E3)
		ensuring data are correct and meaningful for the purpose of collection, for example, creating rules to determine whether data are correct when measuring height of another student measured in centimetres, within a range of 70 cm and 170 cm, stored in numerical format (AC9M5ST01_E4)
		investigating data relating to Australia's reconciliation process with Aboriginal and Torres Strait Islander Peoples, posing questions, discussing and reporting on findings (AC9M5ST01_E5)
	construct, interpret and compare data represented as line graphs, using software to construct graphs and create information where appropriate. Discuss the relationships that are represented (AC9M5ST02)	discussing the key aspects of a correct graph, including the appropriateness of the titles and labels and the selection of the scale (AC9M5ST02_E1)
		interpreting real life data represented as a line graph, for example, data about bushfires, floods, election results, to identify the likelihood of a particular event (AC9M5ST02_E2)
		matching unlabelled line graphs to the context they represent based on the story of the different contexts (AC9M5ST02_E3)
		interpreting the data represented in a line graph making inferences (AC9M5ST02_E4)
	plan and conduct statistical investigations by posing	posing questions about insect diversity in the playground, collecting data by taping a one-metre-square piece of paper to the playground and observing the type and number of insects on it over time (AC9M5ST03_E1)

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	investigative questions or identifying a problem and collecting data relevant to the question or problem using surveys and digital tools. Select and use appropriate displays or visualisations, interpret and communicate findings or solutions within the context (AC9M5ST03)	discussing if the data generated from questions provide the information necessary to answer the questions (AC9M5ST03_E2)
		developing survey questions that are objective and without opinion and have a balanced set of answer choices without bias (AC9M5ST03_E3)
		exploring First Nations Ranger Groups and other groups' biodiversity detection techniques to care for Country/Place, posing investigative questions, collecting and interpreting related data to represent and communicate findings (AC9M5ST03_E4)
Probability	list the possible outcomes of chance experiments involving equally likely outcomes and compare to those which are not equally likely (AC9M5P01)	discussing what it means for an outcome to be equally likely and comparing possible outcomes of chance events, for example, drawing a card from a normal deck of cards there are four possible outcomes if you are interested in the suit or two possible outcomes if you are interested in the colour or 52 outcomes if you are interested in the exact card (AC9M5P01_E1)
		commenting on the likelihood of winning games of chance by considering the number of possible outcomes and the consequent chance of winning in games of chance (AC9M5P01_E2)
		investigating why some games are fair and others appear not, for example, drawing up a track game to resemble a running race, taking it in turns to roll two dice, where runner 1 moves a square if the difference between the two dice is 0, 1 or 2 and runner 2 moves a square if the difference is 3, 4 or 5; responding to questions '*Is this game fair*?', '*Are some differences more likely to come up than others*?', '*How can you work that out*?' (AC9M5P01_E3)
		comparing the likelihood of a head or a tail when a coin is tossed or whether some numbers on a die are more likely to be facing up when the die is rolled or the likelihood of getting a 1, 2 or 3 on a spinner with uneven regions for the numbers (AC9M5P01_E4)
		discussing supermarket promotions such as collecting stickers or objects and whether there is an equal chance of getting each of them (AC9M5P01_E5)

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	use experiments to observe and record the outcomes of repeated trials of chance events including those with and without equally likely outcomes. Use frequency to compare outcomes and estimate their likelihoods (AC9M5P02)	discussing and listing all the possible outcomes of an activity and conducting experiments to estimate the probabilities, for example, using coloured cards in a card game and experimenting with shuffling the deck and turning over one card at a time, recording and discussing the results (AC9M5P02_E1)
		conducting experiments, recording the outcomes, and the number of times the outcomes occur, describing the relative frequency of each outcome, for example, '*I threw the coin 10 times and the results were 3 times for a head, so that is 3 out of 10, and 7 times for a tail, so that is 7 out of 10* (AC9M5P02_E2)
		experimenting with and comparing the outcomes of spinners with equal-coloured regions compared to unequal regions; responding to questions '*How does this spinner differ to one where each of the colours has an equal chance of occurring?*' with reasons (AC9M5P02_E3)
		comparing the results of experiments using a fair die and one that has numbers represented on faces more than once, experimenting how this affects the likelihood of outcomes (AC9M5P02_E4)
		using spreadsheets to record the outcomes of an activity and calculate the total frequencies of different outcomes, representing these as a fraction, for example, using coloured balls in a bag, drawing one out at a time and recording the colour then replacing them in the bag (AC9M5P02_E5)
		investigating Aboriginal and Torres Strait Islander children's instructive games, for example, *Diyari koolchee* from the Diyari Peoples near Lake Eyre in South Australia, to conduct repeated trials and explore predictable patterns using digital tools where appropriate (AC9M5P02_E6)

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Year 6

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 6 they:

- expand the repertoire of numbers they work with to include understanding and using integers in practical contexts and when they use the four quadrant Cartesian plane for graphing
- extend their knowledge of factors and multiples to understand the properties of prime and composite numbers
- use all four arithmetic operations with natural numbers of any size
- develop a repertoire of written and digital means for representing objects and three-dimensional spaces in two-dimensions
- begin to formally use deductive reasoning in spatial contexts involving lines and angles
- describe and compare probabilities numerically
- include spread and measure(s) of centre in their reports of findings from their statistical investigations
- develop and use computational approaches to develop algorithms that determine probabilities from long-run frequencies in simulations of random events.

Achievement standard

By the end of Year 6, students use integers in practical situations and to represent points on a number line and in the Cartesian plane. They use their knowledge of the properties of prime and composite numbers to solve problems and simplify calculations. Students connect fractions, decimals and percentages as different representations of the same rational number and order common fractions giving reasons. They use different representations of rational numbers when solving problems. Students apply knowledge of place value, multiplication and addition facts to operate with decimals. They use equivalence to solve problems involving the addition and subtraction of fractions with related denominators. Students use estimation and substitution strategies when appropriate to find approximate solutions to problems involving rational numbers and percentages. They model situations, including financial contexts, using number sentences that involve all four operations and the use of brackets with natural numbers and interpret them in context. Student use equivalent number sentences to find unknown values. They identify patterns of the same form in different contexts and distinguish between patterns growing additively and multiplicatively. Students identify and explain rules used to create and continue number sequences and apply computational thinking to identify and explain patterns.

They interpret and use timetables in practical applications. Students connect decimal representations to the metric system and convert between common units

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of length mass and capacity. They use the formula of a rectangle and the properties of angles formed when two lines intersect in the plane to solve practical problems. Students connect prisms to their parallel cross sections and use computational thinking to conjecture about the effects of combinations of transformations, creating tessellating patterns.

They compare, analyse and report on the variation between data sets collected and represented as part of their statistical investigations and explain their choice of representation(s) in terms of context and purpose. Students critique arguments presented in the media based on statistics. They describe probabilities using familiar fractions, decimals and percentages. They apply computational thinking to conduct simulations that generate and record the outcomes from many trials of a chance experiment. Students use observed frequencies to determine the expected probabilities of the outcomes of chance events.

Strand	Content description *Students learn to:*	Elaboration *This may involve students:*
Number	recognise everyday situations that use integers (including financial contexts). Locate and represent these numbers on a number line and as coordinates on the Cartesian plane (AC9M6N01)	extending the number line in the negative direction to locate and represent integers recognising the difference in location between -2 and +2 and their relationship to zero as -2< 0< 2 (AC9M6N01_E1)
		using integers to represent quantities, exploring financial situations including the concept of profit and loss for an event (AC9M6N01_E2)
		using horizontal and vertical number lines to explore the solutions of everyday problems, locating and ordering integers around zero, for example, elevators, above and below sea level, distinguishing location by referencing to the four quadrants of the cartesian plane (AC9M6N01_E3)
		recognising that the sign indicates a direction in relation to zero such as 30 metres left of the admin block is -30 and 20 metres right of the admin block is +20 or programming robots to move along a number line which is either horizontal or vertical but not both at the same time (AC9M6N01_E4)
		exploring the temperatures of the different planets in the solar system, using a thermometer that models a vertical number line (AC9M6N01_E5)
		exploring boundaries on-Country/Place including the boundary between saltwater and freshwater, dry and wet seasons, hot and cold country, identifying ‘0’ as the boundary line and connecting this to positive and negative integers on a number line (AC9M6N01_E6)

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	identify and describe the properties of prime and composite numbers and use to solve problems and simplify calculations (AC9M6N02)	understanding that a prime number has two unique factors of one and itself and hence 1 is not a prime number (AC9M6N02_E1)
		testing numbers by using division to distinguish between prime and composite numbers, recording the results on a number chart to identify any patterns (AC9M6N02_E2)
		representing composite numbers as a product of their factors including prime factors when necessary and using this form to simplify calculations involving multiplication such as 15 x 16 as 5 x 3 x 4 x 4 which can be rearranged to simplify calculation to 5 x 4 x 3 x 4 = 20 x 12 (AC9M6N02_E3)
		using spread sheets to list all of the numbers that have up to three factors using combinations of only the first three prime numbers, recognise any emerging patterns, making conjectures and experimenting with other combinations (AC9M6N02_E4)
		understanding that if a number is divisible by a composite number then it is also divisible by the prime factors of that number, for example, 216 is divisible by 8 because the number represented by the last three digits is divisible by 8, and hence 216 is also divisible by 2 and 4, using this to generate algorithms to explore (AC9M6N02_E5)
	use estimation strategies appropriate to the context (including financial contexts) to approximate numerical solutions to problems involving rational numbers and percentages, including substituting easier values into calculations to obtain an approximate solution (AC9M6N03)	using familiar fractions, decimals and percentage to approximate calculations such as 0.3 of 18 is about $\frac{1}{3}$ of 18 or 52% is about a half (AC9M6N03_E1)
		choosing appropriate estimation strategies including rounding to the nearest whole number, multiples of 2, 5 or 10 or partitioning numbers in contexts such as measuring or cost per unit (AC9M6N03_E2)
		exploring the effect of rounding on calculations involving fractions or decimals and saying what the answer will be between (AC9M6N03_E3)
		recognising the usefulness of estimation to check calculations for contexts such as dividing wood into a number of lengths, cost per unit, reducing a recipe, dividing cost of dinner for a group (AC9M6N03_E4)
		verifying solutions by estimating percentages in suitable contexts such as discounts and Goods and Services Tax (GST), using common percentages of 10%, 25%, 50% and 1% (AC9M6N03_E5)

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	investigating estimating strategies to make decisions about steam cooking in ground ovens including catering for different numbers of people, and resources needed for cooking, by Aboriginal and Torres Strait Islander Peoples (AC9M6N03_E6)
apply knowledge of equivalence to compare, order, locate and represent common unit fractions and their multiples (including halves, thirds and quarters) on the same number line and justify their order (AC9M6N04)	applying factors and multiples to fraction denominators such as halves with quarters, eighths and twelfths and thirds with sixths, ninths and twelfths to determine equivalent representations of fractions in order to make comparisons (AC9M6N04_E1)
	representing fractions on the same number line, paying attention to relative position, and using this to explain relationships between denominators (AC9M6N04_E2)
	explaining equivalence and order between fractions using number lines, drawings and models (AC9M6N04_E3)
	comparing and ordering fractions by placing cards on a string line across the room referring to benchmark fractions to justify their position, for example, $\frac{5}{8}$ is bigger than $\frac{1}{2}$, that is $\frac{5}{8} > \frac{1}{2}$, because half of eight is four, $\frac{1}{8}$ is smaller than $\frac{1}{6}$, that is $\frac{1}{8} < \frac{1}{6}$, as it is closer to zero, because eighths are smaller than sixths (AC9M6N04_E4)
connect and use equivalent forms of rational numbers to solve problems that require finding a familiar fraction or percentage of a quantity (including percentage discounts of 10%, 25% and 50%). Choose efficient strategies using digital tools where appropriate (AC9M6N05)	exploring and explaining how $\frac{1}{3}$ of a quantity can be achieved by dividing by 3 using situations involving money, length, mass or capacity (AC9M6N05_E1)
	exploring and explaining how knowledge of $\frac{1}{3}$ of a quantity can be used to find $\frac{2}{3}$ or $\frac{4}{3}$ of the same quantity using situations involving money, length, mass or capacity (AC9M6N05_E2)
	investigating percentage discounts of 25% and 50% in a sale, using their equivalent representations of $\frac{1}{4}$ and $\frac{1}{2}$ to calculate the amount of discount on sale items, with and without digital tools (AC9M6N05_E3)
	explaining the equivalence between percentages such as 10%, 25%, 50% and 75% with familiar fractions, for example, $\frac{1}{4}$, is equivalent to $\frac{25}{100}$ and is equivalent to 25% (AC9M6N05_E4)

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		explaining the equivalence between percentages, for example, 33 $\frac{1}{3}$ % and $\frac{1}{3}$; keeping to percentages such as 66 $\frac{2}{3}$ % and 12.5% (AC9M6N05_E5)
		modelling the situations (including financial contexts) using either manipulatives, diagrams and/or mathematical discussion (AC9M6N05_E6)
		representing a situation with a mathematical expression, for example, numbers and symbols such as $\frac{1}{4}$ x 24, that involve finding a familiar fraction or percentage of a quantity; using mental strategies or a calculator and explaining the result in terms of the situation in question (AC9M6N05_E7)
	solve problems involving addition and subtraction of fractions with the related denominators using knowledge of equivalent fractions (AC9M6N06)	modelling addition and subtraction of fractions, using the understanding of equivalent fractions and methods such as jumps on a number line, or diagrams of fractions as parts of shapes (AC9M6N06_E1)
		using an understanding of prime and composite numbers to explore efficient methods for determining the lowest common denominator for fractions with related denominators (AC9M6N06_E2)
		calculating the addition or subtraction of fractions within the context of realistic problems, for example, using part cups or spoons in a recipe; using the understanding of equivalent fractions (AC9M6N06_E3)
		understanding the processes for adding and subtracting fractions with related denominators and fractions as an operator, in preparation for calculating with all fractions, for example, using fraction overlays and array models to give meaning to adding and subtracting fractions with related and unrelated denominators (AC9M6N06_E4)
		investigating the adding and subtracting of fractions in the use of fractional turns to create patterns in the weaving of Aboriginal and Torres Strait Islander Peoples (AC9M6N06_E5)
	apply knowledge of place value to add and subtract decimals, using digital tools where appropriate, and use estimation and rounding to check the reasonableness of answers (AC9M6N07)	applying whole-number strategies, for example, using basic facts, place value, partitioning and the inverse relationship between addition and subtraction, and properties of operations to explore meaningful mental strategies for addition and subtraction of decimal numbers to at least thousandths (AC9M6N07_E1)
		representing measurements in larger units such as mm to metres, mL to litres or grams to kilograms, for example, the difference in weight between a platypus weighing 1.77 kilograms and another weighing 1.708 kilograms (AC9M6N07_E2)

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		applying and explaining estimation strategies to addition and subtraction of decimals to at least thousandths before calculating answers or when situation requires just an estimation (AC9M6N07_E3)
		deciding to use a calculator in situations that explore additive (addition and subtraction) properties of decimals beyond thousandths, for example, 1.0 - 0.0035 or 2.3456 + 1.4999 (AC9M6N07_E4)
	apply knowledge of place value and multiplication facts to multiply and divide decimals by natural numbers using efficient strategies and appropriate digital tools. Use estimation and rounding to check the reasonableness of answers (AC9M6N08)	applying place value knowledge such as the value of numbers is 10 times smaller each time a place is moved to the right, and known multiplication facts, to multiply and divide a natural number by a decimal of at least tenths (AC9M6N08_E1)
		applying and explaining estimation strategies to multiplicative (multiplication and division) situations involving a natural number that is multiplied or divided by a decimal to at least tenths before calculating answers or when the situation requires just an estimation (AC9M6N08_E2)
		deciding to use a calculator in situations that explore multiplication and division of natural numbers being multiplied or divided by a decimal including beyond hundredths (AC9M6N08_E3)
		explaining the effect of multiplying or dividing a decimal by 10, 100, 1000… in terms of place value and not the decimal point shifting (AC9M6N08_E4)
	model situations (including financial contexts) by identifying and describing a mathematical problem and formulating expressions using combinations of all four operations and brackets as appropriate. Choose efficient strategies, using digital tools where	modelling a situation by identifying a problem, formulating a mathematical expression, then using either manipulatives, diagrams and/or mathematical discussion; explaining how and why the mathematical expression represents the situation (AC9M6N09_E1)
		calculating using efficient strategies such as mental calculations, spread sheets or similar, calculators or a variety of informal jottings; explaining the results in terms of the situation (AC9M6N09_E2)
		exploring earning money and budgeting, asking questions such as 'C*an I afford it*?', '*do I need it*?', '*how much do I need to save for it*?', and developing a savings plan or budget for an event or personal purchase (AC9M6N09_E3)

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	appropriate. Justify choices and explain results in terms of the situation (AC9M6N09)	creating a budget for a class excursion or family holiday, using the internet to research costs and expenses and representing the budget in a spreadsheet, creating and using formulas to calculate totals (AC9M6N09_E4)
Algebra	continue and create extended number sequences involving natural numbers, fractions and decimals, using digital tools to assist where appropriate. Describe the rule used to create the sequence and explain emerging patterns (AC9M6A01)	identifying and generalising growing number patterns formed by adding rational numbers (AC9M6A01_E1)
		using function machines to create number sequences using decimals and different operations identifying and exploring emerging patterns (AC9M6A01_E2)
		creating an extended number sequence that represents an additive pattern using decimals, for example, representing the additive pattern formed as students pay their $2.50 for an incursion as 2.50, 5.00, 7.50, 10.00, 12.50, 15.00, 17.50, … (AC9M6A01_E3)
		investigating additive and multiplicative patterns such as the number of tiles in a geometric pattern, or the number of dots or other shapes in successive repeats of a strip or border pattern looking for patterns in the way the numbers increase/decrease (AC9M6A01_E4)
	recognise and distinguish between patterns growing additively and multiplicatively and connect patterns in one context to a pattern of the same form in another context (AC9M6A02)	investigating additive and multiplicative patterns such as the number of tiles in a geometric pattern, or the number of dots or other shapes in successive repeats of a strip or border pattern; looking for patterns in the way the numbers increase/decrease (AC9M6A02_E1)
		using a calculator or spreadsheet to explore number patterns that result from multiplying or dividing, for example, 1 ÷ 9, 2 ÷ 9, 3 ÷ 9…, 210 x 11, 211 x 211, 212 x 11…, 111 x 11, 222 x 11, 333 x 11…, 100 ÷ 99, 101 ÷ 99, 102 ÷ 99… (AC9M6A02_E2)
		investigating the number of regions created by successive folds of a sheet of paper, one-fold – two regions, two folds – four regions, three folds – six regions and describing the pattern using everyday language (AC9M6A02_E3)
		investigating patterns on-Country/Place and describing their sequence using a rule to continue the sequence such as Fibonacci patterns in shells and in flowers (AC9M6A02_E4)

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		identifying growing patterns on-Country/Place, recognising the same pattern in other representations such as branching in trees with river systems and the artworks of Aboriginal and Torres Strait Islander Peoples (AC9M6A02_E5)
	explore the use of brackets and order of operations to write number sentences. Construct equivalent number sentences involving brackets and combinations of the four operations and use the properties of numbers and operations to determine unknown values (AC9M6A03)	exploring the use of brackets and order of operations to write number sentences appreciating the need for rules to complete multiple operations within the same number sentence (AC9M6A03_E1)
		constructing equivalent number sentences involving brackets and combinations of the four operations (AC9M6A03_E2)
		solving two numbers sentences to show that they are true, for example, list possible combinations of whole numbers that makes this statement true 6 + 4 x 8 = 6 x ? + ? (AC9M6A03_E3)
		applying knowledge of inverse operations and number properties to create equivalent number sentences; removing one of the numbers and replacing with a symbol, swapping with a classmate to find the unknown values (AC9M6A03_E4)
	use function machines and rules to generate sets of numbers and apply computational thinking to recognise, interpret and explain emerging patterns (AC9M6A04)	using function machines, to explore the concept of input and output to model operations, describing and explaining relationships and emerging patterns (AC9M6A04_E1)
		playing 'W*hat does the function machine do?*' guessing games given different sets of inputs and corresponding outputs from different situations (AC9M6A04_E2)
		using function machines to explore and compare additive and multiplicative relationships, generating a sequence of numbers and comparing how quickly they are growing in comparison to each other, for example, using the rule adding two to the inputted number compared to multiplying the inputted number by two (AC9M6A04_E3)

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Measurement	convert between common metric units of length, mass and capacity and other standard units of measurement relevant to the context of a problem. Use and convert decimal representations of metric measurements where appropriate (AC9M6M01)	recognising the significance of the prefixes in units of measurement (AC9M6M01_E1)
		identifying and using the correct operations when converting units including millimetres, centimetres, metres, kilometres, milligrams, grams, kilograms, tonnes, millilitres, litres, kilolitres and megalitres (AC9M6M01_E2)
		recognising the equivalence of measurements such as 1.25 metres and 125 centimetres (AC9M6M01_E3)
	establish the formula for the area of a rectangle and use to solve practical problems (AC9M6M02)	solving problems involving the comparison of lengths and areas using appropriate units (AC9M6M02_E1)
		investigating the relationship between the area of a parallelogram and the area of a rectangle by rearranging a parallelogram to form a rectangle of the same area and explaining why all parallelograms on the same base and of the same height will have the same area (AC9M6M02_E2)
		investigating the connection between perimeter and area for fixed area or fixed perimeter, for example, in situations involving determining the maximum area enclosed by a specific length of fencing or the minimum amount of fencing required to enclose a specific area (AC9M6M02_E3)
	interpret and use timetables and itineraries to plan activities and determine the duration of events and journeys (AC9M6M03)	planning a trip involving one or more modes of public transport (AC9M6M03_E1)
		developing a timetable of daily activities for a planned event, for example, a sports carnival (AC9M6M03_E2)
		investigating different way duration is represented in timetables and use different timetables to plan a journey (AC9M6M03_E3)
	recognise the relationships between angles on a straight line, angles at a point and vertically opposite angles. Use the results to find unknown	using protractors or dynamic geometry software to measure and generalise about the size of angles formed when lines are crossed, combinations of angles meet at a point, including combinations that form right or straight angles (AC9M6M04_E1)
		demonstrating the meaning of language associated with properties of angles including, right, complementary, complement, straight, supplement, vertically opposite, angles at a point (AC9M6M04_E2)

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	angles and solve practical problems communicating reasoning (AC9M6M04)	using the properties of supplementary and complementary angles to represent spatial situations with number sentences and solve to find the size of unknown angles (AC9M6M04_E3)
Space	compare the parallel cross sections of objects and recognise their relationship to prisms (AC9M6SP01)	using objects made of foam or polystyrene, slice along different cross sections and record the different shapes (faces) that result; comparing cross sections of different objects (AC9M6SP01_E1)
		using different pieces of fruit, slicing across different cross sections, drawing the cross section; reporting back to the class the results of the investigation (AC9M6SP01_E2)
		observing and drawing the shapes resulting from different ways of slicing through familiar objects, such as when slicing carrots at different angles or cutting through play-dough models of objects (AC9M6SP01_E3)
		using play dough models, fruit or similar to establish which objects can be cut in such a way that the cross section will always be the same shape (AC9M6SP01_E4)
		understanding that prisms are objects where parallel cross sections are the same shape and size (AC9M6SP01_E5)
		connecting different prisms to the shape of their parallel cross section such as a triangular prism which can be described as a stack of the same sized triangles, and a cube or square prism as a stack of the same sized squares (AC9M6SP01_E6)
		investigating the design of Aboriginal and Torres Strait Islander Peoples' dwellings, exploring the relationship between the cross sections and the dwelling's construction (AC9M6SP01_E7)
	use the four quadrants of a Cartesian coordinate system to locate points in the plane. Investigate and describe changes to the coordinates when a point is moved to a different position in the	understanding that the Cartesian plane provides a graphical or visual way of describing location with respect to a fixed origin (AC9M6SP02_E1)
		understanding that the axes are number lines that can have different scales, including fractions and decimals, depending on purpose (AC9M6SP02_E2)
		understanding that the horizontal coordinate is written first and is changed if there is a move to the left or right whereas a move up or down will change the vertical coordinate (AC9M6SP02_E3)

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	plane (AC9M6SP02)	using the Cartesian plane to draw lines and polygons listing co-ordinates in the correct order to complete a polygon (AC9M6SP02_E4)
		exploring the meaning of the four-quadrant coordinate plane by interpreting and creating four-quadrant graphs, using qualitative comparisons instead of values on the axes, for example, taste and healthy choices of food and which are distinguished using left or right, up or down (AC9M6SP02_E5)
		investigating and connecting land or star maps used by Aboriginal and Torres Strait Islander Peoples with the Cartesian plane through a graphical or visual way of describing location (AC9M6SP02_E6)
	recognise and use combinations of transformations to create tessellations and other geometric patterns using dynamic geometric software where appropriate (AC9M6SP03)	understanding that translations, rotations and reflections can change the position and orientation but not the shape or size (AC9M6SP03_E1)
		using digital tools to create tessellations of shapes, including paver and tiling patterns (AC9M6SP03_E2)
		designing a school or brand logo using transformation of one or more shapes (AC9M6SP03_E3)
		identifying shapes or combinations of shapes that will or will not tessellate, answering questions, such as '*Do all triangles tessellate?'* (AC9M6SP03_E4)
		investigating symmetry, transformation and tessellation in different shapes on-Country/Place including rock formations, insects and land and sea animals, discussing the purpose or role symmetry plays in their survival (AC9M6SP03_E5)
	use computational thinking and reasoning to make conjectures about and experiment with transformations of shapes within the plane (AC9M6SP04)	using dynamic geometric software to investigate whether the order of transformations produces different results (AC9M6SP04_E1)
		designing a set of instructions to transform a shape, including getting back to where you started from (AC9M6SP04_E2)
		exploring the effect of a robot moving around the plane using coordinates for movements such as two down, three to the right and combinations of these to transform shapes (AC9M6SP04_E3)
		experimenting with transformations and their application to fractals using dynamic geometric software and digital tools (AC9M6SP04_E4)

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		highlighting properties that may or may not be conserved (orientation, dimensions or shape) when shapes undergo combinations of transformations (AC9M6SP04_E5)
Statistics	interpret and compare a range of displays or visualisations (including side-by-side column graphs) for two categorical variables (AC9M6ST01)	understanding that data can be represented in different ways, sometimes with one symbol representing more than one piece of data, and that it is important to read all information about a representation before making judgements (AC9M6ST01_E1)
		comparing different student-generated diagrams, tables and graphs, describing their similarities and differences and commenting on the usefulness of each representation for interpreting the data (AC9M6ST01_E2)
		using technology to access data sets and graphing software to construct side-by-side column graphs or bar charts, comparing data sets that are grouped by gender, year level, age group or other category and discussing findings (AC9M6ST01_E3)
	identify statistically informed arguments presented in traditional and digital media, discuss and critique methods, data representations and conclusions (AC9M6ST02)	investigating data representations in the media and discussing what they illustrate and the messages the people who created them might want to convey (AC9M6ST02_E1)
		evaluating reports and secondary data relating to the distribution and use of nonrenewable resources around the world (AC9M6ST02_E2)
		identifying potentially misleading data representations in the media, for example, graphs with broken axes or non-linear scales; graphics not drawn to scale; data not related to the population about which the claims are made; pie charts in which the whole pie does not represent the entire population about which the claims are made (AC9M6ST02_E3)
		investigating both traditional and digital media relating to Aboriginal and Torres Strait Islander Peoples, identifying and critiquing statistically informed arguments (AC9M6ST02_E4)
	plan and conduct statistical investigations by posing and refining investigative questions, collecting and recording sample sets of categorical or discrete	selecting and using appropriate peripherals, for example using a scientific probe to collect data about changing soil moisture for plants, interpreting the data and sharing the results as a digital chart (AC9M6ST03_E1)
		using a spreadsheet to record and analyse data, recognising the difference between cell formats in spreadsheets, for example, changing the default general format to numerical, text and date as needed (AC9M6ST03_E2)

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	numerical data using digital tools (including spreadsheets). Interpret and analyse the data and communicate findings within the context (AC9M6ST03)	conducting an investigation into the daily water usage by a student in the home compared to the World Health Organisation (WHO) claim of 50 litres of clean water allocated per person per day (AC9M6ST03_E3)
		conducting an investigation involving the collections of samples sets of 'discrete numerical data', for example, number of cars or pets in a household, where the class is surveyed then other classes surveyed and data is analysed and compared, discussing findings (AC9M6ST03_E4)
Probability	recognise that probabilities lie on numerical scales (0 – 1, 0% – 100%) and use observation and experience to assign probabilities that events occur in a given context, using fractions, percentages and decimals to indicate their estimated likelihood (AC9M6P01)	recognising that the probability of an event occurring can be determined numerically by dividing the number of times an event could happen (the outcome of interest) by the total number of possible outcomes (AC9M6P01_E1)
		investigating the probabilities of all outcomes for a chance experiment and verifying that their sum equals 1 (AC9M6P01_E2)
		exploring the different outcomes for rolling a die and using a scale to locate the relative probability by considering the chance of more or less than for each outcome, for example, the probability of getting a number greater than 4 (AC9M6P01_E3)
		systematically recording the outcome of large numbers spins on a spinner and analysing the relative frequencies of outcomes, representing these as percentages (AC9M6P01_E4)
		exploring the language of situations involving uncertainty such as what it means to be lucky, a 70 % chance of rain or a 1-in-100 years flood (AC9M6P01_E5)
		exploring Aboriginal and Torres Strait Islander children's instructive games, such as *Weme* from the Warlpiri Peoples of central Australia, to investigate and assign probabilities that events will occur, indicating their estimated likelihood (AC9M6P01_E6)
	conduct repeated chance experiments and run simulations with a large number	using digital tools to simulate multiple tosses of a coin or dice and comparing the relative frequency of an outcome as the number of trials increases; identifying the variation between trials and realising that the results tend to the prediction with a larger numbers of trials (AC9M6P02_E1)

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	of trials using digital tools. Use computational thinking to compare observed frequencies across experiments with expected frequencies and explain emerging patterns (AC9M6P02)	using online simulations of repeated random events to explore emerging patterns, discussing and comparing expected results to the actual results (AC9M6P02_E2)

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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:

- 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
- 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
- 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
- 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
- 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
- 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
- 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

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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 *Students learn to:*	Elaboration *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	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,

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	numbers (AC9M7N02)	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 positive and negative fractions, decimals and mixed numbers on a number line (AC9M7N05)	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)
		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)

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	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 using two-digit numbers (AC9M7N06_E7)

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	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 π 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 π 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)

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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.

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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 *Students learn to:*	Elaboration *This may involve students:*
Number	recognise and investigate irrational numbers in applied contexts including certain square roots and π (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 π 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 π 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 $0.\overline{3}$ (AC9M8N03_E2)
		investigating the use of pronumerals to represent recurring decimals as their equivalent fractions, for example, let $x = 0.\overline{7}$ then x = 0.77777… and $10x$ = 7.77777… therefore $10x - x = 7$ and $9x = 7$ 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)

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Year 9

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 9 they: • 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 • 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 • 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 • 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 • formulate and solve related equations exactly or approximately using a combination of numerical, graphical, and algebraic approaches • 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 • 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 • 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.

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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 *Students learn to:*	Elaboration *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 π as an exact real number, for example, the circumference of a circle with diameter 5 units is 5π 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)

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Year 10

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 10 they:

- 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
- 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
- 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
- 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
- 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
- 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.

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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 *Students learn to:*	Elaboration *This may involve students:*
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)

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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
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. Surds provide exact values for certain arguments of circular (trigonometric) functions 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 $\sqrt{96} = 96^{\frac{1}{2}}$, $(\sqrt{5})^2 = (5^{\frac{1}{2}})^2$ $= 5^1$ $= 5$, $(\sqrt[3]{8})^2 = (8)^{\frac{2}{3}}$ $= \sqrt[3]{8^2}$	recognise the connection between algebraic and graphical representations of exponential relations and solve simple related exponential equations using digital tools as appropriate (AC9M10A05) 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)	

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$= 4,$

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

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

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

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

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

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

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

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		$= \frac{16 + 6\sqrt{7}}{2}$ $= 8 + 3\sqrt{7}$		
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) 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 solving equations of the form $\sin(x) = \frac{1}{\sqrt{2}}$ and $\cos(x) = -0.73$ over a specified interval graphically graphing over different domains including negative values	and angles of elevation and depression (AC9M10M05) 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. 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 $5000 \times (1.01)^x = 9000$ solving exponential equations algebraically, using base 10 logarithms 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) interpret and use logarithmic scales to model phenomena involving small and large quantities and change (AC9M10M02) 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 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. Fluency with working with these forms in numerical and algebraic contexts is a useful attribute for students on this pathway The basic relation of interest is what happens to arrangements when there are sub-sets of identical elements. 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 $\frac{n!}{p!q!r!}$ Once this is understood, then both the permutations ^{n}Pr and the combinations ^{n}Cr formulas are special cases.

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