Mathematics

Years 9 -12

Samoa Secondary School Curriculum

Curriculum Design and Materials Division
Ministry of Education, Sports and Culture
Apia 2022

Mathematics. Years 9 - 10
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This curriculum statement was recently externally reviewed, re-aligned, re-written, and re-compiled since February 23, 2022 by Afamasaga Dr Karoline Afamasaga-Fuata'i, using the curriculum statement originally developed by the 2014-2015 Mathematics Committee and later continued by the 2018-2019 Mathematics Committee under the technical supervision of Afamasaga while she was CEO MESC from 2016 up to February 21, 2022. During the intervening period, with the ongoing assistance of Namulaulu Tanielu Viali (MESC) from 2018 up to August 2021, continued further by Toefuataina Schmidt (MESC) since October 2021, the curriculum development and alignment continued intermittently for the Seven Strands to be organized into the Three Tiers Format.

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Content

Foreword

The 2022 Four Year Secondary Level (4YSL) Mathematic Curriculum Statement replaces the old Five Year Mathematics Curriculum. The previous five-year mathematics curriculum has been reorganized by strands to ensure there is an incremental and smooth progression of the development of students' understanding of concepts based on critical thinking and analyses of various worked examples and real life contexts and applications so that students are empowered to use and apply their knowledge and relevant skills to solve a variety of similar and novel problems.

The Government of Samoa has shifted its focus to prioritise TVET subjects hence the re-design of the original 5-year mathematics to two streams, namely, **Mathematics** and **General Mathematics**. The former (Mathematics) remains much the same as before but with the same topics reorganized to ensure an incremental progression over a 4-year period from Year 9 to the new Year 12. The new General Mathematics, in comparison, prepares students for a TVET career pathway such as nursing, primary teaching, welding, plumbing, carpentry, cookery, tourism and hospitality, and other non-science career pathways, with a selection of topics to promote numeracy, graph literacy, financial literacy, statistical literacy, and authentic every day applications of mathematics knowledge and skills which are critical to assure a skilled work force to contribute to Samoa's sustainable infra-structure development into the future.

Introduction

Mathematics is a coherent, consistent, and growing body of concepts, which makes use of specific language and skills to model, analyse, and interpret the world. Mathematics provides a means of communication, which is powerful, concise, and unambiguous. In addition to its practical applications, the study of Mathematics is a valuable pursuit in its own right, providing opportunities for originality, challenge and leisure.

As a human endeavour, mathematics involves creativity and imagination in the discovery of patterns of shape and number, the perceiving of relationships, the making of models, the interpretation of data, and the communication of emerging ideas and concepts. Numeracy (or mathematical literacy) skills, is the ability to effectively use mathematics in everyday situations. It is essential for all Samoan citizens in order to meet the general demands of life at home and at work, and for participation in community, cultural and public life. Mathematics education therefore aims to contribute to the development of the broad range of numeracy skills.

Mathematical understanding and skills contribute to people's sense of self-worth and ability to control aspects of their lives. Students need to have a thorough understanding of Mathematics in order to find solutions to real life problems. Everyone needs to develop mathematical concepts and skills to help them understand and play a responsible role in our democratic society. By linking new mathematical concepts to their daily experiences and existing cultural knowledge, students integrate their knowledge, skills and understanding so that they can use Mathematics in familiar and interesting contexts in their own lives. Mathematics education aims to provide students with those skills and understandings.

The cross-curriculum content addresses issues, perspectives and policies that will assist students to achieve the broad learning outcomes as encapsulated in Samoa's National Curriculum Framework. For these reasons, it is important that we use Mathematics in schools and colleges to produce a numerate or mathematically literate population. The ability to make informed decisions, and to interpret and apply mathematics in a variety of authentic contexts is an essential component of students' preparation for life in the twenty-first century. Students, to participate fully in society, need to develop the capacity to critically analyse and evaluate ideas and arguments that involve mathematical concepts or that are presented in mathematical form.

Mathematics is a reasoning and creative activity employing abstraction and generalisation to identify, describe and apply patterns and relationships. Mathematical ideas have evolved over centuries and across all cultures and they continue to expand. The symbolic nature of Mathematics enables a powerful, precise and concise means of communication.

This new 2022 Samoan Secondary Mathematics Curriculum Statement, for both Mathematics and General Mathematics, focuses on developing the Working Mathematically processes of Interpreting & Posing questions, Strategically Thinking & Representing, Reasoning & Justifying, Reflecting & Evaluating, and Communicating Mathematically. It is a powerful tool for solving familiar and unfamiliar problems both within and beyond Mathematics and in relation to authentic contexts. As such, Mathematics consists of multiple but interrelated and interdependent concepts and systems that students can apply in other subject areas and to realistic situations.

In an increasingly technological age, the need for innovation, and problem-solving and decision-making skills, has been stressed in many reports on the necessary outcomes for education in Samoa. Mathematics education provides the opportunity for students to develop these skills, and encourages them to become innovative and flexible problem solvers.

The ability to communicate findings and explanations, and the ability to work satisfactorily in team projects, have also been highlighted as important outcomes for education. Mathemat-

ics education provides many opportunities for students to develop communication skills and to participate in collaborative problem-solving situations, thereby contributing to the development of many social and co-operative skills.

Increasingly, information is communicated through the use of data graphics. The communication of information through graphics is particularly common in the mass media. It is important that people can draw sensible conclusions from charts, tables, and graphs of various kinds. At the same time, increasing numbers of occupations demand the ability to collect data, to understand and to use information technology for the organisation and interpretation of data, and to present analytical reports and summaries. Mathematics education gives young people the opportunity to develop the critical information skills through learning and practising data handling and data interpretation.

General Aims

Mathematics education aims to develop students' thinking, understanding, competence, and confidence in the application of mathematics, their creativity, enjoyment and appreciation of the subject, and their engagement in lifelong learning. More specifically, mathematics education aims to provide opportunities for students to:

- develop a belief in the value of mathematics and its usefulness to them, to nurture confidence in their own mathematical ability, to foster a sense of personal achievement, and to encourage a continuing and creative interest in mathematics;
- develop skills, concepts, understandings, and attitudes which will enable them to cope confidently with the mathematics of everyday life;
- develop a variety of approaches to solving problems involving mathematics, and to develop the ability to think and reason logically;
- achieve the mathematical and statistical literacy needed in a society which is technologically oriented and information rich;
- develop their mathematical tools, skills, understandings, and attitudes they will require in the world of work;
- develop concurrent learning in other learning areas where mathematical concepts are central;
- build a sound foundation for further studies in mathematics; and
- foster and develop mathematical talent.

Development of Essential Skills through Mathematics

Essential skills are the broader skills that are developed throughout the years of schooling as a result of the quality of the experiences provided in all classroom and school activities and are used by students in all school activities as well as in their social and cultural world outside the school.

The key outcome of mathematics education is the development of the ability to apply certain essential skills - communication skills; numeracy skills; information skills; problem-solving skills; social and co-operative skills; and work and study skills. The mathematical processes identified in this curriculum statement are the expression of these essential skills in mathematical contexts. This curriculum statement, therefore, suggests approaches to teaching, learning, and assessment, which will give students the maximum possible opportunity to develop the essential skills for Working Mathematically.

Communicating effectively

Communication underpins all learning and includes reading, writing, speaking and listening, visual and graphic representation, non-verbal communication, and the use of number and data to convey meaning.

Students are encouraged to express mathematical concepts and processes using their own words as well as using mathematical terminology, representation and notation.

Solving problems

This involves the use of inquiry and reasoning, gathering data and processing information, posing creative solutions and evaluating outcomes. Mathematical concepts and skills are often used when solving problems.

Problem-solving tasks provide opportunities for students to develop the capacity to plan and organise activities. It involves the use of inquiry and reasoning, of gathering data and processing information, posing creative solutions and evaluating outcomes to ensure their reasonableness and meaningfulness given the context of the mathematical task.

Students should plan and organise their own strategies to obtain solutions to tasks by setting goals and establishing priorities; implementing a plan; identifying the focus questions and main concepts used; determining relevant knowledge and skills; selecting and managing resources and time to achieve the goals; monitoring individual performance; and meta-cognitively reflecting on the value of the learning experience in the general context of learning mathematics.

Utilising aesthetic judgement

This involves the use of the visual and performing arts as a means of expression and requires an appreciation of the aesthetic value of objects and experiences.

In Mathematics, group or self-evaluation of mathematical statements, informal descriptions, general rules, multiple strategies, and/or methods of solutions provide students with the opportunities to judge the validity, consistency, sophistication, and/or elegance of their mathematical ideas and reflections.

Students are encouraged to link their school mathematics to every day social, environmental and cultural practices and artefacts at the home, community, village and national levels.

Developing social and cultural skills and attributes

The capacity to operate socially and to work effectively with others is an essential skill. It requires an understanding of context, of the cultural norms and expectations that exist and the ability to negotiate and reach consensus. It also involves individuals developing their ethical framework including an informed understanding of the issues associated with gender.

The experience of working with others and in teams can facilitate learning and enhance social skills. Group work provides the opportunity for students to communicate mathematically with each other, to take risks and make conjectures in a supportive non-threatening environment, to cooperate, to debate, to counter-argue, to logically and mathematically justify ideas, and to persevere when solving problems and undertaking investigations.

Managing oneself and developing work and study skills

Students need to be able to manage their time effectively to allow them to pursue personal, spiritual, sporting and academic interests. They need to know how to resolve conflict in constructive ways that allows all involved to feel that they have been treated with fairness and respect. They need to take personal responsibility for their choices and actions and learn from both their mistakes and successes. This includes responsibility for personal health and fitness.

Planning and organising their own strategies for obtaining solutions to mathematics tasks involves the ability to set goals, establish priorities, implement a plan, select and manage resources and time, and monitor individual progress, performance and achievement of goals.

Integrating knowledge

While learning areas are used as the organisers of knowledge, the prime purpose of education is for students to understand the world around them and see the links between the various areas. This requires a deep and thorough understanding of subjects so the knowledge gained can be linked to experience and complex interrelated understandings developed.

In integrating their knowledge, students develop their competencies in using mathematical ideas and techniques and solving problems. Across the syllabus strands attention is drawn to opportunities for students to solve meaningful and challenging problems in both familiar and unfamiliar contexts, within Mathematics, in other key learning areas, at work and in everyday situations. Problem solving can promote communication, critical reflection, creativity, analysis, organisation, experimentation, synthesis, generalisation, validation, perseverance, and systematic recording of information. In addition, teaching through problems that are relevant to students can encourage improved attitudes to Mathematics and an appreciation of its importance to society.

Effectively using technology

Technology involves the development of the skills and knowledge used to make and construct objects and products used in day-to-day living and in the pursuit of special interests. Technology also involves the use of information technology used to access information stored electronically. Over time, information technology will become more widely available and be increasingly used in all areas of the curriculum to create, locate and store information. In order to achieve the outcomes of this syllabus, students will need to learn about and use appropriate technologies to develop their competency in using technology. It is important for students to determine the purpose of a technology, when and how to apply it, and to evaluate the effectiveness of its application, or whether its use is inappropriate or even counterproductive. Computer software as well as calculators, mobile phones, digital cameras, and video cameras can be used to facilitate teaching and learning.

Skills for Mathematics

Students will develop knowledge, skills and understanding specific to mathematics as follows:

- through inquiry, application of problem-solving strategies including the selection and use of appropriate technology, communication, reasoning, justifying and reflection;
- in mental and written computation and numerical reasoning;
- in patterning, generalisation and algebraic reasoning;
- in collecting, representing, analysing and evaluating information;
- in identifying and quantifying the attributes of shapes and objects and applying measurement strategies; and
- in spatial visualisation and geometric reasoning.

Approaches to Teaching and Learning

Problem-Solving Approach

A balanced mathematical program includes concept learning, developing and maintaining skills, and learning to tackle applications. These should be taught in such a way that students develop the ability to think mathematically.

Students learn mathematical thinking most effectively through applying concepts and skills in interesting and realistic contexts which are personally meaningful to them. Thus, mathematics is best taught by helping students to solve problems drawn from their own experience.

Real-life problems are not always closed, nor do they necessarily have only one solution. Determining the best approximation to a solution, and finding the optimum way of solving a problem when several approaches are possible, are skills frequently required in the workplace. Students need frequent opportunities to work with *open-ended problems*. The solutions to problems which are worth solving seldom involve only one item of mathematical understanding or only one skill. Rather than remembering the single correct method, problem solving requires students to search the information for clues and to make connections to the various pieces of mathematics and other knowledge and skills which they have learned. Such problems encourage analytical thinking and logical reasoning rather than mere recall.

Closed problems, which follow a well-known pattern of solution, develop only a limited range of skills. They encourage memorisation of routine methods rather than consideration and experimentation. While fluency with basic techniques is very important, such routines only become useful tools when students can apply them to *realistic problems*.

The characteristics of good problem-solving techniques include both convergent and divergent approaches. These include the systematic collection of data or evidence, experimentation (trial and error followed by improvement), flexibility and creativity, and reflection — that is, thinking about the process that has been followed and evaluating it critically.

Teachers can create opportunities for students to develop these characteristics by encouraging them to practise and learn such simple strategies as *guessing and checking*, *drawing a diagram*, *making lists*, *looking for patterns*, *classifying*, *substituting*, *re-arranging*, *putting observations into words*, *making predictions*, and *developing proofs*.

Learning to communicate about and through mathematics is part of learning to become a *mathematical problem solver* and learning to *think mathematically*. *Critical reflection* may be developed by *encouraging students* to *share ideas*, to *use their own words* to *explain their ideas*, and to *record their thinking* in a variety of ways, for example, through words, symbols, diagrams, and models.

The chance to look for *problems* as well as to *solve* them, to *create* and to *produce* rather than reproduce what already exists, is important for all students. *Creativity* in problem-solving is recognised as one of the basic traits that must be developed if the *outstanding achievement* is to result, and it plays a major role in *innovation*, *invention*, and *scientific discovery*.

Catering for Individual Needs

It is a principle of the Samoa National Curriculum Framework that all students should be enabled to achieve personal standards of excellence and that all students have a right to the opportunity to achieve to the maximum of their potential. It is axiomatic in this curriculum statement that mathematics is for all students, regardless of ability, background, gender, or ethnicity.

Students of lower ability need to have the opportunity to experience a range of mathematics which is appropriate to their age level, interests, and capabilities. Equally, students with exceptional ability in mathematics must be extended and not simply expected to repeat different per-

mutations of work they have clearly mastered. As new experiences cause students to refine their existing knowledge and ideas, so they construct new knowledge. The extent to which teachers are able to facilitate this process significantly affects how well students learn. It is important that students are given explicit opportunities to relate their new learning to knowledge and skills which they have developed in the past. Factors such as out-of-school experience and language have profound effects on the way students learn mathematics. In many cases in the past, students have failed to reach their potential because they have not seen the applicability of mathematics to their lives and because they were not encouraged to connect new mathematical concepts and skills to experiences, knowledge, and skills which they already had. This has been particularly true for many students, for whom the contexts in which mathematics was presented were irrelevant and inappropriate. These students have developed deeply entrenched negative attitudes towards mathematics as a result.

The development of more positive attitudes to mathematics and a greater appreciation of its usefulness is the key to improving participation rates for all students.

Use of Resources

The importance of the use of apparatus to help students form mathematical concepts is well established. Using apparatus provides a foundation of practical experience on which students can build abstract ideas. It encourages them to be inventive, helps to develop their confidence, and encourages independence.

Junior school teachers are used to choosing an appropriate range of apparatus to focus students' thinking on the concept to be developed and modifying the apparatus as the learner's understanding grows. Teachers know that students are capable of solving quite difficult problems when they are free to use concrete apparatus to help them think the problems through. Such an approach is equally valid with older students and should be used wherever possible.

At all year levels, students should be introduced to new ideas by having their attention drawn to examples occurring in their natural environment, and then by modelling them with apparatus. For example, a child's concept of "four" could be enriched by discussing the number of wheels on a car, legs on a table, or edges on a piece of paper. The child could then be encouraged to explore the idea further, using materials with which to make their own models of "four". Similarly, secondary students could be focused on the concept of "rate of change" by discussing, for example, that younger people grow faster than older people, or by discussing the slope changes on nearby hills. Students could then model uniform and non-uniform rate situations, using apparatus such as sand running through an egg-timer or a ball rolling down a smooth slope.

Textbooks

Many textbooks contain material to provide students with practice and enrichment. Increasing numbers of books contain excellent ideas for problem-solving situations which develop mathematical skills and understandings. However, teachers must realise that there are dangers in adhering too closely to any particular textbook. Many texts contain material not included in this curriculum statement, or have emphases which are different from those advocated for Samoa. In any event, teachers should continually re-evaluate the texts they are using in the light of the particular needs of their students.

Technology

This curriculum statement assumes that both calculators and computers will be available and used in the teaching and learning of mathematics at all year levels. Instruction in the correct and appropriate use of calculators is particularly important.

Calculators, graphics calculators, and computers are learning tools which students can use to discover and reinforce new ideas. Calculators are powerful tools for helping students to discover numerical facts and patterns, and helping them to make generalisations about, for example, repeated operations. Graphics calculators, and computer software such as graphing packages and spreadsheets, are tools which enable students to concentrate on mathematical ideas rather than on routine mechanical manipulation, which often intrudes on the real point of particular learning situations.

E-resources

This curriculum statement assumes that schools have school connectivity through which both teachers and students can access directly online resources that are currently made available via the MESC's website: https://www.mesc.gov.ws/, MESC Facebook, and MESC online resources. More information for each subject are available on the ministry's website.

Assessment and Evaluation

There are three purposes for assessment:

Assessment *for* learning

These assessments should be diagnostic and feedback assessments (classroom activities/ homework/assignments) so the teacher can improve the teaching and learning by diagnosing the learning strengths and weaknesses of students before the teaching and learning continue. The results of diagnosis should enable the teachers to give constructive feedback and formulate activities and responses to improve the learning where needed and ensuring the learning proceeds satisfactorily.

Assessment *as* learning

These assessments are learning outcomes-based. Activities are constructed to test the students' understanding of the learning outcome expected of them. Constant and timely feedback must be provided so the students are aware of their responsibilities as learners.

Assessment *of* learning

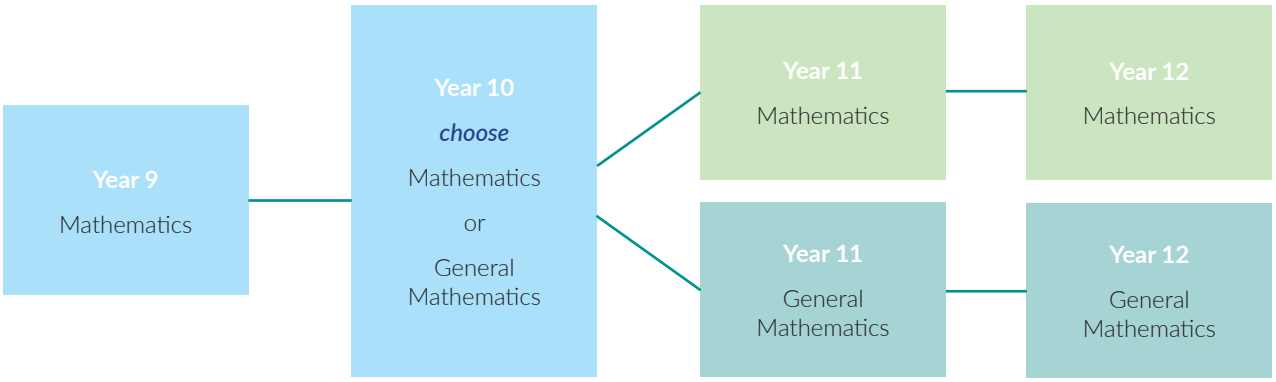
These assessments are summative tests and examinations that take place at the end of a unit or strand or end of term. It is equally important as the other assessments above, that the feedback for students to be constant and timely so that ample opportunities and time for students to react and contribute to correcting or improving their own learning are provided.

Organisation of the Mathematics Curriculum

The Secondary Mathematics Years 9 to 12 curriculum statements consist of a Common Year 9 Mathematics curriculum with the option of selecting ONE of TWO different Mathematics Years 10 to 12 courses, namely, General Mathematics and Mathematics. Specifically, the

- Years 10 to 12 General Mathematics curriculum develops a wide range of mathematical knowledge, skills, understanding, and competence necessary for those students who are undertaking courses for the TVET (Vocational) Pathway, and including those aspiring to be nurses, primary school teachers, secondary Arts teachers, TVET professionals, and secondary TVET teachers.
- Year 10 to 12 Mathematics curriculum develops a more challenging and higher level mathematical knowledge, skills and understanding necessary for those students who are undertaking courses for the Science Pathway and Commerce Pathway and including all those in any of the Science, Commerce or Arts Pathways who are aspiring to be secondary Commerce, Arts, Science, Mathematics, and Computer Studies teachers and professionals.

The following diagram illustrates the progression and options offered from Year 9 through to Year 12.



The mathematics curriculum intended by this statement will provide opportunities for students to:

- *become effective participants in problem-solving teams*, learning to express ideas, and to listen and respond to the ideas of others;
- *develop the skills of presentation and critical appraisal* of a mathematical argument or calculation, use mathematics to explore and conjecture, and learn from mistakes as well as successes;
- *develop the characteristics of logical and systematic thinking*, and apply these in mathematical and other contexts, including other subjects of the curriculum;
- *become confident and competent users of information technology* in mathematical contexts;
- *develop the skills and confidence* to use their own language, and the language of mathematics, to express mathematical ideas;
- *develop the knowledge and skills* to interpret written presentations of mathematics; and
- *develop flexibility and creativity* in applying mathematical ideas and techniques to unfamiliar problems arising in everyday life, and develop the ability to reflect critically on the methods they have chosen.

Organising Strands

The prescribed content in the **Common Year 9 Mathematics** and both the **Years 10 to 12 Mathematics** and **Years 10 to 12 General Mathematics** sequence of courses are organised around the interaction of outcomes and content statements in eight broad strands; one Process Strand, Working Mathematically and seven Content Strands – Number and Operations, Algebra, Statistics & Probability, Measurement, Geometry, and Trigonometry with the seventh content strand, which further extends concepts and content already covered in the other strands, one for Mathematics, Rates of Change & Calculus and the other for General Mathematics, Rates of Changes & Modelling Functions.

This division is a convenient way of categorising the outcomes for mathematics education in schools. It emphasises that there are a number of aspects that are all equally important. The division does not mean that mathematics is expected to be learned in discrete "packages". On the contrary, the Working Mathematically Process Strand is deliberately intended to encourage teachers and students to make connections between the other strands wherever possible.

Working Mathematically Process Strand

Students develop understanding and fluency in mathematics through inquiry by **interpreting and/or posing questions**; exploring and connecting mathematical concepts by **strategically thinking and representing**; choosing appropriate ideas, methods, and approaches by **reasoning and justifying**; and applying problem-solving mathematical techniques by **reflecting and evaluating** a variety of options; and **communicating mathematically** their strategies, conclusions, and solutions. The Working Mathematically (WM) Process Strand, therefore, includes five interrelated groups of sub-processes as listed below.

- **Interpreting &/or Posing Questions**
- **Strategically Thinking & Representing**
- **Reasoning & & Justifying**
- **Reflecting & Evaluating**
- **Communicating Mathematically**

These processes provide the language to build in the developmental aspects of doing, learning, and understanding mathematics. For example, these WM processes should be implemented *when developing new skills* and concepts and also *when applying existing knowledge* to solve routine and non-routine problems both within and beyond Mathematics, cross-curricular with other subject areas, and in relation to authentic contexts.

At different stages of teaching and learning a content area, the focus may be on a particular process or group of processes, but often the five groups of processes interweave and/or overlap. While this WM strand has a set of separate outcomes, it is interwoven into, and underpins, the content of each of the seven content strands in the syllabus.

Seven Content Strands

Within each of the seven Content Strands, particular aspects of students' mathematical learning and understanding are developed. However, students need to be able to make connections between mathematical ideas, concepts and procedures and to link these to daily real-life experiences, cultural and family practices in order to develop a richer understanding and better appreciation of mathematics. Integrating concepts within and between the following strands and authentic contexts will support development of these connections.

As mentioned above, there are seven content strands in the 4YSL Mathematics and General Mathematics curricula, namely, **Number & Operations**, **Algebra**, **Statistics & Probability**, **Measurements**, **Geometry,** and **Trigonometry**, with the seventh content strand being **Rates of Changes & Calculus** for Mathematics and **Rates of Changes & Modelling Functions** for General Mathematics.

Number & Operations Strand

The mathematics curriculum intended by this statement will provide opportunities for students to *develop*:

- *efficient strategies* for numerical calculation, operations and problem solving;
- an *understanding* of numbers, the ways

they are represented, and the quantities for which they stand;
- *accuracy*, *efficiency*, and *confidence* in calculating — mentally, on paper, and with a calculator;
- *the ability to estimate* and to *make approximations*, and to be alert to the reasonableness of results and measurements; and
- *the ability to apply* number properties when operating with numbers.

Algebra Strand

The mathematics curriculum intended by this statement will provide opportunities for students to:

- *develop* efficient strategies for recognising patterns, describing relationships and applying algebraic techniques and generalization;
- *recognise* patterns and relationships in mathematics and the real world, and be able to generalise from these;
- *develop* the ability to think abstractly and to use symbols, notation, and graphs and diagrams to represent and communicate mathematical relationships, concepts, and generalisations; and
- *use* algebraic expressions confidently to solve practical problems.

Statistics & Probability Strand

The mathematics curriculum intended by this statement will provide opportunities for students to:

- *collect*, *represent*, *analyse*, *interpret*, and *evaluate* data, assign and use probabilities, and make sound judgements;
- *recognise* appropriate statistical data for collection, and develop the skills of collecting, organising, and analysing data, and presenting reports and summaries;
- *interpret* data presented in charts, tables, and graphs of various kinds; and
- *develop* the ability to estimate probabilities and to use probabilities for prediction.

Measurement Strand

The mathematics curriculum intended by this statement will provide opportunities for students to:

- *develop* knowledge and understanding of systems of measurement and their use and interpretation;
- *develop* confidence and competence in using instruments and measuring devices;
- *predict and calculate* the effects of changes in variables and rate of change of variables on systems representable by simple mathematical models; and
- *explore* measurement concepts and relationships and apply formulas, strategies and reasoning in the solution of measurement problems.

Geometry Strand

The mathematics curriculum intended by this statement will provide opportunities for students to:

- *identify*, *visualise* and *quantify* attributes of shapes and objects, and explore geometric concepts and relationships, apply formulas, strategies and geometric reasoning in the solution of geometric problems;
- *gain* a knowledge of geometrical relations in two and three dimensions, and recognise and appreciate their occurrence in the environment;
- *develop* spatial awareness and the ability to recognise and make use of the geometrical properties and symmetries of everyday objects; and
- *develop* the ability to use geometrical models as aids to solving practical problems in time and space.

Trigonometry Strand

The mathematics curriculum intended by this statement will provide opportunities for students to:

- *apply* geometric concepts and relationships, formulas, strategies, and geometric reasoning in the solution of geometric problems involving right-angled and non-right-angled triangles and similar figures;
- *develop* spatial awareness and the ability to recognise and make use of the geometrical properties, similarities and symmetries of everyday objects;
- *develop* awareness that in right-angled triangles the ratio of two sides for a particular angle is constant;
- *gain* a knowledge of Pythagorean triads and trigonometric relations, functions, and ratios, and recognise and appreciate their applications in real life for construction surveying and navigation; and

- *develop* the ability to use trigonometry to solve practical problems to determine unknown lengths, heights, and distances in real-life applications.

Rates of Change & Calculus (for Mathematics only)

The mathematics curriculum intended by this statement will provide opportunities for students to:

- *recognize* patterns of relationships between changing quantities in terms of rates of changes;
- *develop* an awareness of, and ability to describe and represent, the relationships between changing quantities in algebraic and graphical forms;
- *develop* the ability to use mathematical concepts and skills and apply complex techniques to the of modeling of, and solving problems;
- *develop* students' capacity to operate with and model situations involving change, using algebraic and graphical techniques to describe and solve problems and to predict outcomes;
- *develop* the ability to solve problems involving algebraic and graphical representations of functions and rates of change of a function;
- *develop* an understanding of the concept of a derivative as a function that defines the rate of change of a given function;
- *reinforce*, numerically, geometrically, and algebraically, the relationship between a function and its derivative function; and
- *develop* an understanding of how integral calculus relates to area under curves and a further understanding of the interconnectedness of topics from across the syllabus.

Rates of Changes & Modelling Functions (for General Mathematics only)

The general mathematics curriculum intended by this statement will provide opportunities for students to:

- *use concepts* and *apply techniques* to the solution of problems in algebra and modelling;
- *recognize* and *make use* of numerical patterns of changing quantities to determine modelling functions;
- *recognize* patterns of relationships between changing quantities in terms of rates of changes;
- *develop* awareness of, and ability to describe and represent, the relationships between changing quantities in algebraic and graphical forms; and
- *develop* the ability to make predictions about situations based on mathematical models.

Year Level Organisation of Learning Outcomes

Each strand is divided into two-year levels describing the development of the mathematics from Year 9 to Year 10.

The number of year levels has been chosen for consistency with the Samoa National Curriculum Framework. The division of the 4YSL mathematics curriculum into four year levels does not mean that there are four well-identified stages, which learners pass through in the development of mathematical understanding. However, it is accepted that some concepts are better introduced to older student, and that the effective learning of some ideas depends on a prior understanding of other ideas. The judgment of experienced teachers as to what students can do at various ages has been combined with recent research into mathematical learning to place material into year levels.

The 3-Tiers of Learning Outcomes and Key Ideas

For both Mathematics and General Mathematics, the Content Strands are organised using three different Tiers of Outcomes and Key Ideas, as follows:

Tier 1 - Major Learning Outcomes (MLO) for each strand, provide a summary overview of the general major outcomes and standards students should achieve, for all its various sub-strands for each Year Level.

Tier 2 - Continuum of Key Ideas (KI) for each strand/sub-strand, indicate the range of ideas and concepts students should explore through investigation and problem solving before generalisation, formalisation, practice, and consolidation.

Tier 3 - Specific Learning Outcomes (SLO) for each strand/sub-strand, are in terms of knowledge and skills a student should be competent and proficient with its application in both familiar and novel/new problem-solving contexts.

A number of Major Learning Outcomes are described in each strand, and at each year level. The MLO defines what students should be able to achieve after appropriate learning experiences in mathematics. They define the progression of learning outcomes which is the core of this curriculum statement in mathematics.

At each year level, the MLO is quite broad. It is expected that, in assessing students' progress, teachers will make judgments as to an individual's degree of achievement of a particular MLO. Teachers' judgments should be based on an assessment of whether or not, students are able to demonstrate and provide evidence of their understanding of relevant Key Ideas (KI) and competency and proficiency in the application of the relevant knowledge and skills (SLO) to solve familiar and novel problems. Teachers should also include a commentary on the degree of achievement when reporting to parents.

The next section provides an overview of the Working Mathematically Process Strand for the four-year levels followed by Tiers 1 to 3 overviews; Major Learning Outcomes, Continuum of Key Ideas, and Specific Learning Outcomes; for each of the seven content strands.

OVERVIEW OF PROCESS OUTCOMES
WORKING MATHEMATICALLY STRAND

Students develop understanding and fluency in mathematics through inquiry by **interpreting and/or posing questions**; exploring and connecting mathematical concepts by **strategically thinking and representing**; choosing appropriate ideas, methods, and approaches by **reasoning and justifying**; and applying problem-solving mathematical techniques by **reflecting and evaluating** a variety of options; and **communicating mathematically** their strategies, conclusions, and solutions.

YEAR 9

Interpreting &/or Posing Questions

Students interpret and/or pose questions**,** when investigating mathematical situations informed by their mathematical experiences, using Year 9 content.

Strategically Thinking & Representing

Students strategically think and analyse, then use a variety of mathematical terminology, algebraic symbols, notations, diagrams, texts, and tables to represent mathematical ideas and interpretations.

Reasoning & Justifying

Students analyse, evaluate, review and justify strategic thinking and interpretations used and conclusions reached and explain the reasonableness of findings and solutions to problems.

Reflecting & Evaluating

Students reflect upon and evaluate the strengths and weaknesses of different strategies to analyse and solve problems more efficiently.

Communicating Mathematically

Students describe, represent, formulate, express, and explain mathematical situations, concepts, methods, and solutions to problems using a variety of presentations utilising appropriate language, notation, or diagrams using the Year 9 content.

YEAR 10

Interpreting &/or Posing Questions

Students interpret and/or pose questions**,** formulate conjectures, and apply general rules to mathematical situations informed by their mathematical experiences, using Year 10 content.

Strategically Thinking & Representing

Students strategically think and analyse, and use a variety of appropriate mathematical language, notations, tables, or diagrams to represent mathematical ideas and interpretations used.

Reasoning & Justifying

Students analyse, infer, generalise, describe and justify strategic thinking and interpretations used and conclusions reached and explain the reasonableness of findings and solutions to problems.

Reflecting & Evaluating

Students reflect upon and evaluate the strengths and weaknesses of different strategies to analyse and solve problems more efficiently.

Communicating Mathematically

Students describe, represent, formulate, express, and explain the bases of their solutions and strategies utilising their mathematical skills and appropriate language, diagrams, or algebraic symbols using the Year 10 content.

YEAR 11

Interpreting &/or Posing Questions

Students interpret and/or pose questions, construct, determine, and apply general rules to mathematical situations informed by their mathematical experiences, using Year 11 content.

Strategically Thinking & Representing

Students strategically think and analyze, and use a variety of appropriate mathematical language, notations, tables, or diagrams to represent mathematical ideas and interpretations used.

Reasoning & Justifying

Students analyze, infer, construct, determine and justify strategic thinking and interpretations used and conclusions reached and explain the reasonableness of findings and solutions to problems.

Reflecting & Evaluating

Students reflect upon and evaluate the strengths and weaknesses of different strategies to analyze and solve problems more efficiently.

Communicating Mathematically

Students describe, represent, formulate, express, evaluate and explain the bases of their solutions and strategies utilizing their mathematical skills and appropriate language, diagrams, or algebraic symbols using the Year 11 content.

YEAR 12

Interpreting &/or Posing Questions

Students interpret and/or pose questions when recognizing, manipulating, evaluating mathematical situations informed by their mathematical experiences, using Year 12 content.

Strategically Thinking & Representing

Students strategically think and analyze, and use a variety of appropriate mathematical language, notations, tables, or diagrams to represent mathematical ideas and interpretations used.

Reasoning & Justifying

Students analyze, conclude, generalize, describe and justify strategic thinking and interpretations used and conclusions reached and explain the reasonableness of findings and solutions to problems.

Reflecting & Evaluating

Students reflect upon and evaluate the strengths and weaknesses of different strategies to analyze and solve problems more efficiently.

Communicating Mathematically

Students describe, represent, formulate, express, manipulate, recognize and explain the bases of their solutions and strategies utilizing their mathematical skills and appropriate language, diagrams, or algebraic symbols using the Year 12 content.

Overview of Major Learning Outcomes

Strand 1 – Number & Operations

Strand 2 – Algebra

Strand 3 – Statistics & Probability

Strand 4 – Measurement

Strand 5 – Geometry

Strand 6 – Trigonometry

Strand 7 (Mathematics only) – Rates of Changes & Calculus

Strand 7 (General Mathematics only) – Rates of Changes & Modelling Functions

TIER 1	MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 1 NUMBER & OPERATIONS		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Number Sets & Operations Students define, order, operate, and calculate with all number sets, integers, fractions, decimals, and percentages and apply a range of strategies to aid calculation; recognise the properties of whole numbers; and use scientific notation to express large numbers. Financial Mathematics Students solve simple financial problems involving earnings, purchasing goods, investing money, and simple interest.	Number Sets & Operations Students distinguish between rational and irrational numbers, operate with integers, fractions, decimals, and percentages; and use scientific notation to write large and small numbers. Indices Students perform simple operations and use index laws to simplify and evaluate numerical expressions involving real numbers raised to integer, fractional, and zero indices.	Number Sets & Operations Students graph sets of real numbers and integers on a number line; Indices Students perform operations with surds and fractional indices $x^{1/n} = \sqrt[n]{x}$, $n \geq 3$.	Number Sets & Operations Students apply four operations of +, -, x / to simplify surds expressions and determine rates and ratios. Indices Students use Binomial Theorem to expand surd expressions to the power of 2.

TIER 1	MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 1 NUMBER & OPERATIONS	
YEAR 10 General Mathematics	YEAR 11 General Mathematics	YEAR 12 General Mathematics
Number Sets & Operations Students operate, and calculate with all number sets, fractions, decimals, and percentages and apply a range of strategies to aid calculation; round numbers to a specified number of significant figures; and use scientific notation to express large numbers. Indices Students use index laws to simplify and evaluate numerical expressions involving positive integer, fractional and zero indices. Financial Mathematics Students apply their knowledge of percentages, fractions, and decimals to solve a variety of financial problems involving earnings, spending money, simple interest, and compound interest.	Number Sets & Operations Students graph sets of real numbers and integers on number lines. Indices Students perform operations with surds and fractional indices (square roots and cube roots). Financial Mathematics Students calculate earnings from pay slips and commissions; explain tax, NPF and ACB deductions; and real household bills (EPC, SWA, phone bills); evaluate the budget with expenses and savings and solve problems involving the applications of the above.	Number Sets & Operations Students define rational and irrational numbers, terminating decimals and recurring decimals. Indices Students apply addition and subtraction to simplify expressions involving surds (with up to two terms). Financial Mathematics Students calculate and graph simple interest and compound interest on Investments; manage earnings, wages, and taxation, and develop an appropriate budget for a given situation. Students develop an ability to justify various types of financial decisions, which will affect their life now and into the future.

TIER 2

CONTINUUM OF KEY IDEAS – TIER 2 – STRAND 1
NUMBER & OPERATIONS

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Number Sets & Operations Students learn about operating with real numbers, integers, fractions, and percentages; applying the basic number properties to aid calculations; and using multiple strategies for mathematical calculations and computations; and recognizing the need for a notation to express large whole numbers in scientific notation. **Financial Mathematics** Students learn about operating with real numbers, fractions, decimals, and percentages to solve financial problems related to earnings, purchasing goods, investing money, and simple interest.	**Number Sets & Operations** Students learn about real numbers that can be expressed in a ratio of two integers (which include perfect squares and recurring decimals) and the rest of the real numbers which cannot be expressed in fraction form; and using scientific notation to write large and small numbers. **Indices** Students learn about performing operations and using index laws to simplify and evaluate real numbers raised to positive integers, fractional, and zero powers.	**Number Sets & Operations** Students will be able to construct a number line and graph points on it, to determine the order of real numbers, the opposite of a real number and the absolute value of a real number. **Indices** Students will learn that surd can be expressed in index form as a fractional index. In general, √(n&a) = a 1/n where n is the nth root of a. We say that: √(4&a) is in surd form and a_4^(1/) is in index form.	**Number Sets & Operations** Students learn how to manipulate surds properly by expressing them in their simplest form. Students compare the size of two or more surds by reversing the process and express a surd in the form ***n*** rather than the form ***bn***. Students learn the technique of removing surds from the denominator or rationalizing the denominator and the realizing of the denominator. **Indices** Students will learn how to employ to rationalize the denominator involving surds by multiplying of the top and bottom by the conjugate of the surd in the denominator but also to find the monic quadratic equation that has these surds as solutions.

YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
Number Sets & Operations Students learn about operating, and calculating with all number sets, fractions, decimals, and percentages and applying a range of strategies to aid calculation; rounding numbers to a specified number of significant figures; and using scientific notation to express large numbers. **Indices** Students learn about applying the index laws to simplify and evaluate numerical expressions involving positive integer, fractional and zero indices. **Financial Mathematics** Students learn about applying their knowledge of percentages, fractions, and decimals to solve a variety of financial problems involving earnings, spending money, simple interest, and compound interest.	**Number Sets & Operations** Students learn about the set of real numbers, denoted R, are defined as the set of all rational numbers combined with the set of all irrational numbers. Therefore, all the numbers defined so far are subsets of the set of real numbers and allow them to visually display real numbers by associating them with unique points on a line. **Indices** Students will learn about using the rules of indices. Students learn about square root and other fractions can be used to represent other roots. **Financial Mathematics** Students learn to calculate income using the Straight Pay or Salary Method, Average Pay Method, Year-to-date Method and Intermittent Work Method.	**Number Sets & Operations** Students identify rational and irrational numbers based on the given set of examples where the rational numbers include all integers, fractions and repeating decimals. Students learn the rules based on arithmetic operations such as addition and multiplication performed on the rational number and irrational number. Students learn to convert a fraction to a recurring decimal which to find an equivalent fraction that only contains 99's on the denominator. Here we will use the bus stop method. Example: 5/37 as a decimal. **Indices** Students learn that surds can be added or subtracted only if they are like surds (that is, if they have the same value under the radical sign). **Financial Mathematics** Students will use number sense, perform operations, solve problems and make decisions using rational and irrational numbers to set and implement financial goals. Students will use graphs, charts and tables for financial decision-making and planning. Students will use rational decision making for financial planning. Students will understand and explain the relationship between income sources and career preparation. Students will use principles of money management.

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 1 NUMBER & OPERATIONS		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Number Sets & Operations Students will be able to: 1. Define and use real, rational, and irrational numbers (√2). 2. Use a pair of compasses and straight edge to construct simple rational and irrational numbers (√2). 3. Use sets and Venn diagrams to illustrate the relationship between number sets (real, rational, irrational, whole numbers, and integers) and subsets of integers. 4. Graph specified sets of real numbers and integers on number lines. 5. Operate with rational numbers (integers, fractions, decimals, and percentages) and apply the order of operations. 6. Distinguish between different types of decimals (i.e. terminating, recurring and non-recurring). 7. Express recurring decimals in fraction form. 8. Round decimals to a specified number of significant figures.	**Number Sets & Operations** Students will be able to: 1. Identify and distinguish between different types of number sets of the real number system including irrational numbers. 2. Use a pair of compasses and straight edge to construct simple rational and irrational numbers (√x) where x is a prime number ≥3. 3. Identify significant figures. 4. Perform the four operations with all number sets using number properties and a variety of strategies. 5. Represent large and small numbers in scientific notation. **Indices** Students will be able to: 1. Perform the four operations with surds. 2. Evaluate real numbers raised to positive and negative integral indices and zero power.	**Number Sets & Operations** Students will be able to: 1. Recognize the real numbers as a distinct number set. 2. Graph specified sets of real numbers and integers on number lines. 3. Calculate absolute value. **Indices** 1. Perform operations with surds and fractional indices. 2. Evaluate rational exponents. 3. Simplify radical expressions involving fractions.	**Number Sets & Operations** Students will be able to: 1. Perform basic operations with fractions, integers, decimals and percentages. 2. Express numbers in standard form. 3. Use radicals and convert to and from fractional indices. **Indices** 1. Define and use multiplication, division and powers of a complex numbers in polar form. 2. Examine and use addition complex numbers as vector addition in the complex plane. 3. Prove and apply the factor theorem and the remainder theorem for polynomials.

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
1. Convert numbers between the forms: fractions, decimals, and percentages. 2. Solve simple application problems using rational numbers. 3. Develop index laws arithmetically by expressing each term in expanded form. 4. Simplify and evaluate numerical expressions involving both positive and negative integer indices. 5. Express large whole numbers in scientific notation. Financial Mathematics Students will be able to: 1. Solve problems involving earnings from wages, annual salaries (fortnightly, weekly, monthly pay, overtime, bonuses). 2. Calculate net earnings after deductions and taxation. 3. Solve problems involving simple interest. 4. Calculate earnings from investing money at simple interest rates. 5. Calculate and compare the cost of purchasing goods using cash, lay-by, deferred payment, or loans. 6. Calculate a 'best-buy'.	7. Evaluate real numbers raised to fractional indices. 8. Apply knowledge of index laws to evaluate and simplify arithmetic expressions raised to integral and fractional indices.		

TIER 3

SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 1
NUMBER & OPERATIONS

YEAR 10
General Mathematics

Number Sets & Operations

Students will be able to:

1. Review definitions and provide examples of real, rational, and irrational numbers.
2. Round decimals to a specified number of significant figures.
3. Convert numbers between the forms: fractions, decimals, and percentages.
4. Distinguish between different types of decimals (i.e. terminating, recurring and non-recurring) and express recurring decimals in fraction form.
5. Perform the four operations with all number sets using number properties and a variety of strategies.
6. Express large whole numbers in scientific notation.

Indices

Students will be able to:

1. Perform the four operations and apply index laws to numerical expressions involving indices.
2. Apply knowledge of index laws to evaluate and simplify arithmetic expressions raised to positive integral and zero indices.
3. Evaluate and simplify numerical expressions raised to fractional indices.
4. Apply index laws to evaluate and simplify numerical expressions raised to positive integer, fractional and zero indices.

YEAR 11
General Mathematics

Number Sets & Operations

Students will be able to:

1. Sketch graphs using the coordinates of two points.
2. Determine linear rules from suitable diagrams, tables of values and graphs and describe them using both words and algebra.
3. Graph simple non-linear relations and solve simple related equations.

Indices

1. Perform operations with surds and fractional indices.
2. Roots of integers and roots of rational numbers.

Financial Mathematics

1. Calculate payments based on government allowances and pension.
2. Calculate weekly or monthly wage from an annual salary, wages from an hourly rate including situations involving overtime and other allowances and earnings based on commission or piecework.
3. Understand the concept of compound interest as a recurrence relation.
4. Use technology to calculate the future value of a compound interest loan or investment and the total interest paid or earned.

YEAR 12
General Mathematics

Number Sets & Operations

Students will be able to:

1. Solve practical problems requiring basic number operations.
2. Apply arithmetic operations according to their correct order.
3. Recognize the significance of place value after the decimal point and evaluate decimal fractions to the required number of decimal places.

Indices

1. Review indices (including fractional indices) and the index laws.
2. Understand and use scientific notation and significant figures.
3. Identify contexts suitable for solving practical problems.

Financial Mathematics

1. Prepare a personal budget for a given income taking into account fixed and discretionary spending.
2. Apply percentage increases and decreases in situation; for example, mark-ups, discounts and GST.
3. With the aid of a calculator or computer-based financial software, solve problems involving compound interest loans or investments; for example, determining the future value of a loan, the number of compounding periods for an investment to exceed a given value, the interest rate needed for an investment to exceed a given value.

YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
Financial Mathematics Students will be able to: 1. Calculate fortnightly, weekly, monthly pay, overtime, and bonuses from wages and annual salaries. 2. Calculate net earnings after deductions and taxation. 3. Calculate compound interest on investments and loans using repetition of the formula for simple interest. 4. Connect the compound interest formula to repeated applications of simple interest by working with authentic information, data and interest rates to calculate interest and solve related problems. 5. Calculate the interest paid on both principal and interest, compounded at regular intervals over a period of time. 6. Calculate the total amount A, over a period of time, based on the rate of interest, and the initial principal using the Compound Interest Formula $\mathbf{A = P(1 + r/n)^{nt}}$ where initial principal of **P**, rate of interest per annum of **r**, time period **t** in years, frequency of the number of times the interest is compounded annually **n**. 7. Calculate the compound interest **CI** of over a period of time, based on the rate of interest, and the initial principal using the Compound Interest Formula: $\mathbf{CI = P(1 + r/n)nt - P}$ 8. Solve problems involving the application of rates and percentages. 9. Compare prices and values using the unit cost method.		

TIER 1	MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 2 ALGEBRA		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Algebraic Techniques Students generalize number properties to operate with, expand, simplify, factorize, and evaluate simple algebraic expressions, and formulas. **Indices** Students operate with positive-integer and zero indices of numerical bases, and extend the same for variable bases, to establish the meaning of negative indices for numerical bases. **Rates of Changes** Students solve contextual real-life word problems involving co-varying or changing quantities that are varying at a constant rate, by examining number patterns of rates of change, and making connections between rates of changes and features of graphs and	**Algebraic Techniques** Students use the algebraic symbol system to simplify simple algebraic expressions, fractions and quotients; expand binomial algebraic products, and factorize monic quadratic expressions. **Indices** Students apply the laws of indices to operate with algebraic expressions involving variable bases with positive- and negative-integer and zero indices; and establish the meaning of fractional indices ($n \leq 3$). **Rates of Changes** Students solve real-life application problems involving two co-varying or changing quantities, and generalize number patterns of rates of changes (first and second differences) to make connections to features of graphs.	**Algebraic Techniques** Students select and apply appropriate techniques to operate with algebraic expressions and algebraic fractions. **Surds and Indices** Students perform operations with algebraic expressions involving surds and fractional indices. **Logarithms** Students use the definition of a logarithm to establish and apply the laws of logarithms, and use the algebraic properties of logarithms to simplify and evaluate logarithmic expressions. **Rates of Changes** **(see Functions Sub-strand) **Equations** Students solve practical problems involving a pair of simultaneous complex linear and/or quadratic functions algebraically and graphically, and rearrange literal equations. **Linear Relationships** Students use formulas to find midpoint, gradient and distance on the Cartesian plane, gradient of parallel and perpendicular lines, and apply standard forms of the equation of a straight line. Students model, analyse and solve problems involving linear functions.	**Algebraic Techniques** Students manipulate complex algebraic expressions involving algebraic fractions; expand binomial products using variety of methods; and factorize non-monic quadratic expressions. Students simplify and evaluate linear and non-linear algebraic expressions and equations. **Surds and Indices** Students use index laws to simplify surds expressions; and use Binomial Theorem to expand surd expressions to the power of 2. **Rates of Changes** **(see Functions Sub-strand) **Equations** Students solve quadratic equations by using the quadratic formula and completing the square. Students solve problems involving complex linear, quadratic, simple cubic and simultaneous equations, and rearrange and evaluate literal equations. Students determine points of intersection of a line with a parabola, hyperbola or circle graphically and algebraically; and solve cubic equations and logarithmic equations. Students solve simple absolute value equations of the form $\|ax+b\|=k$ both algebraically and graphically.

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
by using letters (pronumerals, variables) to represent numbers and translate between words and algebraic symbols to determine an equation for the graph. **Linear Relationships** Students create and display number patterns, graph and analyze linear relationships; perform transformations on the Cartesian plane; derive the distance formula; and determine the midpoint of an interval; and solve problems involving parallel lines. **Equations** Students use algebraic techniques to solve simple linear equations and in-equations with simple algebraic fractions, products, and quotients.	**Linear Relationships** Students use the gradient-intercept form, $y=mx + b$, to interpret and graph vertical, horizontal and linear relationships; use formulas to find the midpoint, gradient, and distance on the Cartesian plane; and determine the gradient of parallel and perpendicular lines. **Non-Linear Relationships** Students connect algebraic and graphical representations to rates of change of simple non-linear relationships; and graph non-linear relationships e.g. $y=ax^2$, $y=ax^2 + c$. **Equations** Students solve linear and simple quadratic equations, linear inequalities, and simultaneous equations, using analytical and graphical techniques.	**Non-Linear Relationships** Students model, analyse, sketch and interpret a variety of non-linear relationships from quadratics to simple cubics ((x)=kx3), and simple exponential ($\boldsymbol{f}(x)=kax$) and unit circle $x2 + y2 = r2$. **Functions and Other Graphs** Students develop their use of mathematical language (notation, domain and range, variables) to describe functions and relations, as mappings between sets, and as a rule or formula that defines one variable quantity in terms of another. Students define and identify algebraically and geometrically, different types of functions and relations on a given domain, using a variety of methods. Students recognize that solving the equation f(x) = 0 corresponds to finding the values of x for which the graph of y=f(x) cuts the x-axis (the x-intercepts). Students recognize, describe and sketch polynomials, and apply the factor and remainder theorems to solve problems.	**Linear Relationships** Students model, analyse and solve problems involving linear relationships, including constructing a straight-line graph and interpreting features of a straight-line graph. Students evaluate gradient using trigonometry relationships; and calculate distance between two points and gradients of quadratic sides. **Non-Linear Relationships** Students model, analyse and solve problems involving quadratics, cubic and exponential functions and circles. **Functions and Other Graphs** Students define the sum, difference, product and quotient of functions and consider their domains and ranges where possible. Students define and use the composite function ((x)) of functions (x) and (x) where appropriate. Students recognize and use the inverse relationship between logarithms and exponentials. Students define and sketch the graph of reciprocal trigonometric functions, in both radians and degrees. Students use graphical methods with supporting algebraic working to solve a variety of practical problems involving any of the functions within the scope of this syllabus, in both real-life and abstract contexts.

TIER 1	MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 2 ALGEBRA	
YEAR 10 **General Mathemetics**	**YEAR 11** **General Mathemetics**	**YEAR 12** **General Mathemetics**
Algebraic Techniques Students apply the four operations and the algebra symbol system to simplify, expand, factorize, and evaluate simple algebraic expressions, fractions, quotients, and formulas. **Indices** Students use the index laws to simplify algebraic expressions, products, and quotients involving positive-integer and zero indices; establish the meaning of negative indices for variable bases; and evaluate numerical expressions with numerical bases raised to integral and zero indices. **Rates of Changes** Students solve a variety of real-life application problems involving two co-varying quantities; examine patterns of rates of changes (first and second differences) to determine links to graph features; and predict modeling equations of the context. **Linear Relationships** Students create and display number patterns, graph, analyze and determine equations of linear relationships; perform transformations on the Cartesian plane; and apply formulas to determine the midpoint of an interval and length of a line segment; and solve problems involving real-life applications of linear relationships and parallel lines.	**Algebraic Techniques** Students simplify algebraic expressions with surds e.g., and involving integer exponents; divide algebraic expressions; and evaluate algebraic expressions. **Indices** Students apply the laws of indices and operate with algebraic expressions involving positive-integer and zero indices. **Rates of Changes** Students solve real life application problems involving two co-varying quantities; and discover, recognize and generalize numerical patterns of first, second and third differences and their connections to algebraic and graphical representations of the changing quantities to derive modeling functions through the use of both dependent and independent variables, domain and range. **Linear Relationships** Students use the gradient-intercept form of the equation of a straight line to interpret and graph linear relationships. Students identify dependent and independent variables, use gradient to find equations of a straight line and solve a variety of direct variation problems.	**Algebraic Techniques** Students expand, simplify and evaluate algebraic expressions; add and subtract algebraic fractions; change subject of a formula and evaluate the subject of a formula; and sketch graphs of quantities that vary over time. **Indices** Students perform operations with algebraic expressions involving surds and fractional indices. **Rates of Changes** Students generate ratios of consecutive terms of exponential relationships and identify patterns; use patterns of ratios of non- linear relations (e.g. exponential) to determine modeling functions. **Linear Relationships** Students use formulas to find midpoint, gradient and distance on the Cartesian plane, find gradient of perpendicular and parallel lines, and apply standard forms of the equation of a straight line. Students graph linear relationships and functions from everyday situations and physical phenomena and draw a line of best fit on a graphed set of ordered pairs. Students identify and evaluate the limitations of a linear model in a real-life situation.

YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
Non-Linear Relationships Students graph simple non-linear relationships and make connections between patterns of rates of change, algebraic equations and graphical representations of simple non-linear relationships *e.g.*, $y=ax^2$, $y=ax^2+c$. **Equations** Students solve simple linear and quadratic equations, and linear inequalities using a variety of techniques and strategies.	**Non-Linear Relationships** Students connect algebraic and graphical representations of simple non-linear relationships Students construct and analyze a quadratic model to solve practical problems involving quadratic functions or expressions of the form **y=ax^2+bx+c.** **Equations** Students solve linear and quadratic equations, linear inequalities and linear simultaneous equations, using analytical and graphical techniques. Students solve a variety of practical and real-life problems using graphs of real-life data and information such as currency and international time conversions.	**Non-Linear Relationships** Students sketch and interpret a variety of non-linear relationships. Students determine the best model (linear or exponential) of a graphed set of data from a practical situation, and discuss the limitations of a non-linear model of a real-life situation. **Equations** Students solve practical problems involving simultaneous and non- linear models of relationships; and solve equations and algebraic expressions.

TIER 2

CONTINUUM OF KEY IDEAS – TIER 2 – STRAND 2
ALGEBRA

YEAR 9 Mathemetics

Algebraic Techniques

Students learn about using number properties to operate with, expand, simplify, factorise, and evaluate simple algebraic expressions, fractions, and formulas.

Indices

Students learn about operating with positive-integer and zero indices of numerical bases, and extending the same for variable bases, to establish the meaning of negative indices for numerical bases.

Rates of Changes

Students learn about solving contextual real-life word problems involving ***co-varying or changing quantities*** that are varying at a constant rate; examining ***number patterns of rates of change*** and making connections to graph features; using letters (***pronumerals, variables***) to represent numbers; and translating between words and algebraic symbols to determine an equation for the graph.

YEAR 10 Mathemetics

Algebraic Techniques

Students learn about using the algebraic symbol system to simplify, expand, and factorise algebraic expressions, fractions, and quotients that include up to monic quadratics.

Indices

Students learn about applying the index laws to operate with algebraic expressions, fractions, and quotients involving variable bases with both positive and negative integer and zero indices.

Rates of Changes

Students learn about generating values from interpretations of real-life application problems; identifying, describing, and generalising types of number patterns of rates of changes of first and second differences; and exploring their connections to features of graphs.

Linear Relationships

Students learn about using the gradient-intercept form to interpret and graph vertical, horizontal and linear relationships; applying

YEAR 11 Mathemetics

Algebraic Techniques

Students learn about adding and subtracting algebraic fractions with numerical denominators including those with binomial numerators.

Surds and Indices

Students learn about the four operations of addition, subtraction, multiplication and division to simplify expressions involving √(a) where a is an algebraic expression

Logarithms

Students learn about the laws of logarithms, algebraic properties of logarithms to simplify and evaluate logarithmic expressions

Rates of Changes

**(see Functions Sub-strand)

Equations

Students learn about pairs of simultaneous complex linear and/or quadratic functions algebraically and graphically.

YEAR 12 Mathemetics

Algebraic Techniques

Students learn about the expansion of binomial products using a variety of strategies and factorising non-monic quadratic expressions also evaluating linear and non-linear algebraic expressions and equations.

Surds and Indices

Students learn about using index laws to simplify surd expressions and the use of Binomial Theorem in expansion of surd expressions to the power of 2.

Rates of Changes

**(see Functions Sub-strand)

Equations

Students learn about quadratic equations, quadratic formula and completing the square, points of intersection of a line with a parabola, hyperbola and logarithmic equations.

Linear Relationships

Students learn about solving linear relationships, constructing a straight-line graph and evaluate gradient using trigonometry relationships and calculating two points and gradients of quadratic sides.

Non-Linear Relationships

Students learn abbot modelling, analyse and solve problems involving quadratics, cubic and exponential functions and circles.

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Linear Relationships Students learn about creating and displaying number patterns, graphing and analysing linear relationships; performing transformations on the Cartesian plane; deriving the distance formula and determining midpoints of intervals; and solving problems involving parallel lines. **Equations** Students learn about using algebraic techniques to solve simple linear equations and in-equations with simple algebraic fractions, products, and quotients.	formulas to find the midpoint, gradient, and distance on the Cartesian plane; determining the gradient of parallel and perpendicular lines; and connecting the general form of linear relationships to the gradient-intercept form. **Non-Linear Relationships** Students learn about algebraic and graphical representations of simple non-linear relationships (e.g., $y=ax^2$, $y=ax^2+c$) and their characteristic number patterns of rates of change. **Equations** Students learn about solving linear and simple quadratic equations of the form $ax^2=c$; linear inequalities; and simultaneous equations using analytical and graphical techniques.	**Linear Relationships** Students learn about formulas to find midpoint, gradient and distance on the Cartesian plane, parallel and perpendicular lines and solve problems involving linear functions. **Non-Linear Relationships** Students learn about non-linear relationships from quadratics to simple cubics $((x)=kx3)$, and simple exponential $(f(x)=kax)$ and unit circle $x^2+y^2=r^2$. **Functions and Other Graphs** Students learn about functions and relations, as mappings between sets, and as a rule or formula that defines one variable quantity in terms of another, the distance of the number from the origin on a number line without regard to its sign and applying this knowledge to everyday problems and applications algebraically and geometrically using a variety of methods. Students learn about sketching polynomials, and application of the factor and remainder theorems to solve problems.	**Functions and Other Graphs** Students learn about the sum, difference, product and quotient of functions cubic functions of the form: $f(x)=kx3$, $f(x)=k(x-b)3+c$ and $f(x)=k(x-a)(x-b)(x-c)$, where a, b, c and k are constants, from their equation and/or graph and identify important features of the graph, their domains and ranges where possible. Students learn about sketching the graphs of $y=kax$, $y=ka-x$ where k is a constant, and $y=\log ax$ and use the inverse relationship between logarithms and exponentials. Students learn about graphing of reciprocal trigonometric functions, in both radians and degrees and examining and applying transformations to sketch functions of the form $y=kf(a(x+b))+c$, where a,b,c and k are constants, in a variety of contexts, where $f(x)$ is one of $\sin x, \cos x$ or $\tan x$, stating the domain and range when appropriate. Students learn about transformations to sketch functions of the form $y=kf(a(x+b))+c$, where $f(x)$ is a polynomial, reciprocal, absolute value, exponential or logarithmic function and a,b,c and k are constants and graphical methods with supporting algebraic working to solve a variety of practical problems involving any of the functions within the scope of this syllabus, in both real-life and abstract contexts.

TIER 2	CONTINUUM OF KEY IDEAS – TIER 2 – STRAND 2 ALGEBRA	
YEAR 10 **General Mathemetics**	**YEAR 11** **General Mathemetics**	**YEAR 12** **General Mathemetics**
Algebraic Techniques Students learn about applying the four operations and the algebra symbol system to simplify, expand, factorise, and evaluate simple algebraic expressions, fractions, quotients, and formulas. **Indices** Students learn about using the index laws to simplify algebraic expressions, products, and quotients involving positive-integer and zero indices; establishing the meaning of negative indices for variable bases; and evaluating numerical expressions with numerical bases raised to integral and zero indices. **Rates of Changes** Students learn about generating a table of values from interpretations of real-life application problems involving two co-varying quantities; examining and describing number patterns of rates of changes (first and second differences) and linking to features of graphs; and predicting modelling equations of the context. **Linear Relationships** Students learn about creating and displaying number patterns; graphing, analysing, and determining equations of linear relationships; performing transformations; applying formulas to determine the midpoint and length of an interval, and gradient of a line segment; and solving problems involving real-life applications of linear relationships and parallel lines.	**Algebraic Techniques** Students learn about simplifying algebraic expressions with surds (e.g. $\sqrt{a}$) and involving integer exponents; divide algebraic expressions; and evaluate algebraic expressions. **Indices** Students learn about the laws of indices and operate with algebraic expressions involving positive-integer and zero indices. **Rates of Changes** Students learn about application problems involving two co-varying quantities; and discover, recognise and generalise numerical patterns of first, second and third differences and their connections to algebraic and graphical representations of the changing quantities to derive modelling functions through the use of both dependent and independent variables, domain and range. **Linear Relationships** Students learn about the gradient-intercept form of the equation of a straight line to interpret and graph linear relationships, dependent and independent variables and use gradient to find equations of a straight line and solve a variety of direct variation problems.	**Algebraic Techniques** Students learn about expansion, simplification and evaluation of algebraic expressions; add and subtract algebraic fractions; change subject of formula; and sketch graphs of quantities that vary over time. **Indices** Students learn about operations with algebraic expressions involving surds and fractional indices. **Rates of Changes** Students learn about ratios of consecutive terms of exponential relationships and identify patterns; use patterns of ratios of non- linear relations (e.g., exponential) to determine modelling functions. **Linear Relationships** Students learn about formulas to find midpoint, gradient and distance on the Cartesian plane, find gradient of perpendicular and parallel lines and functions from everyday situations and physical phenomena and draw a line of best fit on a graphed set of ordered pairs and evaluate the limitations of a linear model in a real-life situation. **Non-Linear Relationships** Students will learn to sketch and interpret a variety of non-linear relationships. Students determine the best model (linear or exponential) of a graphed set of data from a practical situation, and discuss the limitations of a non-linear model of a real-life situation.

$\frac{x}{2}+\frac{x}{3}=$

YEAR 10 General Mathematics	YEAR 11 General Mathematics	YEAR 12 General Mathematics
Non-Linear Relationships Students learn about graphing simple non-linear relationships (e.g. $y=ax^2$, $y=ax^2 + c$); and making connections between patterns of rates of change, algebraic equations and graphical representations of simple non-linear relationships. e.g., $y=ax^2$, $y=ax^2 + c$. **Equations** Students learn about a variety of algebraic techniques to solve simple linear and quadratic equations and simple linear inequalities that model real-life contexts and situations.	**Non-Linear Relationships** Students learn about algebraic and graphical representations of simple non-linear relationships, quadratic model to solve practical problems involving quadratic functions or expressions of the form $y=ax^2+bx+c$. **Equations** Students learn about linear and quadratic equations, linear inequalities and linear simultaneous equations, using analytical and graphical techniques, graphs of real-life data and information such as currency and international time conversions.	**Equations** Students learn about simultaneous and non- linear models of relationships; and solve equations and algebraic expressions.

TIER 3

SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 2
ALGEBRA

YEAR 9 Mathemetics

Algebraic Techniques

Students will be able to:

1. Use letters to represent numbers and develop the notion that a letter is used to represent a variable.
2. Recognise and use equivalent algebraic expressions, e.g., $y + y + y + y = 4y$, $w \times w = w^2$.
3. Translate between words and algebraic symbols and between algebraic symbols and words.
4. Distinguish between algebraic expressions where letters are used as ***variables***, and equations, where letters are used as ***unknowns***.
5. Recognise like terms and add and subtract like terms to simplify algebraic expressions.
6. Recognise the role of grouping symbols and the different meanings of expressions, such as $2a + 1$ and $2(a + 1)$.
7. Use number properties to operate with simple algebraic expressions.
8. Simplify algebraic expressions that involve multiplication and division, e.g., $12a \div 3$, $2ab \times 3a$.
9. Simplify expressions that involve simple algebraic fractions, e.g., $\frac{a}{2} + \frac{a}{3}$, $\frac{2x}{5} - \frac{x}{3}$.

YEAR 10 Mathemetics

Algebraic Techniques

Students will be able to:

1. Describe relationships between the algebraic symbol system and number properties.
2. Link algebra with generalised arithmetic, e.g., use the distributive property of multiplication over addition to determine that $a(b+c) = ab + ac$.
3. Operate with algebraic expressions, fractions, and quotients with pronumerals and indices.
4. Simplify algebraic expressions involving simple fractions, e.g.,

   $\frac{2x}{5} + \frac{2x}{3}$, $\frac{2ab}{3} \times \frac{6}{2b}$, $\frac{2y}{3} \div \frac{y}{6}$, $\frac{7a}{8} - \frac{5a}{12}$.
5. Apply the distributive law to the factorisation of algebraic expressions.
6. Simplify algebraic expressions, with binomial terms, that involve multiplication and division.
7. Expand binomial products using the distributive law and collecting like terms where possible.
8. Factorise monic quadratic expressions using a variety of strategies.
9. Use the algebraic symbol system to simplify, expand, and factorise simple algebraic expressions.

YEAR 11 Mathemetics

Algebraic Techniques

Students are able to:

1. Simplify the algebraic expressions using the basic operations (+, -, / and x).
2. Simplify algebraic expressions involving fractions.
3. Substitute numerical values into algebraic expressions; for example, substitute different values of x to evaluate the expressions $3x/5$, $5(2x - 4)$.
4. Substitute given values for the other pronumerals in a mathematical formula to find the value of the subject of the formula.

Surds and Indices

Students are able to:

1. Review indices including fractional indices and the index laws.
2. Use radicals and convert to and from fractional indices.
3. Understand and use scientific.

Rates of Changes

**(see Functions Sub-strand)

YEAR 12 Mathemetics

Algebraic Techniques

Students are able to:

1. Carry out appropriate manipulation and simplification of algebraic expressions (substitution, changing the subject, expanding, factorising, simplifying and using the laws of logarithms.
2. Find the value of the subject of the formula, given the values of the other pronumerals in the formula.

Surds and Indices

Students are able to:

1. Review indices including fractional indices and the index laws.
2. Use radicals and convert to and from fractional indices.
3. Understand and use scientific notation and significant figures
4. Examine examples of quadratic related variables.

Rates of Changes

**(see Functions Sub-strand.)

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
10. Expand algebraic expressions, by removing grouping symbols using the distributive law, and collecting like terms where possible. 10. Factorising a single term, e.g., $6ab = 3 \times 2 \times a \times b$. 11. Factorise simple algebraic expressions by identifying common factors. 12. Substitute into algebraic expressions and formulas. 13. Generate number patterns from algebraic expressions. 14. Translate from everyday language to algebraic language and from algebraic language to everyday language. 15. Replace written statements describing patterns with equations written in algebraic symbols. **Indices** Students will be able to; 1. Extend the law previously established (Year 8) for numerical bases to develop index laws in algebraic form for algebraic terms raised to integral and zero indices. 2. Establish that $x^0 = 1$ using index laws, e.g., $a^3 \div a^3 = a^{3-3} = a^0$ and pattern extension from positive integral towards zero.	10. Check expansions and factorisations by performing the reverse process. 11. Explain why an algebraic expansion or factorisation is incorrect, e.g., $24x^2y + 16xy^2 = 8xy(3x-2)$. 12. Verify whether a given expression represents a correct simplification of another algebraic expression by substituting numbers for pronumerals. **Indices** Students will be able to: 1. Apply index laws to simplify algebraic expressions with variable bases raised to integer indices (both positive and negative) including zero indices. 2. use index notation and the index laws to establish that: $a^{-1} = \frac{1}{a}$. 3. Explain the difference between pairs of algebraic expressions that appear similar e.g., 'Are x^{-2} and $-2x$ equivalent expressions? Why or why not?'. 4. Write expressions involving negative indices as expressions involving positive indices and vice-versa. 5. Apply the index laws to simplify algebraic expressions, products, and quotients involving negative indices, e.g., $4b^{-5} \times 8b^{-3}$ and $9x^{-4} \div 3x^3$.	**Equations** Students are able to: 1. Solve simultaneous equations using graphical methods. 2. Recognize the equations and sketch the graphs of the following functions: exponential, cubic, circle and hyperbole. 3. Use algebra in practical contexts. **Linear Relationships** Students are able to: 1. Form a linear graph using the 3 points method; the gradient intercept method and the intercept-intercept method. 2. Interpret a linear graph where appropriate e.g rate of change. 3. Solve linear equations , in-equations and show solutions on a number line. 4. Solve simultaneous linear equations.	**Equations** Students are able to: 1. Solve simple equations involving logarithmic functions algebraically and graphically. 2. Solve equations involving exponential functions using technology, and algebraically in simple cases. **Linear Relationships** Students are able to: 1. Interpret the point of intersection and other important features of given graphs of two linear functions drawn from practical contexts; for example, the 'break-even' point. 2. Choose suitable strategies (graphic, numeric and algebraic) for finding solutions to equations or linear in-equations including those containing brackets and/ or fractions and interpret the results 3. Calculate distance between 2 points and gradients of quadratic sides.

TIER 3

SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 2 - *continued*
ALGEBRA

YEAR 9 Mathemetics

3. Simplify, using index laws, expressions that involve $x^0 = 1$.
4. Simplify, using index laws, products and quotients of simple algebraic terms involving positive integral indices.
5. Compare expressions such as $3a^2 \times 5a$ and $3a^2 + 5a$ by substituting values for a and explain your answer.
6. Establish the meaning of negative indices for numerical bases.
7. Apply index laws to numerical expressions with integer indices.
8. Evaluate numerical expressions involving a negative index by first rewriting with a positive index, e.g., $3^{-2} = \frac{1}{3^2}$
9. Write given numbers in index form (integral indices only) and vice versa.

Rates of Changes

Students will be able to:

1. Generate tables of values from real-life relationships and examine patterns of change where one quantity changes in relation to another.
2. Generate rates of changes (first and second differences) from tables of values.
3. Identify and describe types of number patterns of rates of changes of first differences.

YEAR 10 Mathemetics

6. Explain why given statements of equality are true or false and give reasons e.g., explain why each of the following is true or false: $5x^0 = 1$, $9x^5 \div 3x^5 = 3x$, $a^5 \div a^7 = a^2$, $2c^{-5} = \frac{1}{2c^5}$.
7. Write the numerical value of a given numerical fraction raised to the power of -1, leading to: $\left(\frac{a}{b}\right)^{-1} = \frac{b}{a}$
8. Use index laws to assist with the definitions of the fractional indices for square root.
9. Use index laws to assist with the definitions of the fractional indices for cube root.
10. Explain why finding the cube root of an expression is the same as raising the expression to the power of one-third.

Rates of Changes

Students will be able to:

1. Generate values from interpretations of real-life application problems involving linear and non-linear relationships to form tables of values.
2. Examine, identify, describe, and generalise types of number patterns of rates of changes of first and second differences for linear and non-linear relationships.

YEAR 11 Mathemetics

Non-Linear Relationships

Students are able to:

1. Interpret in context the slope and intercept of a straight-line graph used to model and analyse a practical situation.
2. Solve quadratic equations using the quadratic formula and by completing the square.
3. Expand quadratic and cubic polynomials from factors.
4. Factorise quadratic expressions.

Functions and Other Graphs

Students are able to:

1. Identify linear functions.
2. Express linear functions in the forms $y = mx + c$ and $ax + bx + c = 0$.
3. Use function notation, domain and range, independent and dependent variables.
4. Understand the concept of the graph of a function.
5. Sketch quadratic expressions which are capable of being factorised.

YEAR 12 Mathemetics

Non-Linear Relationships

Students are able to:

1. Find the equation of a straight line given sufficient information; parallel and perpendicular lines.
2. Define and use multiplication by a scalar of a vector in component form.

Functions and Other Graphs

Students are able to:

1. Demonstrate familiarity with Cartesian coordinates in two dimensions by plotting points on the Cartesian plane.
2. Generate tables of values for linear functions, including for negative values of x.
3. Identify contexts suitable for modelling by exponential functions and use them to solve practical problems.
4. Plot and sketch graphs of linear, quadratic and cubic polynomials, circles and rectangular hyperbole, exponential functions, logarithmic functions and trigonometric functions.

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
4. Replace written statements describing patterns with equations written in algebraic symbols to derive an equation to represent the covarying relationship between two quantities. 5. Determine and describe the connections between the number patterns of rates of changes, features of graphs, and terms of the equation of the relationship. 6. Solve a variety of real-life examples of increasing and decreasing linear relationships to verify the rate of change and terms of equation result. **Linear Relationships** Students will be able to: 1. Graph points on the number plane from a table of values, number sequence, or set of ordered pairs, using an appropriate scale. 2. Extend the line joining a set of points to show there is an infinite number of ordered pairs that satisfy a given linear relationship. 3. Derive a rule for a set of points that have been graphed on the number (Cartesian) plane. 4. Create a table of values for a linear relationship by substituting a set of appropriate values for either of the pronumerals (e.g. $y = 2x + 1$) and graphing the number pairs on the Cartesian plane.	3. Explore links of number patterns of rates of changes to graph features and terms of the equations representing the relationship between the two covarying quantities. 4. Identify and generalise the connections between number patterns of rates of changes, algebraic, and graphical representations of linear and simple non-linear relationships. 5. Solve a variety of real-life application problems involving two covarying quantities to generate tables of values, rates of change, and graphs to determine modelling functions of the relationships in context. **Linear Relationships** Students will be able to: 1. Use the gradient-intercept form to interpret and graph linear, vertical, and horizontal relationships. 2. Graph a variety of linear relationships by constructing tables of values and plotting coordinates using an appropriate scale, e.g., graph the following: $y = 3 - x$, $y = \frac{x+1}{2}$, $x + y = 5$, $x - y = 2$, $y = \frac{2}{3}x$. 3. Construct tables of values and using coordinates to graph vertical and horizontal lines such as $x = 3$, $x = -1$, $y = 2$, $y = -3$. 4. Identify the x- and y-intercepts of graphs.	6. Recognise features of the graphs of $y = x2$, $y = a(x-b)2 + c$ and $y = a(x - b)(x - c)$, including their parabolic nature, turning points, axes of symmetry and intercepts. ----------	7. Investigate and interpret the following: domain and range, symmetries of odd and even functions, behaviour for large values of x, axes intercepts and asymptotes. 8. Recognise the concepts of transforming functions by sketching translations, change of scale and reflection in the x-axis. 9. Sketch graphs of inverse functions. ----------

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 2 - *continued* ALGEBRA

YEAR 9 Mathemetics

5. Graph more than one line on the same set of axes and compare graphs to determine similarities and differences (e.g., parallel, passing through the same point, passing through the x- and y-axes).
6. Explore and determine the relationship between gradients of parallel lines.
7. Explore, execute and examine transformations of lines and figures on the Cartesian plane.
8. Use the average concept to establish the formula for midpoint $M(x,y)$ for the interval joining two points (x_1,y_1) and (x_2,y_2) on the number plane.
9. Determine the midpoint of an interval from a diagram.
10. Graph two points to form an interval on the number plane and form a right-angled triangle by drawing a vertical side from the higher point and a horizontal line from the lower point.
11. Use the right-angled triangle drawn between the two points on the number plane and Pythagoras' theorem to determine the length of an interval joining (or distance between) the two points.
12. Use the right-angled triangle drawn between two points on the number plane and the relationship: gradient = rise/run, to find the gradient of the interval joining the two points.
13. Use triangle relationships to determine midpoints of line segments.
14. Solve problems involving parallel lines.
15. Identify, describe, and consolidate the connection between gradients, number patterns of rates of change, graph features, and terms of the equation of the straight line graph.

YEAR 10 Mathemetics

5. Explain why the x-axis has equation $y = 0$ and why the y-axis has equation $x = 0$.
6. Graph a variety of straight lines (including parallel, intersecting and perpendicular lines) and compare their gradients to establish the condition for lines to be perpendicular.
7. Recognise that when two straight lines are perpendicular, the gradient of one line is the negative reciprocal of the gradient of the other line.
8. Explore, identify, and validate the gradient of parallel and perpendicular lines.
9. Find the equation of a straight line parallel or perpendicular to another given line using $y = mx + b$.
10. Connect, identify, and match the straight line graphs to the terms of its equation with justifications.
11. Rearrange an equation in general form $(ax + by + c = 0)$ to the gradient-intercept form.
12. Use the appropriate formulas to find the midpoint, gradient, and distance on the Cartesian plane.

Non-Linear Relationships

Students will be able to:

1. Generate tables of values and rates of change (first and second differences) of non-linear (parabolic) relationships e.g., $y = ax^2$, $y = ax^2 + c$.
2. Draw graphs of simple non-linear (parabolic) relationships, $y = ax^2$, $y = ax^2 + c$.
3. Examine, identify, and describe connections between the terms of the equations, number patterns of rates of change, and features of graphical representations of simple non-linear relationships.
4. Describe characteristic patterns of rates of change of non-linear (parabolic) relationships.
5. Identify, describe, and represent algebraically the characteristic pattern of rates of change of the non-linear (parabolic) relationship.
6. Identify, describe, and represent algebraically the characteristic number pattern of rates of change of parabolic relationships.
7. Describe the effect on the graph of $y = x^2$ of multiplying $x2$ by different numbers (including negative numbers) or of adding different numbers (including negative numbers) to x^2.
8. Connect, identify and match the shape of a parabolic graph to the terms of its equation.
9. Determine the x-coordinate of a point on a parabola, given the y-coordinate of the point.

YEAR 9 Mathemetics	YEAR 10 Mathemetics
Equations Students will be able to: 1. Solve simple linear equations using strategies such as guess, check and improve, and backtracking (reverse flow chart). 2. Solve equations using algebraic methods that involve up to and including 3-steps in the solutions process and have solutions that are not necessarily whole numbers. 3. Check solutions to equations by substituting. 4. Translate a word problem into an equation, solve the equation and translate the solution into an answer to the problem. 5. Solve equations arising from substitution into formulas, e.g. $P = 2\ell + 2b$ and $P=20, \ell=6$, solve for b. 6. Find a range of values that satisfy an inequality using strategies such as 'guess and check'. 7. Solve simple inequalities such as: $5a \leq 20;\ 7y < 23;\ \frac{s}{8} > -3.$ 8. Represent solutions to simple inequalities on the number line. 9. Solve equations with simple monomial algebraic fractions (where the variable is either part of the denominator or numerator, not both). 10. Solve equations with simple algebraic products and quotients.	10. Solve real-life problems involving simple quadratic relationships and derive equations to represent the relationship between the two covarying quantities using a variety of strategies, including the connection to the number pattern of rates of change. 11. Use a number of strategies to solve unfamiliar problems including; using a table, drawing a diagram, looking for patterns, working backward, simplifying the problem, and trial and error. **Equations** Students will be able to: 1. Solve linear equations involving simple algebraic fractions such as: $\frac{x}{2}+\frac{x}{3}=5,\ \frac{2y-3}{3}=-2,\ \frac{z-3}{2}+6=1, \frac{3r+1}{4}=\frac{2r-4}{5}.$ 2. Solve linear equations, including equations that involve grouping symbols such as $3(a+2)+2(a-5)=10,$ $3(2t-5)=2t+5.$ 3. Solve word problems that result in equations. 4. Solve non-routine problems using algebraic methods. 5. Explore the number of solutions that satisfy simple quadratic equations of the form $x^2 = c$. 6. Solve simple quadratic equations of the form $ax^2 = c$. 7. Explain why a particular value could not be a solution to an equation. 8. Explain why quadratic equations could be expected to have two solutions. 9. Solve equations arising from substitution into a formula. 10. Solve linear inequalities such as: $3x-1<9,\ \frac{t+4}{5} < -3.$ 11. Solve simultaneous equations using non-algebraic methods, such as 'guess and check', setting up tables of values or looking for patterns. 12. Solve linear simultaneous equations by finding the point of intersection of their graphs. 13. Solve simple linear simultaneous equations using an analytical method e.g., solve: $3a + b = 17$ $2a - b = 8$ 14. Generate simultaneous equations from simple word problems. 15. Solve linear simultaneous equations resulting from problems and interpret the results.

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 2 ALGEBRA	
YEAR 10 **General Mathemetics**	**YEAR 11** **General Mathemetics**	**YEAR 12** **General Mathemetics**
Algebraic Techniques Students will be able to: 1. Use number properties and the algebra symbol system to operate with simple algebraic expressions, fractions, and quotients. 2. Simplify algebraic expressions with binomial terms that involve multiplication and division. 3. Determine and justify whether a simplified expression is correct by substituting numbers for letters. 4. Expand binomial products using the distributive law and collect like terms where possible. 5. Factorise simple algebraic expressions by identifying common factors. 6. Check expansions and factorisations by performing the reverse process. 7. Distinguish between algebraic expressions where letters are used as ***variables***, and equations, where letters are used as ***unknowns***. 8. Generate a variety of equivalent expressions that represent a particular situation or problem. 9. Generate number patterns from algebraic expressions. 10. 1Translate from everyday language to algebraic language and from algebraic language to everyday language. 11. Substitute values for pronumerals or variables to evaluate algebraic expressions and formulas to solve problems. 12. Solve applications problems involving operations with algebraic expressions, fractions and quotients.	**Algebraic Techniques** Students are able to: 1. Factorise algebraic expressions by taking out a common algebraic factor. 2. Investigate the relationship between algebraic long division and the factor and remainder theorems. 3. Evaluate algebraic expressions involving integer exponents. **Indices** Students are able to: 1. Apply knowledge of index laws to algebraic terms. 2. Simplify algebraic expressions using both positive and negative integral indices. **Rates of Changes** Students are able to: 1. Substitute values into formulas to determine an unknown. 2. Solve simple equations arising from formulas.	**Algebraic Techniques** Students are able to: 1. Substitute numerical values into linear algebraic and simple non-linear algebraic expressions and evaluate. 2. Substitute given values for the other pronumerals in a mathematical formula to find the value of the subject formula. **Indices** Students are able to perform operations with algebraic expressions involving surds and fractional indices. **Rates of Changes** Students are able to: 1. Establish and use the algebraic properties of exponential functions. 2. Recognise the qualitative features of the graph of $y=a$ to the x power $(a>0)$ including asymptotes, and of its translations ($y=a$ to the x power $+ b$ and $y=a$ to the x power $+ c$). 3. Identify contexts suitable for modelling by exponential functions and use them to solve practical problems.

YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
Indices Students will be able to: 1. Apply the index laws to algebraic expressions, fractions, and quotients involving variable bases raised to positive integer and zero indices. 2. Use pattern extension from variable bases with positive integral indices, and index laws to establish the meaning of negative indices for variable bases. 3. Write expressions involving negative indices as expressions involving positive indices, e.g., $a^{-n} = \frac{1}{a^n}$ and $\frac{1}{a^{-n}} = a^n$ 4. Simplify, using index laws, simple algebraic expressions, products, and quotients containing positive-integer indices. 5. Write the numerical value of a given numerical fraction raised to the power of -1, leading to: $\left(\frac{a}{b}\right)^{-1} = \frac{b}{a}$ 6. Compare expressions (e.g., $5b^2 \times 3b$ and $5b^2 + 3b$) and explain the differences by substituting values for b. 7. Apply index laws to numerical expressions with integer and fractional indices. 8. Evaluate numerical expressions involving integral and fractional indices. 9. Write given numbers in index form (integer indices only) and vice versa.	**Linear Relationships** 1. Solve problems involving linear equations, including those derived from formulas. 2. Represent word problems with simple linear equations and solving them to answer questions. 3. Use gradient to find equations of a straight line. 4. Derive modelling functions through the use of dependent and independent variable, domain and range. **Non-Linear Relationships** Students are able to: 1. Solve linear inequalities and graph their solutions on a number line. 2. Solve problems involving parallel and perpendicular lines. **Equations** Students are able to: 1. Solve linear simultaneous equations, using algebraic and graphical techniques. 2. Associate solution of simultaneous equations with the coordinates of the intersection of their corresponding graphs. 3. Solve simple quadratic equations using a range of strategies.	**Linear Relationships** Students are able to: 1. Graph linear functions for all values of x with pencil and paper and with graphing software. 2. Determine the coordinates of the midpoint of two points. 3. Examine examples of direct proportion and linearly related variables. **Non-Linear Relationships** Students are able to: 1. Review of quadratic relationships by examining examples of quadratic related variables. 2. Recognise features of the graph of the general quadratic $y = ax2 + bx + c$. **Equations** Students are able to: 1. Find the value of the subject of the formula, given the values of the other pronumerals in the formula. 2. Solve equations involving exponential functions and algebraically in simple cases. 3. Solve quadratic equations using the quadratic formula and by completing the square. 4. Solve linear equations.

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 2 - *continued* ALGEBRA	
YEAR 10 **General Mathemetics**	**YEAR 11** **General Mathemetics**	**YEAR 12** **General Mathemetics**
Rates of Changes Students will be able to: 1. Interpret a variety of real-life application problems, involving two co-varying quantities that are increasing or decreasing as the other quantity increases, to generate tables of values. 2. Explore, identify, and describe number patterns of rates of changes of first and second differences. 3. Connect types of number patterns of rates of changes to features of graphs. 4. Generalise number patterns in word descriptions and algebraic symbols in a variety of ways. 5. Use letters to represent numbers and translate between words and algebraic symbols. 6. Identify and describe the connections between rates of changes, graph features, and algebraic representations of the problem context. 7. Solve a variety of real-life application problems that have constant increasing, constant decreasing, and variable rates of change to generate tables of values, rates of change, and graphs to determine modelling functions of the relationships in context. **Linear Relationships** Students will be able to: 1. Examine, classify, identify, describe, and display various examples of real-life situations where the rates of change are constant (increasing and decreasing). 2. Graph, analyse, generalise, and interpret a variety of linear relationships to determine the gradients of the straight line graphs using a variety of strategies. 3. Describe the relationship between the gradient of a linear relationship and rates of change.	----------	----------

YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
4. Identify independent and dependent variables in practical contexts. 5. Establish a meaning for the y-intercept on the vertical axis in a practical context. 6. Explain the effect of changing the gradient or the y-intercept on the graph of a straight line. 7. Explore and determine the image of a straight line graph after a reflection along the x-axis or y-axis and a vector translation. 8. Predict the equation of a straight line graph after a transformation in the coordinate plane. 9. Recognise that equations of the form $y = mx + b$ represent straight lines with gradient m and y-intercept b. 10. Establish formulas to determine the midpoint and length of a line segment. 11. Use the distance formula to determine distances between two points on the number plane. 12. Solve a variety of problems involving real-life applications of linear relationships, parallel lines, and involving distances, gradients, and midpoints of lines. **Non-Linear Relationships** Students will be able to: 1. Generate tables of values and graph a variety of simple non-linear relationships (e.g. $y=ax^2$, $y=ax^2 + c$). 2. Examine, identify and describe in words the types of number patterns of rates of changes of first and second differences that indicate non-linear (parabolic) relationships. 3. Identify and describe the connections between the number pattern of rates of change (first and second differences) and terms of the quadratic equations. 4. Represent algebraically the characteristic number pattern of rates of change of parabolic relationships.		

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 2 - *continued* ALGEBRA		
	YEAR 10 **General Mathematics**	**YEAR 11** **General Mathematics**	**YEAR 12** **General Mathematics**
	5. Identify parabolic shapes in the environment. 6. Describe the effect on the graph of $y = x^2$ of multiplying x^2 by different numbers (including negative numbers) or of adding different numbers (including negative numbers) to x^2. 7. Connect, identify and match the shape of a parabolic graph to the terms of its equation. 8. Determine the x-coordinate of a point on a parabola, given the y-coordinate of the point. 9. Explore graphs on the same pair of axes and make connections between features of algebraic and graphical representations of a variety of simple non-linear relationships. 10. Solve a variety of real-life application problems that have variable rates of change of first differences in contrast to those with constant rates, and determine the modelling function of the non-linear relationship. 11. Use a number of strategies to solve unfamiliar problems including; using a table, drawing a diagram, looking for patterns, working backward, simplifying the problem, and trial and error. **Equations** Students will be able to: 1. Solve problems involving simple linear equations, including those derived from formulas, using a variety of strategies. 2. Translate word problems into equations, stating clearly the meaning of introduced pronumerals as representing 'the number of ....', and interpret the solutions. 3. Solve word problems involving familiar formulas, e.g., 'If the area of a triangle is 30 square centimetres and the base length is 12 centimetres, find the perpendicular height of the triangle.'		

YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
4. Explain why the solution to a linear equation generated from a word problem may not be a solution to the given problem. 5. Solve a variety of simple quadratic equations of the form $ax^2 = c$ using multiple strategies, leaving answers in exact form and as decimal approximations. 6. Recognise and explain why $x2 = c$ does not have a solution if c is a negative number. 7. Represent linear inequalities on the number line, e.g., represent $x < -3$ on a number line. 8. Recognise that an inequality has an infinite number of solutions unless other restrictions are made. 9. Solve linear inequalities, including through reversing the direction of the inequality sign when multiplying or dividing by a negative number, and graph the solutions, e.g., solve and graph the inequalities on a number line, $2(a + 4) \geq 24$ and $1 - 4y \leq 6$. 10. Use a numerical example to justify the need to reverse the direction of the inequality sign when multiplying or dividing by a negative number. 11. Verify the direction of the inequality sign by substituting a value within the solution range. 12. Solve equations arising from substitution into formulas, from other strands of the syllabus or other subjects, to determine an unknown and interpret solutions, e.g., $C = \frac{5}{9}(F - 32)$, $V = \pi r^2 h$. 13. Solve a variety of simple near and quadratic equations and simple linear inequalities that model real-life contexts and situations.		

TIER 1	MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 3 STATISTICS & PROBABILITY		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Relative Frequency & Probability Students explore chance events through experiments; develop the language of probability; calculate ***relative frequencies*** to estimate the ***probability*** of events; and use 2-way tables to calculate probability. **Theoretical Probability** Students explain the relationship between the relative frequency of an event and its *theoretical probability*. **Data Analysis & Evaluation** Students explore data through collecting and displaying data; interpret, compare and describe shapes of data displays of two sets of numerical data using measures of location and range.	**Relative Frequency & Probability** Students estimate and calculate probabilities using arrays, tables, tree diagrams or listing all outcomes of 2-step chance experiments with and without replacement; and determine expected values for simple events. **Theoretical Probability** Students calculate theoretical probabilities from sample spaces that can be listed for a variety of events; and use complementary events to calculate probabilities in 2-step chance experiments. **Data Analysis & Evaluation** Students collect statistical data using either a census or a sample; group data to aid analysis and construct frequency and cumulative frequency tables and graphs; and write and evaluate simple statistical reports.	**Relative Frequency & Probability** Students draw probability trees and use their sample spaces to solve problems using sequences of events; calculate theoretical probabilities from sample spaces that can be listed for simple events; calculate probabilities of simple and compound events; investigate and calculate probabilities in conditional statements using the language of 'if ... then', 'given', 'of', 'knowing that'. **Theoretical Probability** Students evaluate theoretical probabilities from sample spaces calculate results of two and 3 step chance of experiments both with and without replacements **Data Analysis & Evaluation** Students identify skewed and symmetrical sets of data displayed in graphs; describe positive/negative, weak/strong relationships of variables in graphs; compare two or more sets of data using parallel box plots; make predictions from scatter plots; calculate and interpret quartiles and interquartile, mean and standard deviation of data selected from the Sciences, Technology, Commerce and the Arts.	**Relative Frequency & Probability** Students calculate probabilities using probability trees, listed outcomes of simple and compound events, and as described by conditional statements; estimate the relative frequencies of events from recorded data; use relative frequencies to obtain approximate probabilities; use standard deviation to analyze data. **Theoretical Probability** Students investigate complex theoretical probabilities, three step chance experiments with or without replacements. **Data Analysis & Evaluation** Students recognize the difference between continuous and non-continuous quantitative data; describe data classification as quantitative & qualitative; organize data in tally charts & frequency tables, develop box and whiskers graphs from a five number summary; identify the process of statistical inquiry, including: posing questions, collecting data, organizing data, summarizing and displaying data, analyzing data, and drawing conclusions; identify issues of privacy and ethics in data collection and analysis.

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
		Sampling Method Students investigate and evaluate the appropriateness of sampling methods, sample size. **Statistical Analysis & Interpretation of results** Students collect raw data; explain any limitations in data collected; list key findings, make recommendations and draw conclusions based on research evidence; write statistical reports to summarize findings from a simple statistical research.	Students identify and interpret trends, patterns, comparisons, relationships between variables; and calculate measures of location and analysi[s] Students use standard normal distribution to calculate probability; define and calculate z-score; interpret sample statistics and population parameters. **Sampling Method** Students distinguish between sampling methods: random, stratified, and systematic; and select appropriate samples that match population characteristics to control and enhance the quality and relevance of findings. **Statistical Analysis & Interpretation of results** Students collect and present data on graphs and tables; calculate sample statistics and population parameters; evaluate and summarize key findings from data analysis; list recommendations and draw conclusion; write a full statistical research report including recommendations.

TIER 1	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 3 STATISTICS & PROBABILITY	
YEAR 10 General Mathematics	YEAR 11 General Mathematics	YEAR 12 General Mathematics
Relative Frequency & Probability Students explore chance events through experiments consolidating the language of probability; calculate relative frequencies to estimate the probability of events, and use 2-way tables to calculate probability. **Theoretical Probability** Students investigate theoretical probabilities from sample spaces of 2-step chance experiments, and explore misconceptions relating to chance experiments. **Data Analysis & Evaluation** Students differentiate between data types; collect and display data on graphs and in frequency tables, histograms, and polygons; calculate measures of location and range; and write and evaluate simple statistical reports.	**Relative Frequency & Probability** Students construct and use tree diagrams to determine the probability of a given sequence of events; classify data into types; collect and display data on line graphs and stem-and-leaf plots (including back to back); interpret data displays representing two or more dependent numerical variables; use scatter plots to investigate and comment on relationships between two numerical variables. **Theoretical Probability** Students calculate simple theoretical probabilities, investigate and evaluate outcomes for 2 step chance experiments with or without replacements. **Data Analysis & Evaluation** Students describe positive/negative, weak/strong relationships of variables in graphs; compare two or more sets of data using parallel box plots; make predictions from scatter plots; calculate and interpret quartiles and interquartile, mean and standard deviation of data. **Sampling Method** Students investigate and evaluate the appropriateness of sampling methods, sample size. Statistical Analysis & Interpretation of results. Students collect raw data and write statistical reports to summarize findings from a simple statistical research.	**Relative Frequency & Probability** Students construct and read cumulative frequency tables; organize data in tally charts & frequency tables; create graphs including dot plots to represent data sets; identify the process of statistical inquiry, including: posing questions, collecting data, organizing data, summarizing and displaying data, analyzing data, and drawing conclusions; Identify issues of privacy and ethics in data collection and analysis. **Data Analysis & Evaluation** Students calculate simple descriptive statistics (mean, median, mode, and variance). Define and calculate z-score; interpret sample statistics and population parameters by undertaking a research. **Sampling Method** Students distinguish between sampling methods: random, stratified, and systematic; relate sample selection to population characteristics; and use principles for questionnaire designs (simple language). **Statistical Analysis & Interpretation of results** Students collect and present data on graphs and tables; calculate sample statistics and population parameters; evaluate key findings from data analysis and write a full statistical research report including recommendations.

TIER 2	CONTINUUM OF KEY IDEAS – TIER 2 – STRAND 3 STATISTICS & PROBABILITY		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Relative Frequency & Probability Students learn about using relative frequency to estimate probabilities; developing the language of probability; and using 2-way tables to list outcomes and estimate probability. **Theoretical Probability** Students learn about the relationship between relative frequencies and theoretical probabilities. **Data Analysis & Evaluation** Students learn about collecting and displaying data; and comparing and describing the shape of data using the measures of location and ranges of sets of numerical data.	**Relative Frequency & Probability** Students learn about estimating and calculating probabilities using arrays, tables, ***tree diagrams*** or listing all outcomes of 2-step chance experiments with and ***without replacement***; and determining expected values for simple events. **Theoretical Probability** Students learn about calculating ***theoretical probabilities*** from sample spaces that can be listed for a variety of events, and using ***complementary events*** to calculate probabilities in 2-step chance experiments. **Data Analysis & Evaluation** Students learn about sampling and census; making predictions from samples and diagrams; analyzing data using the measures of location and range; constructing frequency tables and finding a mean and modal class for grouped data; determining cumulative frequency; and finding median using a cumulative frequency table or polygon.	**Relative Frequency & Probability** Students learn about probabilities of events based on observation of long run-relative frequency by using tree diagrams. **Theoretical Probability** Students learn about theoretical probabilities by using three-step chance experiments. **Data Analysis & Evaluation** Students learn about skewed and symmetrical sets of data displayed in graphs; describe positive/negative, weak/strong relationships of variables in graphs; compare two or more sets of data using parallel box plots; make predictions from scatter plots; calculate and interpret quartiles and interquartile, mean and standard deviation of data, frequency and cumulative frequency tables. **Sampling Method** Students learn about investigating and evaluating the appropriateness of sampling methods, sample size.	**Relative Frequency & Probability** Students learn about exploring outcomes from tree diagrams and frequency tables and investigate long run relative frequencies, the expected value of a number of trials, the mean and the standard deviation of a data set. **Theoretical Probability** Students learn about complex theoretical probabilities of combined events, 3 step chance experiments with or without replacements. **Data Analysis & Evaluation** Students learn about identifying and interpreting trends, patterns, comparisons, relationships between variables; calculate simple descriptive statistics (mean, median, mode, and variance); use standard normal distribution to calculate probability; define and calculate z-score; tally charts and frequency tables using develop box and whisker graphs.

TIER 2	CONTINUUM OF KEY IDEAS – TIER 2 – STRAND 3 - *continued* STATISTICS & PROBABILITY		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
----------	----------	**Statistical Analysis & Interpretation of results** Students learn about collecting raw data; explain any limitations in data collected; list key findings, make recommendations and draw conclusions based on research evidence; write statistical reports to summarize findings from a simple statistical research.	**Sampling Method** Students learn about sampling methods: random, stratified, and systematic; relate sample selection to population characteristics; and use principles for questionnaire designs (simple language). **Statistical Analysis & Interpretation of results** Students learn about presenting data on graphs and tables; calculate sample statistics and population parameters; evaluate and summarize key findings from data analysis; list recommendations and draw conclusion; write a full statistical research report including recommendations.

TIER 2	CONTINUUM OF KEY IDEAS – TIER 2 – STRAND 3 STATISTICS & PROBABILITY	
YEAR 10 General Mathematics	YEAR 11 General Mathematics	YEAR 12 General Mathematics
Relative Frequency & Probability Students learn about exploring chance events through experiments and consolidating the language of probability; calculating relative frequencies to estimate the probability of events; and using 2-way tables to calculate probability. **Theoretical Probability** Students learn about investigating theoretical probabilities from sample spaces of 2-step chance experiments, and exploring misconceptions relating to chance experiments. **Data Analysis & Evaluation** Students learn about differentiating between data types; collecting and displaying data on graphs and in frequency tables, histograms and polygons; calculating measures of location and range; and writing and evaluating simple statistical reports.	**Relative Frequency & Probability** Students learn about using tree diagrams to determine the probability of a given sequence of events, collect and display data on line graphs and stem-and-leaf plots, use scatter plots to investigate and comment on relationships between two numerical variables. **Theoretical Probability** Students learn about simple theoretical probabilities, outcomes of simple and compound events, probabilities in conditional statements and explain common misconceptions related to chance experiments. **Data Analysis & Evaluation** Students learn about positive/negative, weak/strong relationships of variables in graphs; two or more sets of data, parallel box plots quartiles and interquartile, mean and standard deviation of data. **Sampling Method** Students learn about the appropriateness of sampling methods, sample size. **Statistical Analysis & Interpretation of results** Students collect raw data and write statistical reports to summarize findings from a simple statistical research.	**Relative Frequency & Probability** Students learn about cumulative frequency tables; create graphs including dot plots to represent data sets; identify the process of statistical inquiry, including: posing questions, collecting data, organizing data, summarizing and displaying data, analyzing data, and drawing conclusions; Identify issues of privacy and ethics in data collection and analysis. **Data Analysis & Evaluation** Students learn about simple descriptive statistics (mean, median, mode, and variance); Z-score; interpret sample statistics and population parameters by undertaking a research. **Sampling Method** Students distinguish between sampling methods: random, stratified, and systematic; relate sample selection to population characteristics; and use principles for questionnaire designs (simple language). **Statistical Analysis & Interpretation of results** Students learn about presenting data on graphs and tables; calculate sample statistics and population parameters; evaluate key findings from data analysis and write a full statistical research report including recommendations.

TIER 3

SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 3
SPECIFIC & PROBABILITY

YEAR 9 Mathemetics

Relative Frequency & Probability

Students are able to:

1. List all outcomes of a simple event.
2. Use the term 'sample space' to denote all possible outcomes.
3. Assign probabilities to simple events by reasoning about equally likely outcomes.
4. Express the probability of a particular event as a fraction between 0 and 1.
5. Assign probability of zero to events that are impossible and probability of one to events that are certain.
6. Recognise that sum of the probabilities of all possible outcomes of a simple event is 1.
7. Calculate probability using Venn diagrams and 2-way tables.
8. Repeat an experiment a number of times to determine the relative frequency of an event.
9. Estimate the probability of an event from experimental data using relative frequencies.
10. Identify the complement of an event.

YEAR 10 Mathemetics

Relative Frequency & Probability

Students are able to:

1. Calculate relative frequencies from given or collected data to estimate probabilities of events of chance experiments involving 'and' or 'or'.
2. Repeat a chance experiment a number of times to determine the relative frequencies of events.
3. Recognise that probability estimates become more stable as the number of trials increases.
4. Predict the probability of an event from experimental data using relative frequencies.
5. Design a device to produce a specified relative frequency, e.g., a four-coloured spinner.
6. Calculate basic probabilities of events, including events involving 'and', 'or' and 'not', from data contained in Venn diagrams representing two or more attributes or 2-way tables.
7. Distinguish informally between independent and dependent events and provide examples.

YEAR 11 Mathemetics

Relative Frequency & Probability

Students are able to:

1. Determine the probabilities of events based on observations of long run-relative frequency.
2. Construct and use tree diagrams to determine the probability of a given sequence of events.

Theoretical Probability

Students are able to:

1. Calculate basic theoretical probabilities of combined events (including union, intersection and null set).
2. Describe the results of two-step chance experiments, with and without replacement.
3. Sample, with and without replacement, in two-step chance experiments.
4. Calculate probabilities of simple compound events in two-step chance experiments, with and without replacement.

Data Analysis & Evaluation

Students are able to:

1. Identify types of Data (Quantitative and Qualitative).

YEAR 12 Mathemetics

Relative Frequency & Probability

Students are able to:

1. Predict outcomes from tree diagrams and frequency tables.
2. Calculate long run relative frequencies, the expected value of a number of trials, the mean and the standard deviation of a data set.

Theoretical Probability

Students are able to:

1. Calculate more complex theoretical probabilities of combined events (including union, intersection and null set).
2. Describe the results of three-step chance experiments, with and without replacement.
3. Sample, with and without replacement, in three-step chance experiments.
4. Calculate probabilities of more complex and compound events in three-step chance experiments, with and without replacement.

Data Analysis & Evaluation

Students are able to:

1. Recognize the difference between continuous and non-continuous quantitative data.

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
11. Find the probability of a complementary event. 12. Solve probability problems arising in games. 13. Solve problems involving the application of relative frequency and probability in contexts. **Theoretical Probability** Students are able to: 1. Identify and determine theoretical probabilities as the likelihood of outcomes occurring under ideal circumstances. 2. Express the probability of an event A given a finite number of equally likely outcomes as: $P(Event\ A) = \frac{number\ of\ favourable\ outcomes}{total\ number\ of\ outcomes}$ 3. Use the formula to calculate probabilities of simple events. 4. Simulate probability experiments using random number generators. 5. Explain the relationship between the relative frequency of an event and its theoretical probability.	8. Sample with and without replacement in 2-step chance experiments. 9. Analyse 2-step events through constructing organised lists, tables, and/or tree diagrams. 10. Record and list all outcomes of 2-step chance experiments with and without replacement to determine probabilities. 11. Calculate probability of compound events using tree diagrams, organised lists, tables, or arrays. 12. Calculate expected values for simple events. 13. Solve real-life applications problems involving the application of relative frequencies and probability in contexts. 14. Solve 2-step probability problems including instances of sampling with or without replacement. **Theoretical Probability** Students are able to: 1. Calculate probabilities of simple events using the formula: $P(Event\ A) = \frac{number\ of\ favourable\ outcomes}{total\ number\ of\ outcomes}$	2. Collect and display data on line graphs and stem-and-leaf plots (including back to back). 3. interpret data displays representing two or more dependent numerical variables 4. Use scatter plots to investigate and comment on relationships between two numerical variables. 5. Make predictions from a given scatter plot or other graph. **Statistical Analysis & Interpretation of results** Students are able to: 1. Collect raw data. 2. Explain any limitations in data collected. 3. List key findings, make recommendations and draw conclusion from research. 4. Write statistical reports to summarize findings from a simple statistical research. **Sampling Method** Students are able to: 1. Explain differences between sample means and the population mean. 2. Recognize and explain sources of bias and unreliability in sampling situations.	2. Describe data classification as Quantitative & Qualitative. 3. Organize data in Tally charts & Frequency tables. 4. Develop box and whiskers graphs from a five number summary. 5. Identify the process of statistical inquiry, including: i. posing questions ii. collecting data iii. organizing data iv. summarizing and displaying data v. analyzing data and drawing conclusions 6. Identify issues of privacy and ethics in data collection and analysis. **Statistical Analysis & Interpretation of results** Students are able to: 1. Collect and present data on graphs and tables. 2. Calculate sample statistics and population parameters. 3. Evaluate and summarize key findings from data analysis. 4. List recommendations and draw conclusion. 5. Write a full statistical research report including recommendations.

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 3 - *continued* SPECIFIC & PROBABILITY		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Data Analysis & Evaluation Students are able to: 1. Identify and classify data as numerical or categorical. 2. Distinguish between discrete and continuous numerical data. 3. Describe the difference between numerical data [discrete or continuous] and categorical (nominal or ordinal) data. 4. Collect and display data (e.g. marks) in frequency tables and basic graphs (e.g., picture graphs, pie graphs and divided bar graphs). 5. Draw frequency histograms and polygons. 6. Draw and use dot plots. 7. Use line graphs for continuous data only. 8. Draw and use stem-and-leaf plots. 9. Use the terms 'cluster' and 'outlier' to describe data. 10. Calculate measures of location (mean, median and mode) and range for small sets of data. 11. Carry out investigations into, and report on situations relevant to the students' lives. 12. Analyse graphical displays to recognise features that may cause misleading interpretation, e.g., displaced zero, irregular scales.	2. Apply the formula to calculate probabilities of simple events. 3. Calculate theoretical probabilities from sample spaces that can be listed for a variety of events. 4. Use complementary events of two-step chance experiments to calculate probability. 5. Explain the relationship between the relative frequency of an event and its theoretical probability. 6. Identify and explain common misconceptions related to chance experiments. 7. Solve real-life applications problems involving the application of theoretical probability in contexts. **Data Analysis & Evaluation** Students are able to: 1. Identify types of data that are quantitative (continuous or discrete) and qualitative (nominal or ordinal). 2. Formulate key questions to generate data for a problem of interest. 3. Refine key questions after a trial. 4. Describe the difference between a census and a sample. 5. Use measures of location and range to analyse data that is displayed in a frequency distribution table, stem-and-leaf plot, or dot plot. 6. Construct frequency tables and draw frequency histograms and polygons. 7. Collect data using a random process. 8. Make predictions from a sample that may apply to the whole population. 9. Collect and display data online graphs, pie graphs, divided bar graphs, and stem-and-leaf plots (including back to back).	----------	**Sampling Method** Students are able to: 1. Evaluate and explain the meaning of confidence intervals in estimating population parameters and in using samples for quality control; 2. Identify situations where the sample may not have come from a clearly defined population, and discuss the relevance of the findings.

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
	10. Interpret data displays representing two dependent numerical variables. 11. Use scatter plots to investigate and comment on relationships between two numerical variables. 12. Make predictions from a given scatter plot or another graph. 13. Use spreadsheets to tabulate and graph data. 14. Construct a cumulative frequency table for ungrouped data. 15. Construct a cumulative frequency histogram and polygon (ogive). 16. Use a cumulative frequency polygon to find the median. 17. Group data into class intervals. 18. Construct a frequency table for grouped data. 19. Construct a histogram for grouped data. 20. Find the mean using the class center. 21. Find the modal class. 22. Write simple reports to summarize statistical findings. 23. Evaluate simple statistical reports linking claims to displays & statistics, and recognize features in graphical displays that may cause misleading interpretations.		

TIER 3

SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 3
STATISTICS & PROBABILITY

YEAR 10
General Mathematics

Relative Frequency & Probability

Students are able to:

1. Calculate relative frequencies from given or collected data to estimate probabilities of events of chance experiments.
2. Repeat a chance experiment a number of times to determine the relative frequencies of events.
3. Estimate probabilities in experiments using relative frequencies.
4. Predict the probability of an event from experimental data using relative frequencies.
5. Design a device to produce a specified relative frequency, e.g., a four-coloured spinner.
6. Calculate expected values for simple events.
7. Apply relative frequency to predict future experimental outcomes.
8. Recognise that probability estimates become more stable as the number of trials increases.
9. Calculate probability using Venn diagrams of collected data representing two or more attributes or 2-way tables of collected data.
10. Determine probability using tree diagrams, organised lists, tables, or arrays.
11. Record outcomes of 2-step chance experiments with replacement to determine probabilities.
12. Solve a variety of real-life application problems using relative frequency and probability.
13. Solve real-life applications problems involving 2-step chance experiments with replacement.

YEAR 11
General Mathematics

Relative Frequency & Probability

Students are able to draw probability trees and use their sample spaces to solve problems using sequences of events.

Theoretical Probability

Students are able to:

1. Determine the simple theoretical probabilities (including union, intersection and null set) of the outcomes of events (rolling a die, drawing a card from a deck).
2. List all outcomes for two-step chance experiments, with and without replacement.
3. Calculate probabilities of simple and compound events.

Data Analysis & Evaluation

Students are able to:

1. Identify types of Data (Quantitative and Qualitative).
2. Collect and display data on line graphs and stem-and-leaf plots (including back to back).
3. Interpret data displays representing two or more dependent numerical variables.

YEAR 12
General Mathematics

Relative Frequency & Probability

Students are able to:

1. Estimate the relative frequencies of events from recorded data.
2. Use relative frequencies to obtain approximate probabilities.

Theoretical Probability

Students are able to:

1. Determine the complex theoretical probabilities (including union, intersection and null set) of the outcomes of events (rolling a die, drawing a card from a deck).
2. List all outcomes for three-step chance experiments, with and without replacement.
3. Calculate probabilities of complex and compound events.
4. Investigate and calculate probabilities in conditional statements using the language of 'if ... then', 'given', 'of', 'knowing that'.
5. Identify and explain common misconceptions related to chance experiments.

Data Analysis & Evaluation

Students are able to:

1. Construct and read cumulative frequency tables.

YEAR 10 General Mathematics	YEAR 11 General Mathematics	YEAR 12 General Mathematics
Theoretical Probability Students are able to: 1. Identify and determine theoretical probabilities as the likelihood of outcomes occurring under ideal circumstances. 2. Express the probability of an event A given a finite number of equally likely outcomes as: $$P(Event\ A) = \frac{number\ of\ favourable\ outcomes}{total\ number\ of\ outcomes}$$ 3. Use the formula to calculate theoretical probabilities from sample spaces that can be listed for simple events such as those related to cards, dice, and other games. 4. List all outcomes for two-step chance experiments in an organised list, array, table, or tree diagram. 5. Explain the difference between the relative frequency of an event in a simple experiment and its theoretical probability. 6. Use complementary events to calculate probabilities in two-step chance experiments. 7. Identify misconceptions relating to chance experiments. 8. Solve a variety of real-life application problems using theoretical probabilities. **Data Analysis & Evaluation** Students are able to: 1. Differentiate between numerical, categorical, quantitative and qualitative data. 2. Explain the difference between numerical data that are discrete versus continuous. 3. Sort, classify, and analyse categorical data (nominal and ordinal). 4. Collect and display data on line graphs, pie graphs, divided bar graphs, dot plots, and stem-and-leaf plots (including back to back).	5. Use scatter plots to investigate and comment on relationships between two numerical variables. 6. Make predictions from a given scatter plot or other graph. **Statistical Analysis & Interpretation of results** Students are able to: 1. Collect raw data. 2. Explain any limitations in data collected. 3. List key findings, make recommendations and draw conclusion from research. 4. Write statistical reports to summarize findings from a simple statistical research. **Sampling Method** Students are able to: 1. Explain differences between sample means and the population mean. 2. Recognize and explain sources of bias and unreliability in sampling situations.	2. Organize data in Tally charts & Frequency tables. 3. Create graphs including dot plots to represent data sets. 4. Identify the process of statistical inquiry, including: a. posing questions b. collecting data c. organizing data summarizing and displaying data d. analyzing data and drawing conclusions 5. Identify issues of privacy and ethics in data collection and analysis. **Statistical Analysis & Interpretation of results** Students are able to: 1. Collect and present data on graphs and tables. 2. Calculate sample statistics and population parameters. 3. Evaluate and summarize key findings from data analysis. 4. List recommendations and draw conclusion. **Sampling Method** Students are able to evaluate and explain the meaning of confidence intervals in estimating population parameters and in using samples for quality control.

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 3 - *continued* STATISTICS & PROBABILITY	
YEAR 10 General Mathematics	YEAR 11 General Mathematics	YEAR 12 General Mathematics
5. Interpret back-to-back stem-and-leaf plots when comparing data sets. 6. Compare the strengths and weaknesses of different forms of data display. 7. Construct frequency tables and draw frequency histograms and polygons. 8. Describe the difference between bivariate data and single variable data using an appropriate example. 9. Carry out investigations into, and report on situations relevant to the students' lives. 10. Formulate key questions to generate data for a problem of interest. 11. Refine key questions after a trial. 12. Describe the difference between a census and a sample. 13. Use measures of location and range to analyse data that is displayed in a frequency distribution table, stem-and-leaf plot, or dot plot. 14. Collect data using a random process. 15. Detect bias in the selection of a sample. 16. Consider the size of the sample when making predictions about the population. 17. Compare two sets of data by finding the mean, mode and/or median, and range of both sets. 18. Make predictions from a sample that may apply to the whole population. 19. Recognize that summary statistics may vary from sample to sample.		

YEAR 10 General Mathematics	YEAR 11 General Mathematics	YEAR 12 General Mathematics
20. Draw conclusions based on the analysis of data using the mean, mode and/or median, and range. 21. Question when it is more appropriate to use the mode or median, rather than the mean, when analyzing data. 22. Interpret ***data displays*** representing two dependent numerical ***variables***. 23. Use scatter plots to investigate and comment on relationships between two numerical variables and make predictions. 24. Write simple reports to summarize statistical findings. 25. Evaluate simple statistical reports linking claims to displays & statistics; and recognize features in graphical displays that may cause misleading interpretations.		

TIER 1	MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 4 MEASUREMENTS		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Time Students perform calculations of time that involve mixed units. **Metric System** Students convert between appropriate metric measures of length, area, and volume. **Perimeter and Area** Students use formulas and Pythagoras' Theorem to calculate the perimeter and area of circles (using π=3) and figures composed of rectangles and triangles. **Surface Area and Volume** Students calculate the surface area of rectangular and triangular prisms and the volume of right prisms and cylinders.	**Time** Students perform calculations of time that involve international time zones and rates. **Metric System** Students convert between metric and imperial units (of length, area, and volume), and vice-versa. **Perimeter and Area** Students use formulas to calculate the area of triangles and quadrilaterals and find areas and perimeters of simple composite figures. **Surface Area and Volume** Students apply formulas to find the surface area of right prisms and right cylinders and the volume of right pyramids, cones, and spheres (π=3.14), and calculate the surface area and volume of composite solids.	**Time** Students investigate very small and very large time scales and intervals; apply to and solve real life applications (e.g. electronic and paper-based timetables and schedules). **Metric System** Students use objects to make reasonable estimations of length, mass and capacity; and solve complex applications of imperial and metric. **Perimeter; Area; Surface Area Volume** Students calculate area of an arc and segment of a circle; apply formula to simple application problems; use Heron's formula to find the area of a triangle; apply Pythagoras theorem to solve more complex problems involving perimeter; use area authentic (real-life) problems for volume and capacity; deals with 2D and 3D simple shapes [π=3.14]; and solve authentic real-life problems involving complex applications of measurements. **Limits of accuracy** Students calculate possible resulting errors expressed using inequality notations; give appropriate upper and lower bounds for data to a specific accuracy; and solve authentic real-life problems involving complex combinations of limits of accuracy.	**Time** Students use and solve applications of more complex everyday problems; calculate link between time, distance and speed; calculate application problems with 12 hr and 24 hr clock notation; and solve real life applications. **Metric System** Student use objects to make reasonable estimations of length, mass and capacity; and solve a variety of applications of imperial and metric units. **Perimeter; Area; Surface Area Volume** Students calculate areas for irregular piece of block of land; analyse nets of cylinders to establish formulae for surface area; and solve a variety of complex authentic real-life problems involving measurements. **Limits of accuracy** Students calculate possible resulting errors expressed using inequality notations; give appropriate upper and lower bounds for data to a specific accuracy; and solve a variety of authentic real-life problems involving complex combinations of limits of accuracy. **Reading and Interpreting scales/tables** Students read and interpret scales on a range of measuring instruments; recognise that the measurement made is approximate and recording results to a required degree of accuracy; construct and interpret scale drawings and compare readings on different scales; and solve a variety of authentic real-life problems involving complex applications and interpretations of readings and measurements on different scales.

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Limits of accuracy Students estimate metric measurements; and round numbers and measures to an appropriate degree of accuracy (e.g., number of significant figures). **Scales and Scale Drawings** Students read and interpret scales on a range of measuring instruments; and calculate real measurements using scale factors.	**Limits of accuracy** Students choose appropriate units of measurement and the number of significant figures to meet the specified degree of accuracy in calculations. **Scales and Scale Drawing** Students read and interpret scales on a range of measuring instruments (e.g. thermometers, scales, etc.); construct scale drawings (2-D shapes) and compare readings on different scales.	**Reading and Interpreting scales/tables** Students read and interpret scales on a range of measuring instruments (e.g. thermometer, scales, etc); recognise that the measurement made is approximate and recording results to a required degree of accuracy; construct scale drawings (2-D shapes) and compare readings on different scales; and solve authentic real-life problems involving complex applications and interpretations of readings and measurements on different scales. **Sequence & Series** Students list required sequence; graph required sequence (simple) on a pair of axes of both arithmetic and geometric sequences; find nth term and sum of required terms of an arithmetic sequence and a geometric sequence using the formulas; and solve authentic real-life problems involving complex applications of first and second difference number patterns, common difference, and common ratio to determine modelling functions. **Rates and Ratios – Arithmetic Sequence and Series** Students solve complex non-linear and linear rates and describe qualitatively the rates of change.	**Sequence & Series** Students list required sequence; graph required sequence (complex) on a pair of axes of both arithmetic and geometric sequences; find nth term and sum of required terms of an arithmetic sequence and a geometric sequence using the formulas; and solve authentic real-life problems involving complex applications of first and second difference number patterns, common difference, and common ratio to determine modelling functions. **Rates and Ratios - Geometric Sequence and Series** Students recognise and use the recursive definition of a geometric sequence: $Tn = rTn\text{-}1 - 1, T1 = a$, establish and use the formula for the nth term of a geometric sequence: $T = arn - 1$, where a is the first term, r is the common ratio and n is a positive integer, and recognise its exponential nature. Students establish and use the formula for the sum of the first n terms of a geometric sequence: $Sn = a(1\text{-}r\text{^}n)/(1\text{-}r) = a(r\text{^}n\text{-}1)/(r\text{-}1)$. Students establish and use the formula for the sum of the first n terms of a geometric sequence: $Sn = a(1\text{-}r\text{^}n)/(1\text{-}r) = a(r\text{^}n\text{-}1)/(r\text{-}1)$. Students derive and use the formula for the limiting sum of a geometric series with $\|r\| < 1$: $S = a/(1\text{-}r)$–. Students understand the limiting behaviour as □→∞ and its application to a geometric series as a limiting sum and use the notation $\lim n \to \infty\ rn = 0$ for $\|r\| < 1$. Students solve practical problems involving geometric sequences and series.

TIER 1	MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 4 MEASUREMENTS	
YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
Time Students perform calculations of time that involve mixed units and time differences. **Metric** Students convert between appropriate metric measures of length, area, and volume. **Perimeter and Area** Students use formulas and Pythagoras' Theorem to calculate the perimeter and area of circles and figures composed of rectangles and triangles. **Surface Area and Volume** Students calculate the surface area and volume of rectangular and triangular prisms and right circular cylinders and the volume of right prisms and cylinders. **Limits of accuracy** Students estimate metric measurements; and round numbers and measures to an appropriate degree of accuracy (e.g., number of significant figures). **Scales and Scale Drawings** Students read and interpret scales on a range of measuring instruments; and calculate real measurements using scale factors.	**Time** Students apply and solve real life applications (e.g. electronic and paper-based timetables and schedules) involving complex combinations of time zones and time differences. **Metric** Solve using objects to make reasonable estimations of length, mass and capacity; and solve complex applications of imperial and metric units. **Perimeter; Area; Surface Area; Volume** Students use Heron's formula to find the area of a triangle; use area authentic (real-life) problems for volume and capacity; deals with 2D and 3D simple shapes [π=3.14]; and extend volumes use of units to also include mm3 and km3; and solve real-life problems involving complex combinations of measurements. **Limits of accuracy** Students develop a sense of the levels of accuracy that are appropriate to particular situations; and solve real-life problems involving complex combinations of limits of accuracy. **Reading and Interpreting scales/tables** Students construct scale drawings (2-D shapes) and compare readings on different scales; and solve authentic real-life problems involving complex applications and interpretations of readings and measurements on different scales.	**Time** Students calculate application problems with 12 hr and 24 hr clock notation; and solve authentic real-life applications of a variety of complex combinations of time zones, time differences, time, distance and speed in contexts. **Metric** Solve using objects to make reasonable estimations of length, mass and capacity; and solve a variety of complex applications of imperial and metric units. **Perimeter; Area; Surface Area; Volume** Students calculate areas for irregular piece of block of land; and develop and apply formula to solve a variety of complex measurement application problems related to volume and surface areas. **Limits of accuracy** Students develop a sense of the levels of accuracy that are appropriate to particular situations; and solve a variety of real-life problems involving complex combinations of limits of accuracy. **Reading and Interpreting scales/tables** Students read and interpret scales on a range of measuring instruments (e.g. thermometer, scales, etc); recognise that the measurement made is approximate and recording results to a required degree of accuracy; construct scale drawings (2-D shapes) and compare readings on different scales; and solve authentic real-life problems involving a variety of complex applications and interpretations of readings and measurements on different scales in areas

YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
	Sequence & Series Students solve authentic real-life problems involving complex applications of first and second difference patterns to determine modelling functions for given contexts. **Rates and Ratios** Students solve problems involving simple ratios and rates; draw, interpret and analyse graphs of physical phenomena. Students use rates (best-buys, speed etc) and ratios (mixtures, scales)) to solve and describe practical problems.	**Sequence & Series** Students solve complex authentic real-life problems that can be modelled by linear and non-linear functions that are derived from identification of number patterns of first differences and second differences and/or common ratios as appropriate; and solve authentic real-life problems involving a variety of complex applications of first and second difference patterns to determine modelling functions for given contexts. **Rates and Ratios** Students solve problems involving health rates (heart beats, blood pressure) and calculate number of people given percentage breakdown of the population with different health rates, and identify mathematical trends in Health Rates (eg: heart rate, blood pressure) over time under different conditions; read health charts & interpret healthiness of a reading.

TIER 2	CONTINUUM OF KEY IDEAS – TIER 2 – STRAND 4 MEASUREMENTS		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Time Students learn about performing operations involving mixed time units, time differences, and interpreting a variety of timetables and charts. **Metric System** Students learn about conversions between appropriate metric measures of length, area, and volume. **Perimeter and Area** Students learn about developing formulas to find the area and perimeter of triangles, rectangles, parallelograms, and simple composite figures; applying Pythagoras' Theorem; and investigating and finding the area and circumference of circles. **Surface Area and Volume** Students learn about finding the surface area of rectangular and triangular prisms; and the volume of right prisms and cylinders.	**Time** Students learn about international time zones and the use of international times and hourly rates to solve problems. **Metric System** Students learn about conversions between metric and imperial units, and vice-versa. **Perimeter and Area** Students learn about using formulas to calculate the area of triangles and quadrilaterals; developing formulas to find the area of rhombuses, trapeziums, and kites; and finding the area and perimeter of simple composite figures consisting of two shapes including quadrants and semicircles. **Surface Area and Volume** Students learn about finding the surface area of right prisms, right cylinders, and composite solids; and finding the volume of right pyramids, cones, spheres, and composite solids.	**Time** Students learn about very small and very large time scales and intervals; real life applications (e.g. electronic and paper-based timetables and schedules) **Metric System** Students learn about making reasonable estimations of length, mass and capacity; and solve complex applications of imperial and metric. **Perimeter; Area; Surface Area; Volume** Students learn about area of an arc and segment of a circle; formula to simple application problems; Heron's formula to find the area of a triangle; Pythagoras theorem and learn about more complex problems involving perimeter; use area authentic (real-life) problems for volume and capacity; deals with 2D and 3D simple shapes [π=3.14]; and solve authentic real-life problems involving complex applications of measurements. **Limits of accuracy** Students learn about resulting errors expressed using inequality notations; give appropriate upper and lower bounds for data to a specific accuracy; and solve authentic real-life problems i nvolving complex combinations of limits of accuracy.	**Time** Students learn about more complex everyday problems; link between time, distance and speed, application problems with 12 hr and 24 hr clock notation; and solve real life applications. **Metric System** Students learn about more reasonable estimations of length, mass and capacity; and solve a variety of applications of imperial and metric units. **Perimeter; Area; Surface Area Volume** Students learn about areas of irregular piece of block of land; nets of cylinders to establish formulae for surface area; and solve a variety of complex authentic real-life problems involving measurements. **Limits of accuracy** Students learn about resulting errors expressed using inequality notations; give appropriate upper and lower bounds for data to a specific accuracy; and learn about a variety of authentic real-life problems involving complex combinations of limits of accuracy.

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Limits of accuracy Students learn about the limits of accuracy of measuring instruments; and rounding numbers and measures to an appropriate degree of accuracy (e.g., number of significant figures). **Scales and Scale Drawings** Students read and interpret scales on a range of measuring instruments; and calculate real measurements using scale factors.	**Limits of Accuracy** Students learn about the limits of accuracy of given measurements and determining the appropriate degree of accuracy in calculations. **Scales and Scale Drawings** Students learn how to read and interpret a variety of scales on measurement instruments and how to use scale on scale drawings and maps to calculate real measurements.	**Reading and Interpreting scales/tables** Students learn about scales on a range of measuring instruments (e.g. thermometer scales, etc); results are recorded to a required degree of accuracy; learn about scale drawings (2-D shapes) and solve authentic real-life problems involving complex applications and interpretations of readings and measurements on different scales. **Sequence & Series** Students learn about sequence; graph sequence (simple) on a pair of axes of both arithmetic and geometric sequences; find nth term, terms of an arithmetic sequence and a geometric sequence using formulas; and solve authentic real-life problems involving complex applications of first and second difference number patterns, common difference, and common ratio to determine modelling functions. **Rates and Ratios** Students will learn a list of numbers, in which the difference between successive terms is constant, add or subtract a fixed, non-zero number, each time infinitely and the variation in the members of the sequence. Students learn to find the equation for the nth term when an arithmetic sequence is determined completely by the first terms a, and the common difference d.	**Reading and Interpreting scales/tables** Students learn about more ranges of measuring instruments; recognise that the measurement made is approximate and recording results to a required degree of accuracy; construct and interpret scale drawings and compare readings on different scales; and solve a variety of authentic real-life problems involving complex applications and interpretations of readings and measurements on different scales. **Sequence & Series** Students learn about required sequence (complex) on a pair of axes of both arithmetic and geometric sequences; find nth term and learn about sum of required terms of an arithmetic sequence and a geometric sequence using the formulas; and learn about authentic real-life problems involving complex applications of first and second difference number patterns, common difference, and common ratio to determine modelling functions. **Rates and Ratios** Students will learn the geometric progression is a constant multiple of the previous term in which the sequence is a fixed multiplied or divided non-zero number each time infinitely. Students will learn the common ratio between successive terms represented by 'r' and the variation in the elements of the sequence is exponential.

TIER 2	CONTINUUM OF KEY IDEAS – TIER 2 – STRAND 4 MEASUREMENTS	
YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
Time Students learn about performing operations involving mixed time units and time differences. **Metric System** Students learn about conversions between appropriate metric measures of length, area, and volume. **Perimeter and Area** Students learn about developing and using formulas to find the area and perimeter of triangles, rectangles, parallelograms, and simple composite figures; applying Pythagoras' Theorem; and investigating and finding the area and circumference of circles. **Surface Area and Volume** Students learn about finding the surface area and volume of rectangular and triangular prisms and right circular cylinders. **Limits of accuracy** Students learn about estimating metric measurements and rounding numbers and measures to an appropriate degree of accuracy (e.g., number of significant figures). **Scales and Scale Drawings** Students learn about reading and interpreting scales on a range of measuring instruments; and calculating real measurements using scale factors.	**Time** Students learn about electronic and paper-based timetables and schedules) involving complex combinations of time zones and time differences. **Metric** Solve learn about objects to make reasonable estimations of length, mass and capacity; and solve complex applications of imperial and metric units. **Perimeter; Area; Surface Area; Volume** Students learn about Heron's formula to find the area of a triangle; area authentic (real-life) problems for volume and capacity; 2D and 3D simple shapes [π=3.14]; learn about volumes use of units to also include mm3 and km3; and learn about real-life problems involving complex combinations of measurements. **Limits of accuracy** Students learn about how to develop a sense of the levels of accuracy that are appropriate to particular situations; and learn about solving real-life problems involving complex combinations of limits of accuracy. **Reading and Interpreting scales/tables** Students learn about construction of scale drawings (2-D shapes) and compare readings on different scales; and solve authentic real-life problems involving complex applications and interpretations of readings and measurements on different scales.	**Time** Students learn about application problems with 12 hr and 24 hr clock notation; and solve authentic real-life applications of a variety of complex combinations of time zones, time differences, time, distance and speed in contexts. **Metric** Students learn about objects to make reasonable estimations of length, mass and capacity; and solve a variety of complex applications of imperial and metric units. **Perimeter; Area; Surface Area; Volume** Students learn about areas for irregular piece of block of land; and develop and apply formula to solve a variety of complex measurement application problems related to volume and surface areas. **Limits of accuracy** Students learn about solving a variety of real-life problems involving complex combinations of limits of accuracy. **Reading and Interpreting scales/tables** Students learn about reading and interpreting scales on a range of measuring instruments (e.g. thermometer, scales, etc); approximate and recording results to a required degree of accuracy; construction of scale drawings (2-D shapes) and compare readings on different scales; and solve authentic real-life problems involving a variety of complex applications and interpretations of readings and measurements on different scales in areas.

YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
	Sequence & Series Students learn about solving authentic real-life problems involving complex applications of first and second difference patterns to determine modelling functions for given contexts. **Rates and Ratios** Students learn what ratios are, how they can be used to create a proportion, and how to use them to solve a word problem. Students learn different methods to use to solve proportions with an unknown ratio Students will learn how to determine the ratio or rate of change of a relation from a table or graph. Students will also compare and contrast ratios, rates, and rates of change.	**Sequence & Series** Students learn about complex authentic real-life problems that can be modelled by linear and non-linear functions that are derived from identification of number patterns of first differences and second differences and/or common ratios as appropriate; and learn about authentic real-life problems involving a variety of complex applications of first and second difference patterns to determine modelling functions for given contexts. **Rates and Ratios** Students learn how to measure health status including geographical, occupational, socio-economic position and other socio-demographic variations

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 4 MEASUREMENTS		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Time Students are able to: 1. Read, write and record time with the correct units – seconds, minutes, hours, day, week, month, and year. 2. Add and subtract time mentally using bridging strategies e.g., from 2:45 to 3:00 is 15 minutes and from 3:00 to 5:00 is 2 hours so the time from 2:45 until 5:00 pm is 15 minutes plus 2 hours = 2 hours 15 minutes. 3. Add and subtract time with a calculator using the 'degrees, minutes, seconds' button. 4. Round calculator answers to the nearest minute or hour. 5. Interpret calculator displays for time calculations, e.g., 2.25 on a calculator display for a time calculation means 2 hours and 15 minutes. 6. Convert 12-hour time to 24-hour time and vice versa. 7. Compare times and calculate time differences between major Pacific regions, e.g., 'Samoa is 2 hours ahead of Vanuatu, what time is it in Vanuatu when it is 10 pm in Samoa?'	**Time** Students are able to: 1. Calculate time taken for a variety of activities or events, e.g., using a stop watch to time a race. 2. Compare times and calculate time differences between major cities of the world or between Samoa and major cities of the world e.g., 'Given that Samoa is 13 hours ahead of London, what time is it in London when it is 6:00 pm in Samoa?' 3. Solve a variety of application problems that require the use of mixed time units (years / months / days / hours and/or minutes / seconds). 4. Explore and discuss examples of international time zones. 5. Interpret and use information related to international time zones from airline and shipping timetables. 6. Ask questions about international time relating to airline and shipping schedules, eg, 'If a flight from Los Angeles, USA to Paris, France leaves at 6 pm on Sunday and it takes approximately 10 hours 40 minutes, what time in Paris will the flight arrive?	**Time** Students are able to: 1. Use pm and am notations and solve simple time problem. 2. Investigate very small and very large time scales and intervals. 3. Use and interpret electronic and paper-based timetables and schedules to make time calculations as for planning events or activities. 4. Calculate time durations across hours, days and months. 5. Select the most appropriate unit of time for a given task and justifies choice. **Metric System** Students are able to: 1. Choose the appropriate unit of measure. 2. Solve simple application problems using imperial units and metric units. 3. Use the comparative size of familiar objects to make reasonable estimations of length, mass, area and capacity.	**Time** Students are able to: 1. Sequencing familiar events in time order. 2. Compare and order duration of events using everyday language of time. 3. Choose events and actions that make connections with students' everyday family routines. 4. Compare and contrast aspects of time and time management as they impact on us. 5. Use the link between time, speed and distance to carry out related calculations. **Metric System** Students are able to: 1. Use metric units of mass, their abbreviations, conversions between them, and appropriate choices of units. 2. Use metric units of volume, their abbreviations, conversions between them, and appropriate choices of units.

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
8. Ask questions about international time relating to everyday life e.g., whether a particular soccer game can be watched live on television during normal working hours? 9. Solve problems involving calculations with mixed time units e.g., 'How old is a person today if he/she was born on 30/6/1989? 10. Plan the most efficient journey to a given destination involving a number of connections and modes of transport. **Metric System** Students are able to: 1. Convert between metric measures of length, $1\ cm = 10\ mm, 1\ m = 100\ cm = 1{,}000\ mm$. 2. Convert between metric units of area, $1\ cm^2 = 100\ mm^2, 1\ m^2 = 1{,}000{,}000\ mm^2$, $1\ ha = 10{,}000\ m^2, 1\ km^2 = 1{,}000{,}000\ m^2 = 100\ ha.$ 3. Convert between metric units of volume, $1\ cm^3 = 1000\ mm^3, 1\ L = 1000\ mL = 1000\ cm^3, 1\ m^3 = 1000\ L = 1\ kL.$	7. Calculate and use rates including such ideas as average speeds, flow rates, hourly rates and exchange rates. **Metric system** Students are able to: 1. Convert between metric units and imperial units of length, and vice-versa. 2. Convert between metric units and imperial units of area, and vice-versa. 3. Convert between metric units and imperial units of volume, and vice-versa. **Perimeter and Area** Students are able to: 1. Use formulas to find the area and perimeter of triangles, rectangles, squares and parallelograms. 2. Determine the areas of simple composite figures that may be dissected into rectangles and triangles. 3. Compare various shapes with the same perimeter and ask questions related to their area such as whether they have the same area. 4. Explain the relationship that multiplying, dividing, squaring, and factoring have with the areas of squares, rectangles, with integer side lengths.	**Perimeter; Area; Surface Area Volume** Students are able to: 1. Identify different methods that can be used to find the Perimeter and Area of a simple 2D shape or Volume of a simple 3D shape. 2. Calculate the area of an arc and segment of a circle. 3. Develop and apply formulae to answer simple application problems. 4. Use Heron's formula to find the Area of a triangle. 5. Apply Pythagoras theorem to solve problems involving Perimeter and Area. 6. Connect volume and capacity of a cylinder to solve authentic problems. **Limits of Accuracy** Students are able to: 1. Calculate possible resulting errors expressed using inequality notations give appropriate upper and lower bounds for data to a specific accuracy. 2. Determine limits of accuracy. 3. Use simple authentic comparable object size to make reasonable estimation.	**Perimeter; Area; Surface Area Volume** Students are able to: 1. Calculate perimeters of familiar shapes, including triangles, squares, rectangles, polygons, circles, arc lengths, and composites of these. 2. Use formulas to calculate areas of regular shapes, including triangles, squares, rectangles, parallelograms, trapeziums, circles and sectors. 3. Find the area of irregular figures by decomposition into regular shapes. 4. Find the surface area of familiar solids, including cubes, rectangular and triangular prisms, spheres and cylinders. 5. Find the surface area of pyramids, such as rectangular- and triangular-based pyramids. 6. Use addition of the area of the faces of solids to find the surface area of irregular solids. 7. Use formulas to find the volume and capacity of regular objects such as cubes, rectangular and triangular prisms and cylinders. 8. Use formulas to find the volume of pyramids and spheres.

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 4 - *continued* MEASUREMENTS		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Perimeter and Area Students are able to: ***Length and Perimeter*** 1. Estimate lengths and distance using visualisation strategies. 2. Recognise that all are measurements are approximate. 3. Interpret the meaning of the prefixes 'milli', 'centi', and 'kilo'. 4. Find the perimeter of simple composite figures. ***Pythagoras' Theorem*** 5. Identify the hypotenuse as the longest side in any right-angled triangle and also as the side opposite the right angle. 6. Establish the relationship between the lengths of the sides of a right-angled triangle in practical ways, including the dissection of areas. 7. Using Pythagoras' Theorem to find the length of sides in right-angled triangles. 8. Solve problems involving Pythagoras' Theorem giving an exact answer as a surd (e.g., √5) and approximating the answer using an approximation of the square root.	5. Develop and use formulas to find the area and perimeter of quadrilaterals such as a kite or rhombus, $Area = \frac{1}{2}xy$ where x and y are the lengths of the diagonals. 6. Develop and use formulas to find the area of a trapezium $Area = \frac{1}{2}h(a+b)$ where h is the perpendicular height and a and b the lengths of the parallel sides. 7. Identify the perpendicular height of a trapezium in different orientations. 8. Select and use the appropriate formula to calculate the area of a quadrilateral. 9. Dissect composite figures into simpler shapes. 10. Solve practical problems involving area of quadrilaterals and simple composite figures. 11. Calculate the area of simple composite figures consisting of two shapes including quadrants and semicircles. 12. Use formulas to calculate the area A, of circles with radius r; $A=\pi r^2$, and circumference C; $C=2\pi r = \pi d$ where d is the diameter of the circle.	**Reading and Interpreting scales/ tables** Students are able to find simple perimeters, areas and volumes of everyday objects (irregular and composite shapes) and state the answer. **Rates and Ratios** Students are able to: 1. Develop linear formula from a word description. 2. Use the recursion to generate an arithmetic sequence. 3. Express rational numbers as terminating or eventually recurring decimals and vice versa.	**Limits of Accuracy** Students are able to solve complex application problems of metric and imperial measures. **Reading and Interpreting scales/ tables** Students are able to: 1. Recognize the relationship between the gradient of a graph and the rate of change. 2. Apply differentiation to find gradients , stationary points, turning points, to assist with sketching graphs of functions and to solve maxima and minima problems. 3. Read and interpret complex scales on a range of measuring instruments. **Sequence and Series** Students are able to: 1. Use sequence and series to model real problems and interpret their solutions. 2. Describe and use arithmetic and geometric sequences or series in common situations. 3. Find the derivative of a polynomial.

YEAR 9 Mathematics	YEAR 10 Mathematics	YEAR 11 Mathematics	YEAR 12 Mathematics
9. Identify a Pythagorean triad as a set of three numbers such that the sum of the squares of the first two equals the square of the third. 10. Use the converse of Pythagoras' Theorem to establish whether a triangle has a right angle. ***Areas of Squares, Rectangles, Triangles and Parallelograms*** 11. Develop and use formulas for the area of a square and rectangle. 12. Develop (by forming a rectangle) and using the formula for the area of a triangle. 13. Find the areas of simple composite figures that may be dissected into rectangles and triangles. 14. Develop the formula by practical means for finding the area of a parallelogram e.g., by forming a rectangle using cutting and folding techniques. 15. Explain the relationship that multiplying, dividing, squaring and factoring have with the areas of squares and rectangles with integer side lengths. ***Circumferences and Areas of Circles*** 16. Demonstrate by practical means that the ratio of the circumference to the diameter of a circle is constant, e.g., by measuring and comparing the diameter and circumference of cylinders.	13. Calculate the perimeter of simple composite figures consisting of two shapes including quadrants and semi-circles. **Surface Area and Volume** Students are able to: ***Surface Area of Right Prisms and Right Cylinders*** 1. Distinguish between the lateral surface area of a prism which is the surface area of all its sides (excluding the top and base) and total surface area which is the lateral surface area plus the areas of its top and base. 2. Explore and use nets to find the total surface area of rectangular and triangular prisms and right cylinders. 3. Develop and use formulas to find the total surface area of a triangular and a rectangular prism by exploring nets. 4. Develop and use the formula to find the surface area of right cylinders. $SA = 2\pi r^2 + 2\pi r^2 h$ where r is the length of radius and h is the perpendicular height. 5. Calculate the height of a right cylinder given its total surface area and areas of its top and base, or (b) total surface area and radius of its base. 6. Calculate the height of a rectangular prism given; (a) its total surface area and areas of its top and base, or (b) total surface area and length and breadth of its cross-section.		4. Find the anti-derivative of a polynomial and evaluate definite integrals. 5. Consolidate formulas for more complex sequence. **Rates and Ratios** Students are able to: 1. Recognize and use the recursive definition of a geometric sequence. 2. Solve practical problems involving geometric sequences and series.

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 4 - *continued* MEASUREMENTS		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11	YEAR 12

17. Define the number π as the ratio of the circumference to the diameter of any circle.
18. Develop, from the definition of π, formulas to calculate the circumference of circles in terms of r or diameter d,

$$C = \pi d \text{ or } C = 2\pi r$$

19. Develop by dissection and using the formula to calculate the area of circles: $A = \pi r^2$.

Surface Area and Volume

Students are able to:

Surface Area of Prisms

1. Identify the surface area and edge lengths of rectangular and triangular prisms.
2. Find the surface area of rectangular and triangular prisms by practical means e.g., from a net.
3. Calculate the surface area of rectangular and triangular prisms.

Volume of Prisms

4. Using the kilolitre as a unit to measure large volumes.
5. Construct and draw various prisms from a given cross-sectional diagram.
6. Identify and draw the cross-section of a prism.
7. Develop the formula for the volume of prisms by considering the number and volume of layers of identical shapes.

$$Volume = base\ area \times height$$

8. Calculate the volume of a prism given its perpendicular height and the area of its cross-section.
9. Calculate the volume of prisms with cross-sections that are rectangular and triangular.

7. Calculate the surface area of composite solids involving right cylinders and prisms.
8. Solve a variety of practical problems involving the lateral and total surface areas of rectangular and triangular prisms and right cylinders.
9. Calculate the surface area of composite solids involving right cylinders and prisms.

Volume of Right Prisms and Cylinders

10. Calculate the volume of a prism given its perpendicular height and the area of its cross-section.
11. Determine the area of the cross-section of a prism given its volume and perpendicular height.
12. Find the volume of prisms with cross-sections that are simple composite figures that may be dissected into rectangles and triangles.
13. Use the formula, $V = \pi r^2 h$, to find the volume of cylinders (r is the length of the radius of the base and h is the perpendicular height).
14. Calculate the radius of a cylinder given its volume and perpendicular height.
15. Develop and use a formula to calculate the volume of a cylinder constructed by rolling a rectangular sheet of material (of length l and breadth b) along its length.
16. Solve problems involving the volume and capacity of right prisms and cylinders.

Volume of Right, Pyramids, Cones and Spheres

17. Use the fact that a pyramid has one-third the volume of a prism with the same base and the same perpendicular height.
18. Use the fact that a cone has one-third the volume of a cylinder with the same base and the same perpendicular height.
19. Use the formula $V = \frac{1}{3}Ah$ to find the volume of pyramids and cones where A is the base area and h is the perpendicular height.

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11	YEAR 12
10. Calculate the volume of prisms with cross-sections that are simple composite figures that may be dissected into rectangles and triangles. *Volume of Cylinders* 11. Develop and use the formula to find the volume of cylinders (r is the length of the radius of the base and h is the perpendicular height): $V = \pi r^2 h$. **Limits of accuracy** Students are able to: 1. Estimate and describe limits of accuracy of measuring instruments (± 0.5 unit of measurement). 2. Round numbers and measurements to an appropriate degree of accuracy (e.g., number of significant figures). 3. Write answers to a specified or sensible level of accuracy, using the 'approximately equals' (≈) sign. **Scales and Scale Drawings** Students are able to: 1. Read scales on a variety of measuring instruments accurately (thermometers, weight scales, clocks, stopwatches, measuring tapes, protractors, etc.). 2. Read and interpret how a scale on a scale drawing is converted into real numbers using the scale factor. 3. Identify the scale factor on a scale drawing and use it to determine the real size of the object. 4. Read and interpret how a scale on a map is converted into real numbers. 5. Identify the scale on a map and use it to calculate real distances between locations. 6. Produce a scale drawing of a floor plan of your classroom or school using an appropriate scale factor. 7. Solve a variety of application problems on reading measurement scales and interpreting scales on scale drawings and maps to determine real measurements.	20. Use the formula $V = \frac{4}{3}\pi r^3$ to find the volume of spheres where r is length of radius. 21. Find the dimensions of solids given their volume and/or surface area by substitution into a formula to generate an equation. 22. Find the volume of prisms whose bases can be dissected into triangles, special quadrilaterals and sectors. 23. Find the volume of composite solids by dissecting them into several simpler shapes. 24. Solve practical problems related to volume and capacity, e.g., find the volume of a swimming pool with a given rectangular surface and a trapezoidal side. **Limits of Accuracy** Students are able to: 1. Estimate the degree of accuracy of given measurements. 2. Round numbers and measurements to an appropriate degree of accuracy (e.g., number of significant figures). 3. Calculate answers to a specified degree of accuracy, using the ≈ sign. **Scales and Scale Drawings** Students are able to: 1. Read scales on a variety of measuring instruments accurately (digital instruments, volumetric cylinders, scales, etc.). 2. Use scales on a variety of scale drawings, building plans, and maps to calculate real measurements to inform decisions. 3. Produce a scale drawing of a floor plan of your house, school, computer lab, or any other place of interest in your home/school environment. 4. Solve a variety of application problems on reading measurement scales and interpreting scales on scale drawings and maps to determine real measurements in order to inform decision making.		

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 4 MEASUREMENTS	
YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
Time Students are able to: 1. Read, write and record time with the correct units – seconds, minutes, hours, day, week, month, year. 2. Convert between 12-hour time and 24-hour time and vice versa and solve a variety of real-life problems on events and travel that use a mixture of the two notations. 3. Ask questions about international time relating to everyday life e.g., determine the local time a particular overseas event can be watched live on television. 4. Solve problems involving calculations with mixed time units e.g., 'Peni is 34 days older than Sina. If Sina's birthday is 27/02/1979, when is Peni's birthday? 5. Solve practical problems involving calculations of the duration of a variety of activities or events, e.g., using a stopwatch to time who takes the shortest time to complete 10 jumps. 6. Solve real-life problems for a most efficient journey involving a number of connections and modes of transport based on interpreting information on timetables that use the 24-hour clock. 7. Solve problems involving comparison of times and time differences between Samoa and major cities of the world e.g., 'Given that Samoa is 21 hours ahead of Los Angeles, USA, what time is it in Los Angeles when it is 9:00 pm in Samoa?'	**Time** Students are able to: 1. Use pm and am notations and solve simple time problem. 2. Investigate very small and very large time scales and intervals. 3. Use and interpret electronic and paper-based timetables and schedules to make time calculations as for planning events or activities. 4. Investigate time involvement – with the appropriate time unit to complete any practical tasks. 5. Calculate time durations across hours, days and months. 6. Carry out practical tasks and investigations involving time events. 7. Select the most appropriate unit of time for a given task and justifies choice. **Metric** Students are able to : 1. Choose the appropriate unit of measure. 2. Solve simple application problems using imperial units and metric units. 3. Use the comparative size of familiar objects to make reasonable estimations of length, mass, area and capacity. **Perimeter; Area; Surface Area; Volume** Students are able to : 1. Calculate the area of an arc and segment of a circle.	**Time** Students are able to: 1. Sequencing familiar events in time order. 2. Compare and order duration of events using everyday language of time. 3. Choose events and actions that make connections with students' everyday family routines. 4. Use the link between time, speed and distance to carry out related calculations. 5. Calculate durations of activities and events including situations bridging across several hours and parts of hours using both 12 hour clock and 24 hour notations. **Metric** Students are able to: 1. Solve complex application problems of metric and imperial measures. 2. Use complex authentic comparable object size to make reasonable estimations. **Perimeter; Area; Surface Area; Volume** Students are able to: 1. Calculate irregular piece of block of land. 2. Solve simple problems involving measurement. 3. Analyse nets of cylinders to establish formulae for surface area.

YEAR 10 General Mathematics	YEAR 11 General Mathematics	YEAR 12 General Mathematics
8. Solve a variety of application problems that require the use of mixed time units ... (years / months /days /hours and/or minutes /seconds). 9. Solve a variety of problems on time by interpreting, and using information from timetables, charts, and tide schedules. **Metric System** Students are able to: 1. Convert between metric measures of length, $1\ cm = 10\ mm, 1\ m = 100\ cm = 1{,}000\ mm$. 2. Convert between metric units of area, $1\ cm^2 = 100\ mm^2, 1\ m^2 = 1{,}000{,}000\ mm^2, 1\ ha = 10{,}000\ m^2, 1\ km^2 = 1{,}000{,}000\ m^2 = 100\ ha.$ 3. Convert between metric units of volume, $1\ cm^3 = 1000\ mm^3, 1\ L = 1000\ mL = 1000\ cm^3, 1\ m^3 = 1000\ L = 1\ kL.$ **Perimeter and Area** Students are able to: *Length and Perimeter* 1. Find the perimeter of simple composite figures. 2. Find the dimensions of a square given its perimeter, and of a rectangle given its perimeter and one side length. 3. Solve real-life application problems relating to perimeter and area.	2. Develop and apply formulae to answer simple application problems involving Volumes and Capacities. 3. Apply Pythagoras theorem to solve problems involving Perimeter and Area. 4. Measure and calculate the Perimeter of composite rectilinear shapes in centimetres and meters 5. Calculate, estimate and compare volume of cubes and cuboids using standard units, including cubic centimetres (cm^3) and cubic meters (m^3), and extending to other units [for example, mm^3 and km^3]. **Limits of accuracy** Students are able to : 1. Solve simple application problems using imperial and metric measures. 2. .Use simple authentic comparable object size to make reasonable estimations. **Reading and Interpreting scales/tables** Students are able to: 1. Interpret and use simple information about rates presented in a variety of ways in real life situations. 2. Construct scale drawing 2D shapes and compare readings on different scales. **Sequence & Series** Students are able to distinguish between simple arithmetic and geometric sequence giving the nth term and the first term of a sequence.	**Limits of accuracy** Students are able to: 1. Solve complex application problems using imperial and metric measures. 2. Use complex authentic comparable object size to make reasonable estimations. **Reading and Interpreting scales/tables** Students are able to: 1. Read and interpret complex diagrams involving the reading of scales, maps and plans. 2. Recognize that the measurement made is approximate and recording results to a required degree of accuracy. 3. Construct, interpret and solve a scale drawing problem and compare readings on different scales. **Sequence & Series** Students are able to distinguish between complex arithmetic and geometric sequence giving the nth term and the first term of a sequence. **Rates and Ratios** Students are able to: 1. Convert units of rates occurring in practical situations to solve problems. 2. Use rates to make comparisons. 3. Calculate absolute value.

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 4 - *continued* MEASUREMENTS		
	YEAR 10 General Mathematics	YEAR 11 General Mathematics	YEAR 12
	Pythagoras' Theorem 6. Identify the perpendicular height of a right-angled triangle in different orientations. 7. Use Pythagoras' Theorem to find the length of sides in right-angled triangles. 8. Apply Pythagoras' Theorem to solve application problems involving perimeter and area. *Areas of Squares, Rectangles, Triangles and Parallelograms* 9. Use formulas to find the area of a square, rectangle, triangle, and parallelogram. 10. Determine the areas of simple composite figures that may be dissected into rectangles and triangles. 11. Identify the perpendicular height of triangles and parallelograms in different orientations. 12. Compare rectangles with the same area and ask questions related to their perimeter such as whether they have the same perimeter. 13. Compare various shapes with the same perimeter and ask questions related to their area such as whether they have the same area. 14. Explain the relationship that multiplying, dividing, squaring, and factoring have with the areas of squares and rectangles, with integer side lengths. *Circumferences and Areas of Circles* 15. Use formulas to calculate the circumference $(C=\pi d = 2\pi r)$ and area of circles $(A = \pi r^2)$ in terms of radius r or diameter d. 16. Find the area and perimeter of quadrants and semi-circles. 17. Solve problems relating to perimeter, area, and circumference of circles. 18. Find radii of circles given their circumference or area. **Surface Area and Volume** Students are able to: *Surface Area of Prisms and Right Cylinders* 1. Determine the edge lengths of rectangular and triangular prisms to calculate their surface areas. 2. Determine the perpendicular height of a right circular cylinder and radius of its circular base. 3. Distinguish between the lateral surface area of a prism which is the surface area of all its sides (excluding the top and base) and total surface area which is the lateral surface area plus the areas of its top and base.	**Rates and Ratios** Students are able to: 1. Find the ratio of two quantities. 2. Review identifying common usage of rates such as km/h. 3. Complete calculations with rates, including solving problems involving direct proportion in terms of rates.	----------

YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12
4. Explore and use nets to find the total surface area of rectangular and triangular prisms and right cylinders. 5. Establish, using the net of a closed right cylinder, that the formula to find the surface area of right cylinders is: $SA = 2\pi r^2 + 2\pi r^2 h$, where r is the length of radius and h is the perpendicular height. 6. Find the surface area of right cylinders. 7. Calculate the surface area of composite solids involving right cylinders and prisms. 8. Solve practical problems related to surface area of right cylinders. 9. Calculate the lateral surface area and total surface area of a variety of rectangular and triangular prisms and cylinders. 10. Calculate the height of a rectangular prism given; (a) its total surface area and areas of its top and base, or (b) total surface area and length and breadth of its cross-section. 11. Calculate the height of a right cylinder given its total surface area and areas of its top and base, or (b) total surface area and radius of its base. 12. Solve a variety of problems involving the lateral and total surface areas of rectangular and triangular prisms and cylinders. 13. Solve practical problems related to surface area, e.g., compare the amount of packaging material needed for different shapes. *Volume of Prisms* 14. Find the height of a prism given its volume, length and breadth. 15. Draw various prisms from given cross-sectional diagrams. 16. Identify and draw the cross-section of a prism. 17. Calculate the volume of a prism given its perpendicular height and the area of its cross-section. 18. Determine the area of the cross-section of a prism given its volume and perpendicular height. 19. Identify and justify the appropriate formula to use based on given information. 20. Calculate the volume of prisms with cross-sections that are rectangular and triangular. 21. Find the volume of prisms with cross-sections that are simple composite figures that may be dissected into rectangles and triangles. 22. Recognise, giving examples, those prisms with the same volume may have different surface areas, and prisms with the same surface area may have different volumes.		

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 4 - *continued* MEASUREMENTS		
	YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12
	Volume of Cylinders 23. Use the formula, $V = \pi r^2 h$, to find the volume of cylinders (r is the length of the radius of the base and h is the perpendicular height). 24. Calculate the radius of a cylinder given its volume and perpendicular height. 23. Develop a formula and use it to calculate the volume of a cylinder constructed by rolling a rectangular sheet of material (of length l and breadth b) along its length. 24. Solve a variety of practical problems involving the volume and capacity of right prisms and cylinders. **4.5 Limits of accuracy** Students are able to: 1. Estimate and describe limits of accuracy of measuring instruments (± 0.5 unit of measurement). 2. Discuss why measurements are never exact. 3. Choose appropriate units of measurement based on the required degree of accuracy. 4. Round numbers and measurements to an appropriate degree of accuracy (e.g., number of significant figures). **Scales and Scale Drawings** Students are able to: 1. Read scales on a variety of measuring instruments accurately (thermometers, digital scales, digital clocks and stopwatches etc.). 2. Identify the scale factor on a scale drawing and use it to determine the real size of the object. 3. Identify the scale on a map and use it to calculate real distances between locations. 4. Produce a scale drawing of a floor plan of your classroom or school using an appropriate scale factor, or scales drawing of an object of your choosing. 5. Solve a variety of application problems on reading scales on measuring devices and interpreting scales on scale drawings and maps to determine real measurements.		

TIER 1

MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 5
GEOMETRY

YEAR 9 Mathemetics

Angles

Students identify and name different angles formed by the intersection of straight lines, including those related to transversals on sets of parallel lines, and make use of the relationships between them.

Properties of Geometrical Figures

Students classify, construct, and determine the properties of triangles and quadrilaterals; and identify congruent and similar 2-D figures.

Circle

Students identify different parts of the circle, investigate line and rotational symmetry of circles, and establish simple angle relationships.

Transformations

Students use vector translation, rotation, and reflection to transform figures on a coordinate plane.

YEAR 10 Mathemetics

Angles

Students determine the sum of exterior angles result and the sum of interior angles result for convex polygons including 5-ided to 10-sided equilateral polygons.

Properties of Geometrical Figures

Students develop and apply results for proving that triangles are congruent or similar.

Circle

Students prove the interior and exterior angles properties of cyclic quadrilaterals.

Transformations

Students explore transformations using enlargement with positive scale factors including unit fractions and explore patterns using line and rotational symmetry.

YEAR 11 Mathemetics

Angles

Students use interior and exterior angles of polygons to solve more complex problems; find sum of interior and exterior angles of 6-sided to 10-sided equilateral and non–equilateral polygons; calculate more complex angle equations using properties of equilateral polygons; and solve authentic real-life problems involving ***complex applications*** of angle properties and polygons.

Parallel Lines

Students solve applications problems involving ***complex combinations*** of angle properties between parallel lines.

Circle

Students prove properties of angles in circles related to its interior and exterior angles and those at the centre, on circumference, inside semicircles, and subtended by arcs and chords; and solve ***complex*** authentic real-life problems.

Transformation

Students construct simple regular polygons inscribed in circles; construct in-centres, circum-centres, and angle bisectors of triangles and perpendicular bisectors of line segments; and solve ***simple*** authentic real-life problems involving the application of the geometry of transformations.

Geometrical Figures

Students apply logical reasoning, including the use of congruence and similarity, to proofs and numerical exercises involving plane shapes; prove properties of interval joining the midpoints of two sides of a triangle in relation to the third side, and the converse; determine scale factors of matching areas and matching volumes; and solve simple authentic application problems involving similarity ratios and areas and volumes.

YEAR 12 Mathemetics

Angles

Students solve a ***variety*** of authentic real-life problems involving applications of angle properties and polygons.

Parallel Lines

Students solve ***complex applications*** problems for a ***variety*** of situations which involve the application of the properties of angles between parallel lines.

Circle

Students solve ***complex applications*** problems which involve the application of the properties of circle geometry.

Transformation

Students solve a ***variety*** of complex applications problems involving the geometry of transformations.

Geometrical Figures

Students use similarity properties of two 2D figures to determine relevant enlargement or reduction factors; calculate actual dimensions; and solve ***complex*** applications problems involving the geometry of similar and congruent figures.

TIER 1	MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 5 GEOMETRY	
YEAR 9 General Mathematics	YEAR 10 General Mathematics	YEAR 11 General Mathematics
Angles Students identify and label angles of parallel lines as well as interior and exterior angles of geometry; solve simple angle equations using angle properties; find sum of angles of interior and exterior angles of 5-ided to 10-sided equilateral polygons; calculate angle equations using properties of equilateral polygons. **Parallel Lines** Students determine simple combinations of unknown angles using properties of angles between parallel lines and justifying them with reasons. **Circle** Students prove angle properties of cyclic quadrilaterals regarding its interior and exterior angles. **Transformation** Students explore transformations using enlargement with positive scale factors including unit fractions; explore patterns using lines and rotational symmetry; and find unknown bearings and unknown distances using scale diagrams. **Geometrical Figures** Students formulate proofs for congruent figures or similar figures; apply logical reasoning, including the use of congruence and similarity, to proofs and numerical exercises involving plane shapes; express in algebraic terms the interior angle sum of a polygon with n sides; and solve problems involving their applications in real-life situations.	**Angles** Students use interior and exterior angles of polygons to solve more complex problems; find sum of interior and exterior angles of 6-sided to 10-sided equilateral and non–equilateral polygons; calculate more complex angle equations using properties of equilateral polygons and solve authentic real-life problems involving complex applications of the geometry of angles of polygons. **Parallel Lines** Students solve applications problems involving complex combinations of angle properties between parallel lines. **Circle** Students prove properties of angles in circles related to its interior and exterior angles and those at the centre, on circumference, inside semicircles, and subtended by arcs and chords. **Transformation** Students construct simple regular polygons inscribed in circles; construct incentres, circumcentres, and angle bisectors of triangles and perpendicular bisectors of line segments; and solve problems involving the geometry of transformations. **Geometrical Figures** Students apply logical reasoning, including the use of congruence and similarity, to proofs and numerical exercises involving plane shapes; prove properties of interval joining the midpoints of two sides of a triangle in relation to the third side, and the converse; determine scale factors of matching areas and matching volumes; and solve simple authentic application problems involving similarity ratios and areas and volumes.	**Angles** Students solve a variety of authentic real-life problems involving complex applications of the geometry of angles of polygons. **Parallel Lines** Students solve complex applications problems which involve the application of the properties of angles between parallel lines. **Circle** Students solve complex applications problems which involve the application of the properties of circle geometry. **Transformation** Students construct more complex regular polygons (up to 10-sided) inscribed in circles including incentres, circumcentres and angle bisectors of triangles, and perpendicular bisectors of line segments; construct more complex shapes using the compass, ruler and protractor; and solve complex applications problems in the areas which involve the geometry of transformations. **Geometrical Figures** Students use similarity properties of two 2D figures to determine relevant enlargement or reduction factors; calculate actual dimensions; solve complex application problems in the different areas which involve the geometry of similar and congruent figures.

TIER 2

CONTINUUM OF KEY IDEAS – TIER 2 – STRAND 5
GEOMETRY

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Angles Students learn about classifying angles and determining angle relationships; and constructing parallel and perpendicular lines and determining associated angle properties. **Properties of Geometrical Figures** Students learn about classifying, constructing, and determining the properties of triangles and quadrilaterals; and completing simple numerical exercises based on geometrical properties; and identifying congruent and similar 2-S figures. **Circle** Students learn about the different parts of the circle, line and rotational symmetry, and establishing simple angle properties of circles. **Transformations** Students learn about transforming figures using vector translation, rotation, and reflection.	**Angles** Students learn about determining the sum of exterior angles result and the sum of interior angles result for convex polygons including 5-ided to 10-sided equilateral polygons. **Properties of Geometrical Figures** Students learn about identifying similar triangles and describing their properties, using simple deductive reasoning in numerical and non-numerical problems, and verifying the properties of special quadrilaterals using congruent triangles. **Circle** Students learn about exploring and proving angle properties of cyclic quadrilaterals regarding its opposite angles, and interior and exterior angles. **Transformations** Students learn about enlargements with positive scale factors and unit fractions, and exploring patterns using lines and rotational symmetry.	**Angles** Students learn about interior and exterior angles of polygons; learn about sum of interior and exterior angles of 6-sided to 10-sided equilateral and non–equilateral polygons; learn about more complex angle equations using properties of equilateral polygons; and solve authentic real-life problems involving complex applications of angle properties and polygons. **Parallel Lines** Students learn about solving applications problems involving complex combinations of angle properties between parallel lines. **Circle** Students learn about properties of angles in circles related to its interior and exterior angles and those at the centre, on circumference, inside semicircles, and subtended by arcs and chords; and solve complex authentic real-life problems. **Transformation** Students learn about construction of simple regular polygons inscribed in circles; construct in-centres, circum-centres, and angle bisectors of triangles and perpendicular bisectors of line segments; real-life problems involving the application of the geometry of transformations. **Geometrical Figures** Students learn about logical reasoning, including the use of congruence and similarity, proofs and numerical exercises involving plane shapes; properties of interval joining the midpoints of two sides of a triangle in relation to the third side, and the converse; determine scale factors of matching areas and matching volumes; and solve simple authentic application problems involving similarity ratios and areas and volumes.	**Angles** Students learn about a variety of authentic real-life problems involving applications of angle properties and polygons. **Parallel Lines** Students learn about complex applications problems for a variety of situations which involve the application of the properties of angles between parallel lines. **Circle** Students learn about complex applications problems which involve the application of the properties of circle geometry. **Transformation** Students learn about a variety of complex applications problems involving the geometry of transformations. **Geometrical Figures** Students learn about similarity properties of two 2D figures to determine relevant enlargement or reduction factors; calculate actual dimensions; and solve complex applications problems involving the geometry of similar and congruent figures.

TIER 2

CONTINUUM OF KEY IDEAS – TIER 2 – STRAND 5
GEOMETRY

YEAR 9
General Mathematics

Angles
Students learn about angles of parallel lines as well as interior and exterior angles of geometry and angle equations using properties of equilateral polygons

Parallel Lines
Students learn about ***simple combinations*** of unknown angles using properties of angles between parallel lines and justifying them with reasons.

Circle
Students learn about angle properties of cyclic quadrilaterals regarding its interior and exterior angles.

Transformation
Students learn about transformations using enlargement with positive scale factors including unit fractions; learn about patterns using lines and rotational symmetry and unknown bearings and unknown distances using scale diagrams

Geometrical Figures
Students learn about proofs for congruent figures or similar figures, logical reasoning, the use of congruence and similarity, numerical exercises involving plane shapes; express in ***algebraic terms*** the interior angle sum of a polygon with n sides; and solve problems involving their applications in real-life situations.

YEAR 10
General Mathematics

Angles
Students learn about interior and exterior angles of polygons to solve more complex problems; learn about the sum of interior and exterior angles of 6-sided to 10-sided equilateral and non–equilateral polygons; learn about more complex angle equations using properties of equilateral polygons and solve authentic real-life problems involving ***complex*** applications of the geometry of angles of polygons.

Parallel Lines
Students learn about applications problems involving ***complex combinations*** of angle properties between parallel lines.

Circle
Students learn about properties of angles in circles related to its interior and exterior angles and those at the centre, on circumference, inside semicircles, and subtended by arcs and chords.

Transformation
Students learn about the construction of ***simple*** regular polygons inscribed in circles; construct incentres, circumcentres, and angle bisectors of triangles and perpendicular bisectors of line segments; and solve problems involving the geometry of transformations.

Geometrical Figures
Students learn about logical reasoning, including the use of congruence and similarity, to proofs and numerical exercises involving plane shapes; learn about properties of interval joining the midpoints of two sides of a triangle in relation to the third side, and the converse; learn about scale factors of matching areas and matching volumes; and solve ***simple*** authentic application problems involving similarity ratios and areas and volumes.

YEAR 11
General Mathematics

Angles
Students learn about a variety of authentic real-life problems involving complex applications of the geometry of angles of polygons.

Parallel Lines
Students learn about ***complex applications*** problems which involve the application of the properties of angles between parallel lines.

Circle
Students learn about ***complex*** applications problems which involve the application of the properties of circle geometry.

Transformation
Students learn about constructing of ***more complex regular*** polygons (up to 10-sided) inscribed in circles including incentres, circumcentres and angle bisectors of triangles, and perpendicular bisectors of line segments; construct more complex shapes using the compass, ruler and protractor; and solve ***complex applications*** problems in the areas which involve the geometry of transformations.

Geometrical Figures
Students learn about similarity properties of two 2D figures to determine relevant enlargement or reduction factors; learn about actual dimensions and solving ***complex*** application problems in the different areas which involve the geometry of similar and congruent figures.

TIER 3

SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 5
GEOMETRY

YEAR 9 Mathemetics

Angles

Students are able to:

Angles at a Point

1. Label and name points, lines and intervals using capital letters.
2. Label the vertex and arms of an angle with capital letters.
3. Label and name angles using ∠A and ∠XYZ notation.
4. Use the common conventions to indicate right angles and equal angles on diagrams.
5. Identify and name adjacent angles (two angles with a common vertex and a common arm), vertically opposite angles, acute angles, obtuse angles, straight angles, and angles of complete revolution, embedded in a diagram.
6. Use the words 'complementary' and 'supplementary' for angles adding to 90° and 180° respectively, and the terms 'complement' and 'supplement'.
7. Recognise and explain why adjacent angles adding up to 90° form a right angle.
8. Recognise and explain why adjacent angles adding up to 180° form a straight angle.

YEAR 10 Mathemetics

Angles

Students are able to:

1. Apply the result for the interior angle sum of a triangle to find, by dissection, the interior angle sum of polygons with 5, 6, 7, 8, 9, 10 sides.
2. Define the exterior angle of a convex polygon.
3. Establish that the sum of the exterior angles of any convex polygon is 360°.
4. Apply angle sum results to find unknown angles.
5. Express in algebraic terms the interior angle sum of a polygon with n sides, e.g. (n – 2) x 180°.
6. Find the size of the interior and exterior angles of regular polygons with 5, 6, 7, 8, ... sides.
7. Solve problems using angle sum of polygon results.

Properties of Geometrical Figures

Students are able to:

Congruent Triangles

1. determine what information is needed to show that two triangles are congruent.

YEAR 11 Mathemetics

Angles

Students are able to:

1. Use interior and exterior angles of polygons to solve more complex problems.
2. Solve problems involving angles properties of lines and polygons and parallel lines.
3. Calculate angle equations using properties of equilateral polygons.

Parallel Lines

Students are able to:

1. Calculate applications of angle properties between parallel lines.
2. Determine the gradients of parallel and perpendicular lines.
3. Construct angle bisector and use a compass to justify it.

Circle

Students are able to:

1. Study circle terminologies and properties of circles.
2. Prove properties of angles in circles; angles at centre is twice the angle at circumference; angles subtended by same arc or chord are equal; angles at semi-circle are right angle; exterior angles of cyclic quadrilaterals are equal in size to the interior and opposite angles; opposite angles of cyclic quadrilaterals sum to 180°.

YEAR 12 Mathemetics

Angles

Students are able to:

1. Recognise the properties of common two-dimensional geometric shapes and three-dimensional solids; Properties of parallelograms; Properties of rhombuses; Properties of squares and rectangles; Properties of trapeziums; Properties of kites.
2. Review: properties of quadrilaterals; Classify quadrilaterals.

Parallel Lines

Students are able to:

1. Find the equation of a straight line given the gradient and one point on the line, a line given two points on the line.
2. Calculate complex applications problems involving properties of angles between parallel lines.

Circle

Students are able to:

1. Recognize parts of a circle.
2. Calculate application problems of all properties of circle geometry.

TIER 3

SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 5 - *continued*

GEOMETRY

YEAR 9 Mathemetics

9. Recognise and explain why adjacent angles adding up to 360° form a complete revolution.
10. Establish and use the equality of vertically opposite angles.
11. Find the unknown angle in a diagram using angle results, giving reasons.

Associated with Transversals

12. Identify and name a pair of parallel lines and a transversal.
13. Use common symbols for 'is parallel to' (∥) and 'is perpendicular to' (⊥).
14. Use the common convention to indicate parallel lines on diagrams.
15. Identify, name and measure the alternate angle pairs, the corresponding angle pairs, and co-interior angle pairs for two lines cut by a transversal.
16. Recognise the equal and supplementary angles formed when a pair of parallel lines are cut by a transversal.
17. Use angle properties to identify parallel lines.
18. Apply angle results to construct a pair of parallel lines using a ruler and a protractor, a ruler and a set square, or a ruler and a pair of compasses.

YEAR 10 Mathemetics

- *If three sides of one triangle are respectively equal to three sides of another triangle, then the two triangles are congruent (SSS).*
- *If two sides and the included angle of one triangle are respectively equal to two sides and the included angle of another triangle, then the two triangles are congruent (SAS).*
- *If two angles and one side of one triangle are respectively equal to two angles and the matching sides of another triangle, then the two triangles are congruent (AAS).*
- *If the hypotenuse and a second side of one right-angled triangle are respectively equal to the hypotenuse and a second side of another right-angled triangle, then the two triangles are congruent (RHS).*

2. Apply the congruency tests to justify that two triangles are congruent.
3. Apply congruent triangle results to establish properties of isosceles and equilateral triangles. For example:

- *If two sides of a triangle are equal, then the angles opposite the equal sides are equal.*
- *Conversely, if two angles of a triangle are equal, then the sides opposite those angles are equal.*

YEAR 11 Mathemetics

3. Solve problems involving angle properties of circles.

Transformation

Students are able to:

1. Use transformational geometry processes (enlargement, translation, reflection, rotation and symmetry to solve practical problems.)
2. Describe the effect of combined transformations (enlargement, translation, reflection, rotation).
3. Use bearings to describe direction and plot courses.

Geometrical Figures

Students are able to:

1. Construct and write geometrical arguments to prove a general geometrical result, giving reasons at each step of the argument, e.g., prove that the angle in a semicircle is a right angle.
2. Use the enlargement transformations to explain similarity and to develop the conditions for triangles to be similar.
3. Investigate the minimum conditions needed and establish the four tests, or two triangles to be similar.

YEAR 12 Mathemetics

Transformation

Students are able to:

1. Find unknown bearings and distances using scale diagrams.
2. Use vectors to describe translations.
3. Use vectors to describe displacement.
4. Solve problems involving vector addition and subtraction.

Geometrical Figures

Students are able to:

1. Apply logical reasoning including the use of congruence and similarity, to proofs and numerical exercises involving plane shapes.
2. Write formal proofs of the similarity of the triangles in the standard four- or- five line formats, preserving the matching order of vertices identifying the scale factor when appropriate and drawing relevant conclusions from this similarity.
3. Solve problems involving similarity ratios and areas and volumes.

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11	YEAR 12
4. Use angle relationships to find unknown angles in diagrams, e.g., $3a + 2a + a = 360°$. 5. Construct a pair of perpendicular lines using a ruler and a protractor, a ruler and a set square, or a ruler and a pair of compass. 6. Apply angle and parallel line results to determine properties of 2-D shapes such as the square, rectangle, parallelogram, rhombus, and trapezium. **Properties of Geometrical Figures** Students are able to: 1. Label and name triangles (e.g., ABC) and quadrilaterals (e.g., ABCD) in text and on diagrams. 2. Use the common conventions to mark equal intervals on diagrams. *Triangles* 3. Recognise and classify types of triangles on the basis of their properties (acute-angled triangles, right-angled triangles, obtuse-angled triangles, scalene triangles, isosceles triangles, and equilateral triangles). 4. Construct various types of triangles using geometrical instruments, given different information, e.g., lengths of all sides, two sides and the included angle, two angles and one side.	• *If three sides of a triangle are equal then each interior angle is 60°.* 4. Apply congruent triangle results to establish some of the properties of special quadrilaterals, including diagonal properties. For example: • *The diagonals of a parallelogram bisect each other.* • *The opposite angles of a parallelogram are equal.* • *The diagonals of a rectangle are equal.* 5. Apply the four triangle congruency tests in numerical exercises to find unknown sides and angles. 6. Identify the properties of congruent figures that are preserved. *Similar Triangles* 7. Identify the elements preserved in similar triangles, namely angle size and the ratio of corresponding sides. 8. investigate and determine the minimum conditions needed, and establish the four tests, for two triangles to similar: • *If the three sides of a triangle are proportional to the three sides of another triangle, then the triangles are similar.*	----------	----------

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 5 - *continued* GEOMETRY		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11	YEAR 12
5. Justify informally by paper folding or cutting, and testing by measuring, that the interior angle sum of a triangle is 180°, and that any exterior angle equals the sum of the two interior opposite angles. 6. Use a parallel line construction, to prove that the interior angle sum of a triangle is 180°. 7. Prove, using a parallel line construction, that any exterior angle of a triangle is equal to the sum of the two interior angles. ***Quadrilaterals*** 8. Distinguish between convex and non-convex quadrilaterals (the diagonals of a convex quadrilateral lie inside the figure). 9. Establish that the angle sum of a quadrilateral is 360°. 10. Construct various types of quadrilaterals. 11. Investigate the properties of special quadrilaterals (trapeziums, kites, parallelograms, rectangles, squares, and rhombuses) by using symmetry, paper folding, measurement and/or applying geometrical reasoning. Properties to be considered include: • opposite sides parallel • opposite sides equal • adjacent sides perpendicular • opposite angles equal • diagonals equal in length • diagonals bisect each other • diagonals bisect each other at right angles • diagonals bisect the angles of the quadrilateral 12. Investigate the line symmetries and the order of rotational symmetry of the special quadrilaterals. 13. Classify special quadrilaterals on the basis of their properties.	• *If the two sides of a triangle are proportional to the two sides of another triangle, and the included angles are equal, then the two triangles are similar.* • *If the two angles of a triangle are equal to the two angles of another triangle, then the two triangles are similar.* • *If the hypotenuse and a second side of a right-angled triangle are proportional to the hypotenuse and a second side of another right-angled triangle, then the two right-angled triangles are similar.* 9. Explain why the remaining (third) angles must also be equal if two angles of a triangle are equal to two angles of another triangle. 10. Determine whether triangles are similar and provide reasons. 11. Apply the enlargement or reduction factor to find unknown sides in similar triangles. 12. Justify their solutions to problems by giving reasons using their own words. 13. Calculate the scale factor for a pair of similar triangles. 14. Apply the properties of congruent and similar triangles to solve problems, justifying the results. 15. Apply simple deductive reasoning in solving numerical and non-numerical problems. 16. Investigate whether any two rectangles, or any two isosceles triangles, are similar. 17. Apply similarity to finding lengths in the environment where it is impractical to measure directly, e.g., heights of trees, buildings etc. 18. Find examples of similar and congruent figures embedded in designs from many cultures and historical periods.		

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11	YEAR 12
14. Complete simple numerical exercises based on the geometrical properties of triangles and quadrilaterals. 15. Sketch and label triangles and quadrilaterals from a given verbal description. 16. Recognise and explain why two sides of a triangle must together be longer than the third side. 17. Recognise special types of triangles and quadrilaterals embedded in composite figures or drawn in various orientations. 18. Determine if particular triangles and quadrilaterals have a line and/or rotational symmetry. 19. Bisect an angle by applying geometrical properties e.g., constructing a rhombus. 20. Bisect an interval by applying geometrical properties e.g., constructing a rhombus. 21. Draw a perpendicular line from a point on the line by applying geometrical properties e.g., constructing an isosceles triangle. 22. Draw a perpendicular line from a point off the line by applying geometrical properties e.g., constructing a rhombus. 23. Use a ruler and compasses to construct angles of 60° and 120° by applying geometrical properties e.g., constructing an equilateral triangle. *Congruent and Similar Figures* 24. Identify congruent figures by superimposing them through a combination of rotations, reflections and translations. 25. Match sides and angles of two congruent polygons. 26. Name the vertices in matching order when using the ≡ symbol in a congruence statement. 27. Draw congruent figures using geometrical instruments. 28. Determine the condition for two circles to be congruent (equal radii). 29. Recognise that area, length of matching sides, and angle sizes are preserved in congruent figures.	19. Apply geometrical facts, properties, and relationships to find the size of unknown sides and angles of 2-D figures in diagrams, providing appropriate reasons. **Circle** Students are able to: 1. Describe the relationship between central angles, inscribed angles, arcs, and segments. 2. Apply the central and inscribed angles, and arc results to solve unknown angles in diagrams. 3. Explore and establish, by construction and measuring angles, the relationship between opposite angles of a cyclic quadrilateral. 4. Explore and establish, by construction and measuring angles, the relationship between exterior angle of a cyclic quadrilateral and the interior opposite angle. 5. Apply the relationships between opposite angles, and exterior and interior opposite angles, of a cyclic quadratic to calculate unknown angles. 6. Prove that opposite angles of a cyclic quadrilateral are supplementary. 7. Prove that the exterior angle of a cyclic quadrilateral is equal to the opposite interior angle. 8. Describe and apply the test for a quadrilateral to be cyclic to solve problems. 9. Solve real-life context problems using the opposite angles and exterior-interior angles results of cyclic quadrilaterals to determine unknown angles. **Transformations** Students are able to: 1. Enlarge 2-D figures or shapes given a positive scale factor and reduce given a unit fraction. 2. Identify invariant properties when enlarging or reducing 2-D shapes. 3. Identify the centre point of an enlargement.		

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 5 - *continued* GEOMETRY		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11	YEAR 12
30. Use the term 'similar' for any two figures that have the same shape but not necessarily the same size. 31. Match the sides and angles of similar figures. 32. Name the vertices in matching order when using the symbol III in a similarity statement. 33. Determine that shape, angle size, and the ratio of matching sides are preserved in similar figures. 34. Determine the scale factor for a pair of circles. 35. Calculate dimensions of similar figures using enlargement or reduction factor. 36. Choose an appropriate scale in order to enlarge or reduce a diagram. 37. Interpret and use scales in photographs, plans, and drawings found in the media and/or other learning areas. 38. Enlarge diagrams such as cartoons and pictures. 39. Apply geometrical facts, properties, and relationships to solve problems such as finding unknown sides and angles in diagrams. **Circle** Students are able to: 1. Identify and name different parts of the circle and related lines, including arc, tangent and chord. 2. Investigate the line symmetry and the order of rotational symmetry of circles. 3. Investigate the line symmetry and the order of rotational symmetry of diagrams involving circles, such as a sector and a circle with a chord or tangent. 4. Explain that a circle consists of all points that are a given distance from the centre and how this relates to the use of a pair of compasses.	4. Find the scale factors for areas and volumes being enlarged. 5. Explore the placement of similar objects to show a negative enlargement. 6. Investigate and create patterns that involve a combination of translations, reflections, rotations, and enlargement of a figure. 7. Enlarge diagrams such as cartoons or pictures. 8. Use symmetry and the properties of enlargement transformations to solve problems. 9. Investigate and create patterns using line and rotational symmetry. 10. Investigate and create patterns using line symmetry, rotational symmetry (order 2, 3, and 4), and translational symmetry.		

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11	YEAR 12
5. Explore and establish, by construction and measuring angles, the relationship between • angles subtended by the same arc or chord at the centre (central angles) and circumference (inscribed angles). • angles subtended by the diameter at the circumference. • two angles subtended by the same arc at the circumference in the same segment. 6. Apply angles in circle relationships to solve numerical problems such as finding unknown angles in diagrams. **Transformations** Students are able to: 1. Transform figures using translation described in words and by a vector. 2. Use bearings and a grid reference to describe direction and plot courses. 3. Transform figures by reflection along a line. 4. Investigate and create patterns that involve a combination of translations and reflections of a figure. 5. Identify patterns in real life that involve translation and reflection transformations. 6. Create and identify designs that have reflection symmetry. 7. Use symmetry and the properties of reflection and translation transformations to solve problems.			

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 5 GEOMETRY		
	YEAR 9 General Mathemetics	YEAR 10 General Mathemetics	YEAR 11 General Mathemetics
	Angles Students are able to: 1. Investigate triangles including interior and exterior angles, quadrilaterals. 2. Investigate how to measure angles using a projector correctly. 3. Construct required triangles using a ruler, protractor accurately. **Parallel Lines** Students are able to determine simple unknown angles using properties of angles between parallel lines justifying them with reasons. **Circle** Students are able to: 1. Study circle terminologies and properties of circles. 2. Prove properties of cyclic quadrilateral that i) interior opposite angles are supplementary ii) exterior angle of a cyclic quadrilateral is equal to the interior opposite. **Transformation** Students are able to: 1. Explore transformations using enlargement with positive scale factors including unit fractions. 2. Explore patterns using lines and rotational symmetry. **Geometrical Figures** Students are able to: 1. Write formal proofs of the congruence of triangles, preserving matching order vertices. 2. Apply logical reasoning, including the use of congruence and similarity, to proofs and numerical exercises involving plane shapes.	**Angles** Students are able to: 1. Construct simple regular polygons inscribed in circles. 2. Use interior and exterior angles of polygons to solve more complex problems. **Parallel Lines** Students are able to calculate applications of angle properties between parallel lines. **Circle** Students are able to solve problems involving angle properties of circles. **Transformation** Students are able to use transformational geometry processes (enlargement, translation, reflection, rotation and symmetry to solve practical problems.) **Geometrical Figures** Students are able to: 1. Construct and write geometrical arguments to prove a general geometrical result, giving reasons at each step of the argument, e.g. prove that the angle in a semicircle is a right angle. 2. Formulate proofs involving congruent triangles and angle properties.	**Angles** Students are able to: 1. Use interior and exterior angles of polygons to solve more complex problems. 2. Solve problems involving angles properties of lines and polygons and parallel lines. **Parallel Lines** Students are able to: 1. Calculate applications of angle properties between parallel lines. 2. Determine the gradients of parallel and perpendicular lines. **Circle** Students are able to: 1. Calculate application problems of all properties of circle geometry. 2. Construct more complex regular (up to ten) polygons inscribed in circles. **Transformation** Students are able to: 1. Use application of transformation to read maps and plot courses. 2. Use application of bearings to navigate and plot course and determine directions. **Geometrical Figures** Students are able to: 1. Establish properties of similar figures. 2. Recognize similarity in everyday life. 3. Obtain measurements from plans of buildings and rooms. 4. Calculate lengths and areas from a floor plan. 5. Interpret commonly used symbols on house plans.

TIER 1

MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 6
TRIGONOMETRY

YEAR 9 Mathemetics

Trigonometry of Right-Angled Triangles
Students apply trigonometry and Pythagoras' Theorem to solve problems (diagrams given) including those involving angles of elevation and depression.

Trigonometric Functions
Students sketch graphs of the sine and cosine functions for domain $0° \leq \theta \leq 90°$ using special angles and calculator values.

YEAR 10 Mathemetics

Trigonometry of Non-Right-Angled Triangles
Students apply trigonometric relationships and use Pythagoras' Theorem in the unit circle to extend the trigonometric ratios to obtuse angles and to derive the sine rule, cosine rule, and area rule to solve problems.

Trigonometric Functions
Students sketch graphs of the sine and cosine functions for domain $0° \leq \theta \leq 180°$ using special angles and calculator values including graph symmetry.

YEAR 11 Mathemetics

Pythagoras Triads & Trigonometric Functions and Ratios
Students apply Pythagoras' Theorem and trigonometry to solving 3D problems in right-angled triangles: apply trigonometry to solve complex right-angled triangle problems; use Laws of Sine and Cosine to solve application problems; solve trigonometric equations using linear methods, factoring, quadratic formula or graphing; compare features of trigonometric curves, including periodicity and symmetry; and solve authentic real-life problems involving complex combinations and applications of Pythagorean triples.

YEAR 12 Mathemetics

Pythagoras Triads & Trigonometric Functions and Ratios

Students investigate the applications of Pythagoras' theorem in authentic problems; solve problems involving the lengths of the edges and diagonals of rectangular prisms and other 3D objects; solve trigonometric equations using fundamental identities; use right triangles drawn in the unit circle to define the trigonometric functions for any angle; and solve complex authentic combinations and applications of Pythagorean triples.

YEAR 10 General Mathemetics

Pythagoras Triads & Trigonometric Functions and Ratios
Students generate and practice on several combinations of Pythagorean triples; select and use appropriate trigonometric ratios in right-angled triangles to find unknown angles/sides correct to the nearest degree/decimal place; use Laws of Sine and Cosine to solve simple problems on non-triangles; solve simple trigonometric equations; graph simple trigonometric function for angles between 00-360°; and solve applications problems involving simple combinations and applications of Pythagorean triples.

YEAR 11 General Mathemetics

Pythagoras Triads & Trigonometric Functions and Ratios
Students apply Pythagoras' Theorem and trigonometry to solving 3D problems in right-angled triangles: apply trigonometry to solve complex right-angled triangle problems; use Laws of Sine and Cosine to solve application problems; solve trigonometric equations using linear methods, factoring, quadratic formula or graphing; compare features of trigonometric curves, including periodicity and symmetry; clarify the trigonometric symmetry identities using the graphs of the trigonometric functions; and solve authentic real-life problems involving the complex combinations and applications of Pythagorean triples.

YEAR 12 General Mathemetics

Pythagoras Triads & Trigonometric Functions and Ratios
Students investigate the applications of Pythagoras' theorem in authentic problems; solve problems involving the lengths of the edges and diagonals of rectangular prisms and other 3D objects; solve trigonometric equations using fundamental identities; use right triangles drawn in the unit circle to define the trigonometric functions for any angle; prove and apply the identities for products of sines and cosines expressed as sums and differences; and solve a variety of authentic real-life problems involving the complex combinations and applications of Pythagorean triples.

TIER 2

CONTINUUM OF KEY IDEAS – TIER 2 – STRAND 6
TRIGONOMETRY

YEAR 9 Mathemetics

Trigonometry of Right-Angled Triangles
Students learn about using trigonometry and Pythagoras' Theorem to find sides and angles in right-angled triangles; determining the exact trigonometric ratios for 30°-45° and 60°; solving problems involving angles of elevation and depression from diagrams; and establishing the Pythagorean identity and tan in terms of *sin* and *cos*.

Trigonometric Functions
Students learn about sketching graphs of the sine and cosine functions for domain $0° \leq \theta \leq 90°$ using special angles and calculator values.

YEAR 10 Mathemetics

Trigonometry of Non-Right-Angled Triangles
Students learn about applying relationships in trigonometry for complementary angles; determining trigonometric ratios for obtuse angles; exploring trigonometry with non-right-angled triangles: sine rule, cosine rule and area rule; and solving problems involving more than one triangle using trigonometry.

Trigonometric Functions
Students learn about sketching graphs of the sine and cosine functions for domain $0° \leq \theta \leq 180°$ using special angles and calculator values including graph symmetry.

YEAR 11 Mathemetics

Pythagoras Triads & Trigonometric Functions and Ratios
Students learn about Pythagoras' Theorem and trigonometry to solving 3D problems in right-angled triangles: trigonometry to solve complex right-angled triangle problems; Laws of Sine and Cosine to solve application problems; trigonometric equations using linear methods, factoring, quadratic formula or graphing; compare features of trigonometric curves, including periodicity and symmetry; and solve authentic real-life problems involving complex combinations and applications of Pythagorean triples.

YEAR 12 Mathemetics

Pythagoras Triads & Trigonometric Functions and Ratios
Students learn about the applications of Pythagoras' theorem in authentic problems; problems solving involving the lengths of the edges and diagonals of rectangular prisms and other 3D objects; trigonometric equations using fundamental identities; right triangles drawn in the unit circle to define the trigonometric functions for any angle; and solve complex authentic combinations and applications of Pythagorean triples.

YEAR 10 General Mathemetics

Pythagoras Triads & Trigonometric Functions and Ratios
Students learn about on several combinations of Pythagorean triples; appropriate trigonometric ratios in right-angled triangles to find unknown angles/sides correct to the nearest degree/decimal place; Laws of Sine and Cosine to solve ***simple*** problems on non-triangles; ***simple*** trigonometric equations; graph ***simple*** trigonometric function for angles between 00-360°; and solve applications problems involving ***simple*** combinations and applications of Pythagorean triples.

YEAR 11 General Mathemetics

Pythagoras Triads & Trigonometric Functions and Ratios
Students learn about Pythagoras' Theorem and trigonometry to solving 3D problems in right-angled triangles: trigonometry to solve complex right-angled triangle problems; Laws of Sine and Cosine to solve application problems; trigonometric equations using linear methods, factoring, quadratic formula or graphing; features of trigonometric curves, including periodicity and symmetry; trigonometric symmetry identities using the graphs of the trigonometric functions; and solve authentic real-life problems involving the ***complex*** combinations and applications of Pythagorean triples.

YEAR 12 General Mathemetics

Pythagoras Triads & Trigonometric Functions and Ratios
Students learn about the applications of Pythagoras' theorem in authentic problems; problems involving the lengths of the edges and diagonals of rectangular prisms and other 3D objects; trigonometric equations using fundamental identities; right triangles drawn in the unit circle to define the trigonometric functions for any angle; prove and apply the identities for products of sines and cosines expressed as sums and differences; and solve a variety of authentic real-life problems involving the complex combinations and applications of Pythagorean triples.

TIER 3

SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 6
TRIGONOMETRY

YEAR 9 Mathemetics

Trigonometry of Right-Angled Triangles

Students are able to:

1. Identify the hypotenuse, adjacent and opposite sides with respect to a given angle, in a right-angled triangle in any orientation.
2. Label the side lengths of a right-angled triangle in relation to a given angle, e.g., the side c is opposite angle C.
3. Recognise that the ratio of matching sides in similar right-angled triangles is constant for equal angles.
4. Explain why the ratio of matching sides in similar right-angled triangles is constant for equal angles.
5. Define the sine, cosine, and tangent ratios for angles in right-angled triangles.
6. Use trigonometric notation for sine, cosine and tangent, e.g., ***sin A, cos B, tan C***.
7. Use a calculator to find approximations of the trigonometric ratios of a given angle measured in degrees.
8. Use a calculator to find an angle correct to the nearest degree, given one of the trigonometric ratios of the angle.
9. Use similarity to investigate the constancy of the sine, cosine, and tangent ratios for a given angle in right-angled triangles.

YEAR 10 Mathemetics

Trigonometry of Non-Right-Angled Triangles

Students are able to:

1. Use the relationship between the tangent ratio and the gradient of a line to solve problems.
2. Prove, by applying the Pythagoras Theorem in the unit circle, and use the relationship between sine and cosine ratios of complementary angles in right-angled triangles to solve problems:

   $\cos A = \sin(90° - A)$

   $\sin A = \cos(90° - A)$
3. Use the tangent relationship to sine and cosine,

   $$\tan\theta = \frac{\sin\theta}{\cos\theta}$$

   the Pythagorean identity,

   $$\cos^2\theta + \sin^2\theta = 1.$$

   and other trigonometric results to solve application problems involving acute and obtuse angles.
4. Solve real-life problems using exact trigonometric ratios for 30°,45°,and 60°.
5. Establish, using the Pythagoras Theorem in the unit circle, and apply the following relationships for obtuse angles where $0° \le \theta \le 90°$:

   $\sin(180° - A) = \sin A$

   $\cos(180° - A) = -\cos A$

   $\tan(180° - A) = -\tan A$

YEAR 11 Mathemetics

Pythagoras Triads

Students are able to:

1. Apply trigonometry to solve complex right-angled triangle.
2. Prove and use the relationships between the sine and cosine ratios of complementary angles in right- angled triangles $\sin A = \cos(90° - A)$.
3. Identify and prove reciprocal identities.
4. Clarify the trigonometric symmetry identities using the graphs of the trigonometry functions.
5. Recognise unit circle definitions of $\cos\theta$, $\sin\theta$ and $\tan\theta$ and periodicity using radians.
6. Identify the amplitude and Examine amplitude changes.

Trigonometric Functions and Ratios

Students are able to:

1. Use similarity to investigate the constancy of the sine, cosine and tangent ratios for a given angle in right-angled triangles.
2. Describe how the value of each trigonometric ratio changes as the angle increases from 0° to 360°.
3. Recognise the graphs of trigonometric functions.
4. Recognise the graphs of $y = \sin x$, $y = \cos x$ and $y = \tan x$ on extended domains.

YEAR 12 Mathemetics

Pythagoras Triads

Students are able to:

1. Check the reasonableness of answers to trigonometry problems involving right-angled triangles in three dimensions.
2. Solve a variety of practical problems involving angles of elevation and depression, including problems for which a diagram is not provided.
3. Use a given diagram to solve problems involving right-angled triangles in three dimensions.
4. Connect the trigonometric functions to the Pythagorean Theorem in order to derive the Pythagorean identities.
5. Prove and apply the identities for products of sines and cosines expressed as sums and differences.
6. Familiarise with the Cofunction identities presented in degrees.

Rigonometric Functions and Ratios

Students are able to:

1. Apply trigonometry to solve three-dimensional problems in right-angled triangles.

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 6 - *continued* TRIGONOMETRY		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
10. Recognise that Pythagorean triples (e.g., 3, 4, 5; 5, 12, 13; 8, 15, 17) are integer triples that satisfy Pythagoras' Theorem of $a^2 + b^2 = c^2$ where c is the hypotenuse and a and b are the other two sides of the right-angled triangle. 11. Apply Pythagoras' Theorem as needed, and select and accurately use appropriate trigonometric ratios in right-angled triangles to find unknown sides, including the hypotenuse. 12. Select and use appropriate trigonometric ratios in right-angled triangles to find unknown angles correct to the nearest degree. 13. Determine, using the special right-angled triangles (30°-60°-90° and 45°-45°-90°), the exact sine, cosine and tangent ratios for angles of 30°, 45° and 60°. 14. Convert angles from degree to radian measure and vice-versa as needed. 15. Identify angles of elevation and depression. 16. Solve problems involving angles of elevation and depression when given in diagrams. 17. Relate the tangent ratio to the gradient of a line. 18. Prove, using the Pythagoras Theorem in the unit circle, the Pythagorean trigonometric identity: $\cos^2\theta + \sin^2\theta = 1$. 19. Prove, using the Pythagoras Theorem in the unit circle, that the tangent ratio can be expressed as a ratio of sine and cosine ratios, $\tan\theta = \frac{\sin\theta}{\cos\theta}$	6. Find the possible acute and/or obtuse angles, given a trigonometric ratio. 7. Prove the sine rule: In a given triangle ABC, the ratio of a side to the sine of the opposite angle is a constant, $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$ 8. Use the sine rule to find the unknown sides and angles of a triangle, including problems in which there are two possible solutions for an angle. 9. Prove the cosine rule: In a given triangle ABC $a^2 = b^2 + c^2 - 2bc\cos A$ $\cos A = \frac{b^2 + c^2 - a^2}{2bc}$ 10. Use the cosine rule to find unknown sides and angles of a triangle. 11. Prove and use the area rule to find the area of a triangle: In a given triangle ABC $Area = \frac{1}{2}ab\sin C$ 12. Draw diagrams and use them to solve word problems that involve non-right-angled triangles. 13. Solve problems, including practical problems, involving the sine and cosine rules and the area rule, e.g., problems related to surveying or orienteering. 14. Use appropriate trigonometric ratios and formulas to solve 2-D trigonometric problems that require the use of more than one triangle, where the diagram is provided, and where a verbal description is given.	5. Recognize that trigonometric functions are periodic and that this can be used to describe motion. 6. Generate trigonometric inverse functions and calculate values for the trigonometric functions that are the reciprocals of sine, cosine and tangent.	2. Use appropriate trigonometric ratios and formulas to solve two-dimensional problems that require the use of more than one triangle where the diagram is provided and where a verbal description is given. 3. Solve problems involving the lengths of the edges and diagonals of rectangular prisms and other three-dimensional objects. 4. Solve trigonometric equations using fundamental identities. 5. Investigate graphs of the sine, cosine and tangent functions for angles of any magnitude including negative angles. 6. Use the unit circle or graphs of trigonometric functions to establish and use the following relationships for obtuse angles, where $0° \le \theta \le 90°$: $\sin A = \sin(180° - A)$

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
20. Use the Pythagorean identity and trigonometric ratios to determine unknown angles and sides in practical problems. 21. Solve problems in practical situations involving right-angled triangles using trigonometric ratios and Pythagoras' Theorem, e.g., finding the height of a two-storey building, finding the height of a flagpole, finding the pitch of a roof. **Trigonometric Functions** Students are able to: 1. Use the exact values from the special right-angled triangles (30°-60°-90° and 45°-45°-90°), for the sine and cosine ratios for angles 30°, 45° and 60° to draw graphs for the sine and cosine functions for the domain $0° \leq \theta \leq 90°$. 2. Use a calculator to generate other trigonometric ratio values (sine and cosine) for every 15° interval, for angle θ from 0 to 90° to facilitate the sketching of sine, cosine, and tangent graphs for the domain $0° \leq \theta \leq 90°$. 3. Explore and describe the relationship between the cosine and sine values of complementary angles using both numerical values and line symmetry of the two graphs.	15. Recognise that if given two sides and an angle (not included) then two triangles may result, leading to two solutions when the sine rule is used. 16. Explain what happens if the sine, cosine and area rules are applied in right-angled triangles. 17. Ask questions about how trigonometric ratios change as the angle increases from 0° to 180°. 18. Recognise that if sin A ≥ 0 then there are two possible values for A, given $0° \leq \theta \leq 180°$. **Trigonometric Functions** Students are able to: 1. Extend graphs of the trigonometric functions: sine and cosine to include obtuse angles with domain $0° \leq \theta \leq 180°$ using the supplementary angle relationships. 2. Verify the graphs of the trigonometric functions: sine and cosine for domain $0° \leq \theta \leq 180°$ by using special angles and a calculator to generate other trigonometric ratio values (sine and cosine) for every 15° interval, for angle θ = 90° up to θ = 180°. 3. Explore and describe the relationship between the cosine and sine values of supplementary angles using both numerical values and symmetry of the two graphs.		

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 6 TRIGONOMETRY		
	YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
	Pythagoras Triads Students are able to: 1. Solve right-angled triangle problems including those involving direction and angles of depression. 2. Familiarise with radian measure and its relationship with degree measure. 3. Identify and prove Pythagorean identities. **Trigonometric Functions and Ratios** Students are able to: 1. Select and use appropriate trigonometric ratios in right-angled triangles to find unknown angles correct to the nearest degree. 2. Identify angles of elevation and depression 3. Draw diagrams to assist in solving practical problems involving angles of elevation and depression.	**Pythagoras Triads** Students are able to: 1. Use similarity to investigate the constancy of the sine, cosine and tangent ratios for a given angle in right-angled triangles. 2. Apply trigonometry to solve complex right-angled triangle problems. 3. Apply trigonometry to solve complex right-angled triangle problems. **Trigonometric Functions and Ratios** Students are able to: 1. Use the unit circle to define trigonometric functions, and graph them with and without the use of digital technologies. 2. Solve a variety of practical problems involving angles of elevation and depression including problems for which a diagram is not provided. 3. Draw diagrams and use them to solve word problems involving right-angled triangles in three dimensions that include the use of bearings.	**Pythagoras Triads** Students are able to: 1. Apply trigonometry to sole three-dimensional problems in right-angled triangles. 2. Solve problems involving the lengths of the edges and diagonals of rectangular prisms and other three-dimensional objects. 3. Use a given diagram to solve problems involving right-angled triangles in three dimensions. **Trigonometric Functions and Ratios** Students are able to: 1. Determine a number with a given circular function value. 2. Use right triangles drawn in the unit circle to define the trigonometric functions for any angle. 3. Solve trigonometric equations using linear methods, factoring, quadratic formula or graphing. 4. Solve trigonometric equations with multiple angles and with using fundamental identities.

TIER 1	MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 7 RATES OF CHANGE & CALCULUS		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Rates of Change Students identify real-life situations which demonstrate constant and variable rates of changes; and use the relationships between rates of change, gradients, and graph features to determine a suitable algebraic representation of the problem context. **Number Sequences** Students generate different types of number sequences from real life; generalise the rule of the number pattern; predict the required terms; and establish graph type. **Relations and Functions** Students identify, describe, represent, and recognise relations and functions from schematic descriptions, arrow diagrams, and Cartesian diagrams.	**Rates of Change** Students explore and establish equations representing each pattern type of rates of change for gradients and establish a relationship between estimates of area under curves and equations of curves. **Number Sequences** Students generate number sequences from real life and formulate general terms; identify arithmetic and geometric sequences; and predict required terms and graph number sequences. **Relations and Functions** Students identify and distinguish between relations and functions; consolidate connections between function equations, graph features, and rates of change; use various notations to represent domains, ranges, and functions; and investigate graphs transformations of linear, simple quadratic and exponential functions.	**Calculus** Students Interpret and use information about rates presented in a variety of ways, for example, graphically, numerically, or in tables; use techniques such as graphing and averaging to explore rates and rates of change. For example, tax rates, pollution rates measured in parts per million, acceleration, inflation, stocking rates, and unit pricing; explain the relationship between the gradient of a graph and the rate of change; interpret and use information about rates presented in a variety of ways, for example, graphically, or in tables; introduce the basic idea of limits (elaborating from other functions); explore limits with respect to derivatives; explore areas under the curve starting with linear functions (apply trigonometry); introduce concept of integration emphasizing its use for areas under the curve (simple); and solve authentic real-life problems involving complex combinations and applications of rates of change, derivatives and integrals.	**Calculus** Students establishing the relationship between the gradient of a graph and the rate of change, and interpreting this in context, using technology where appropriate. Interpret a straight-line graph, explaining what the slopes represent in a given context, and suggest reasons for changes in slopes. Applying integration, including its use in finding areas under polynomial curves. Discussing applications of differentiation, including maxima, minima, velocity and acceleration; Explore the first principles method. Further information to evaluating constant of integration. Explore 2nd derivatives and effects on graphs. Application problems involving kinematics and rates of change with respect to time. Solve authentic real-life problems involving complex combinations and applications of rates of change, derivatives and integrals.

TIER 1	MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 7 RATES OF CHANGE & MODELLING FUNCTIONS	
YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
Rates of Change Students explore and compare change, for example, growth, temperature, heartbeats; explore and compare 1st difference and 2nd difference numerical patterns; explore rates of change on a curve at different points (model to a real life situation – hiking); and solve authentic real-life problems involving simple combinations and applications of rates of change most relevant to the areas of TVET, Technology, HPE, Visual Arts and Social Studies.	**Modelling Functions** Students Interpret and use information about rates presented graphically and numerically; use techniques such as graphing and averaging to explore a variety of rates and rates of change (such as tax rates, pollution rates, inflation rates, and unit pricing); explain the relationship between the gradient of a graph and the rate of change; derive equations to represent numerical patterns of 1st and 2nd differences and/or common ratios to determine modelling functions for simple authentic real-life situations involving various combinations and applications of rates of change and growth most relevant to the areas of TVET, Technology, HPE, Visual Arts and Social Studies.	**Modelling Functions** Students establish the relationship between the gradient of a graph and the rate of change, and interpreting this in context, using technology where appropriate; interpret a straight-line graph, explaining what the slopes represent in a given context, and suggest reasons for changes in slopes; derive equations to represent numerical patterns of 1st and 2nd differences and/or common ratios to determine modelling functions for a variety of complex authentic real-life situations involving complex combinations and applications of rates of change and growth most relevant to the areas of TVET, Technology, HPE, Visual Arts and Social Studies.

TIER 2	CONTINUUM OF KEY IDEAS – TIER 2 – STRAND 7 RATES OF CHANGE & CALCULUS		
YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11 Mathemetics	YEAR 12 Mathemetics
Rates of Change Students learn about identifying real-life situations that demonstrate constant and variable rates of changes; and using the relationships between rates of change, gradients, and features of graphs to determine suitable algebraic representations of problem contexts. **Number Sequences** Student learn about generating different types of number sequences from real life; generalising the rule of the number pattern; and making predictions for next terms and graph of sequence. **Relations and Functions** Students learn about identifying, describing, representing, and recognising relations and functions from schematic descriptions, arrow diagrams, and Cartesian diagrams.	**Rates of Change** Students learn further about constant and variable rates of change; generalising features of graphs associated with each type of rates of change; algebraically representing rates of change and problem contexts; and identifying real-life examples of each type. **Number Sequences** Student learn about generating number sequences from real life and formulating general terms; identifying arithmetic and geometric sequences; and predicting required terms and graph type of sequences. **Relations and Functions** Students learn about identifying and distinguishing between relations and functions; consolidating connections between function equations, graph features and rates of change; and using various notations to represent domains, ranges, and functions.	**Calculus** Students learn about information about rates presented in a variety of ways, for example, graphically, numerically, or in tables; use techniques such as graphing and averaging to explore rates and rates of change. For example, tax rates, pollution rates measured in parts per million, acceleration, inflation, stocking rates, and unit pricing; learn about the relationship between the gradient of a graph and the rate of change; information about rates presented in a variety of ways, for example, graphically, or in tables; introduce the basic idea of limits (elaborating from other functions); limits with respect to derivatives; areas under the curve starting with linear functions (apply trigonometry); introduce concept of integration emphasizing its use for areas under the curve (simple); and solve authentic real-life problems involving complex combinations and applications of rates of change, derivatives and integrals.	**Calculus** Students learn about the relationship between the gradient of a graph and the rate of change, and interpreting this in context, using technology where appropriate; a straight-line graph, explaining what the slopes represent in a given context, and suggest reasons for changes in slopes. Integration, including its use in finding areas under polynomial curves. Applications of differentiation, including maxima, minima, velocity and acceleration. The first principles method. Further information to evaluating constant of integration. 2^{nd} derivatives and effects on graphs. Application problems involving kinematics and rates of change with respect to time. Solve authentic real-life problems involving ***complex*** combinations and applications of rates of change, derivatives and integrals.

TIER 2	MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 7 RATES OF CHANGE & MODELLING FUNCTIONS	
YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
Rates of Change Students learn about change, for example, growth, temperature, heartbeats; explore and compare 1st difference and 2nd difference numerical patterns; learn about rates of change on a curve at different points (model to a real life situation – hiking); and solve authentic real-life problems involving ***simple*** combinations and applications of rates of change.	**Modelling Functions** Students learn about information about rates presented graphically and numerically; use techniques such as graphing and averaging to explore a variety of rates and rates of change (such as tax rates, pollution rates, inflation rates, and unit pricing); learn about the relationship between the gradient of a graph and the rate of change; derive equations to represent numerical patterns of 1^{st} and 2^{nd} differences and/or common ratios to determine modelling functions for ***simple*** authentic real-life situations involving ***various*** combinations and applications of rates of change and growth	**Modelling Functions** Students learn about the relationship between the gradient of a graph and the rate of change, and interpreting this in context, using technology where appropriate; interpret a straight-line graph, learn about what the slopes represent in a given context, and reasons for changes in slopes; equations to represent numerical patterns of 1^{st} and 2^{nd} differences and/or common ratios to determine modelling functions for a variety of ***complex*** authentic real-life situations involving ***complex*** combinations and applications of rates of change and growth.

TIER 3

SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 7
RATES OF CHANGE & CALCULUS

YEAR 9 Mathemetics

Rates of Change

Students are able to:

1. Interpret and use graphs and tables on speed, travel, conversions between measurement units, and foreign exchange to solve problems on rates of change between two quantities.
2. Identify real-life examples that illustrate constant and variable rates of change.
3. Compare and contrast graphs and tables of values, then qualitatively describe the behaviour of function values as; 'increasing or decreasing' at a 'constant, increasing or decreasing' rate, as x increases.
4. Use number patterns of rates of change to determine an equation to represent the real-life situation.
5. Apply the relationships between rates of change, gradients, and features of graphs to determine a suitable modelling function.
6. Solve application problems rates from other strands or subjects.

YEAR 10 Mathemetics

Rates of Change

Students are able to:

1. Generate a table of values, determine and describe the connection between the number pattern of the rates of change (ROC) of linear relationships and the terms of the equation of the linear relationship.
2. Generalize and describe the connection between positive and negative rates of change, gradients, associated graphical features, and terms of the equation of the linear relationship.
3. Determine an equation to represent the linear rates of change (ROC) of linear relationships.
4. Generate a table of values and explore the connection between the variable rates of change (ROC) and the equation of a simple quadratic relationship $(y = ax^2, y = ax^2 + c)$.
5. Generalize and describe the connection between variable rates of change (ROC), graphical features, and terms of the equation of the quadratic relationship.

YEAR 11 Mathemetics

Calculus

Students are able to:

1. Interpret and use information about rates presented in a variety of ways, for example, graphically, numerically, or in tables.
2. Use techniques such as graphing and averaging to explore rates and rates of change. For example, tax rates, pollution rates measured in parts per million, acceleration, inflation, stocking rates, and unit pricing.
3. Explain the relationship between the gradient of a graph and the rate of change.
4. Interpret and use information about rates presented in a variety of ways, for example, graphically, or in tables; introduce the basic idea of limits (elaborating from other functions).
5. Explore limits with respect to derivatives.
6. Explore areas under the curve starting with linear functions (apply trigonometry).
7. Introduce concept of integration emphasizing its use for areas under the curve (simple).
8. Solve authentic real-life problems involving complex combinations and applications of rates of change, derivatives and integrals.

YEAR 12 Mathemetics

Calculus

Students are able to:

1. Establish the relationship between the gradient of a graph and the rate of change.
2. Interpret this in context, using technology where appropriate.
3. Interpret a straight-line graph, explaining what the slopes represent in a given context, and suggest reasons for changes in slopes.
4. Apply integration, including its use in finding areas under polynomial curves.
5. Discuss applications of differentiation, including maxima, minima, velocity and acceleration.
6. Explore the first principles method; Further information to evaluating constant of integration.
7. Explore 2nd derivatives and effects on graphs.
8. Apply problems involving kinematics and rates of change with respect to time.
9. Solve authentic real-life problems involving complex combinations and applications of rates of change, derivatives and integrals.

TIER 3

SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 7 - *continued*
RATES OF CHANGE & CALCULUS

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11	YEAR 12
Number Sequences Students are able to: 1. Identify real-life examples of number sequences. 2. Generate a variety of number sequences that increase or decrease and record them in more than one way. 3. Represent and apply patterns and relationships in algebraic form. 4. Explain why a particular relationship or rule for a given number sequence is better than another. 5. Deduce the general term of a sequence as the mathematical expression that relates the position that a term occupies in the sequence with its value. 6. Describe in words and represent algebraically the general pattern of terms using the pattern of the rates of change of a number sequence. 7. Predict and generate the required terms of a number sequence. 8. Distinguish between graphs that represent an increasing number sequence and those that represent a decreasing number pattern. 9. Solve practical problems on number sequences and rates of change. **Relations and Functions** Students are able to: 1. Define a relation and provide examples. 2. Compare and distinguish between the different types of relations using arrow diagrams and sets of ordered pairs. 3. Describe and represent using a diagram and graph how two sets of numbers are related to each other. 4. Define a function and provide examples. 5. Discuss four different representations of a function with examples of each type. 6. Demonstrate the different ways relations can be displayed.	6. Determine an equation to represent the variable rates of change (ROC) of quadratic relationships. 7. Generate a table of values and explore the connection between the variable rates of change (ROC) and the equation of a simple cubic relationship $(y = ax^3, y = ax^3 + c)$. 8. Generalize and describe the connection between variable rates of change (ROC), graphical features, and terms of the equation of the cubic relationship. 9. Determine an equation to represent the variable rates of change (ROC) of simple cubic relationships. 10. Analyze the three different function types, equations, respective ROC equations, and graphs to describe and generalize the relationship between the ROC equation and modelling equations of the table of values. 11. Explore the relationship between the areas under the graph $(y=A(x))$ of a linear relationship over an interval from $x=a$ to $x=b$, number pattern of the rates of change, and equation of the linear relationship $(y = f(x))$. 12. Generalize and describe the relationship between the area under a graph $(y=A(x))$ of a linear relationship and the x-axis over the interval [a, b] and equation of the linear relationship $(y = f(x))$. 13. Explore the relationship between estimates of areas under the curve $(y=A(x))$, using n rectangles, of a quadratic relationship over an interval from $x=a$ to $x=b$, with n-subintervals, and equation of quadratic relationship $(y = f(x))$. 14. Generalize and describe the relationship between the estimates of area under a parabola $(y=A(x))$ and the x-axis over the interval [a, b], and quadratic equation. 15. Make predictions about the values of $A(x)$ as n sub-intervals increases for each function type and provide reasons. 16. Analyze the two different function types (linear and quadratic), respective $A(x)$ equations, and graphs to describe and generalise the relationship between the $A(x)$ equation and modelling equations of the table of values.	--------	--------

YEAR 9 Mathemetics	YEAR 10 Mathemetics	YEAR 11	YEAR 12
7. Explain how number patterns relate to functions. 8. Describe and represent algebraically mathematical patterns using function notation. 9. Identify the domain and range of a function. 10. Represent functions using diagrams, sets of ordered pairs, equations, and graphs. 11. Use a variety of notations to algebraically represent functions. 12. Determine whether a relation is a function from a diagram, table, and a set of ordered pairs. 13. Determine whether a relation is a function from its schematic descriptions or equation. 14. Describe and list domains and ranges of functions given as sets of ordered pairs or graphs. 15. Determine equations that can be defined as functions.	15. Make predictions about the values of $A(x)$ as n sub-intervals increases for each function type and provide reasons. 15. Analyze the two different function types (linear and quadratic), respective $A(x)$ equations, and graphs to describe and generalise the relationship between the $A(x)$ equation and modelling equations of the table of values. 16. Solve practical problems involving constant and variable rates of change in context. 17. Explore, compare, and identify rates of change in the media reports, e.g., 2022 COVID-19 daily community cases, COVID-19 daily/monthly vaccinations, temperature, heartbeats, and pollution rates to pose and answer practical questions. **Number Sequences** Students are able to: 1. Identify number sequences in real-life and describe the pattern of their rates of change. 2. Generate a number sequence from its general term. 3. Identify the domain and range of a sequence. 4. Classify a number sequence as finite or infinite. 5. Determine the general term of a linear number sequence using knowledge of linear relationships. 6. Develop a formula for the general term of a geometric sequence using knowledge of non-linear relationships. 7. Describe the main differences between arithmetic and geometric sequences. 8. Distinguish between sequences that are arithmetic, geometric, or neither. 9. Represent arithmetic and geometric sequences on graphs. 10. Generate sequences from graphs or diagrams. 11. Generate terms of the Fibonacci sequence using its rule (each number is the sum of the two preceding ones) with starting terms 0 and 1. 12. Determine the general term of a given number sequence.	--------	--------

TIER 3	SPECIFIC LEARNING OUTCOMES – TIER 3 – STRAND 7 - *continued* RATES OF CHANGE & CALCULUS		
YEAR 9	YEAR 10 Mathemetics	YEAR 11	YEAR 12
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YEAR 9	YEAR 10 Mathemetics	YEAR 11	YEAR 12
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TIER 1	MAJOR LEARNING OUTCOMES – TIER 1 – STRAND 7 RATES OF CHANGE & MODELLING FUNCTIONS		
	YEAR 10 General Mathemetics	YEAR 11 General Mathemetics	YEAR 12 General Mathemetics
	Students are able to: 1. Read and interpret everyday statements involving time. 2. Show analogue time as digital time and vice versa. 3. Use analogue and digital clocks to measure time, converting between analogue and digital expressions of time and using seconds in practical contexts for example; fitness circuits. 4. Explore and compare change for example, growth, temperature and heartbeats.	**Modelling Functions** Students are able to: 1. Perform calculations with time, including 24 hour clock times. 2. Read and 24 hour clock and discuss the differences between 12 hour and 24 hour time and the reasons for using 24 hour times. 3. Explore concepts of change including the use of units for example, pulse rate, birth rate, power consumption, phone bills, car speed. 4. Interpret and use information about rates presented in a variety of ways for example, graphically or in tables. 5. Explore areas under the curve starting with linear functions (apply trigonometry). 6. Introduce concept of integration emphasising its use for areas under the curve (simple).	**Modelling Functions** Students are able to: 1. Explain the relationship between the gradient of a graph and the rate of change. 2. Use calculating and interpreting rates in a variety of contexts for example, retention rates, staffing ratios and the half-life of nicotine, coffee, alcohol and radioactive materials. 3. Establish the relationship between the gradient of a graph and the rate of change, and interpret this in context using technology where appropriate. 4. Explore limits of functions. 5. Introduce further information for evaluating the constant of integration.