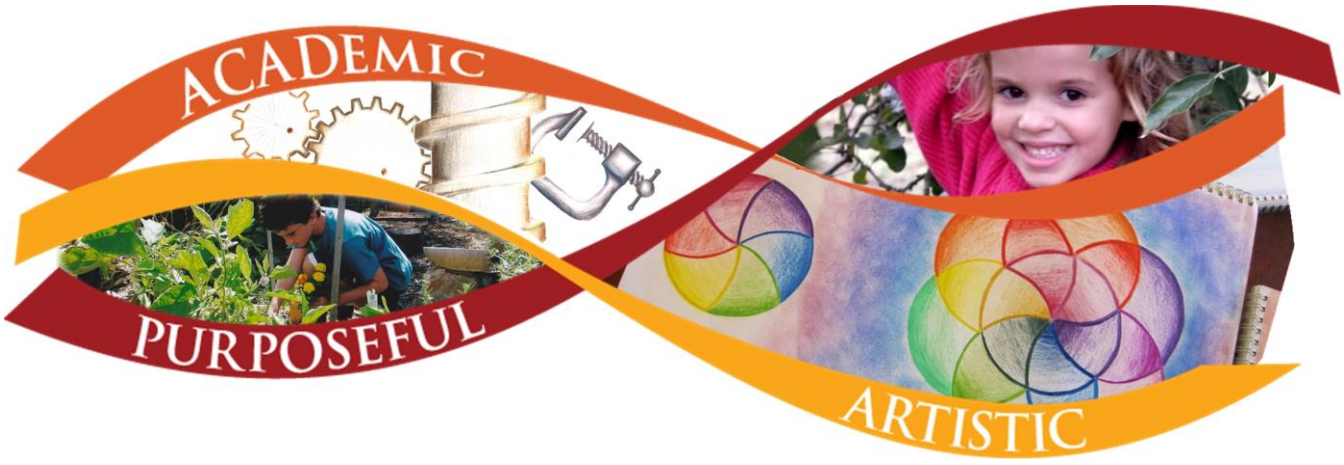


STEINER EDUCATION AUSTRALIA

AUSTRALIAN STEINER CURRICULUM FRAMEWORK 2011

MATHEMATICS HIGH SCHOOL

Extended Curriculum
Stage 4: Year 10

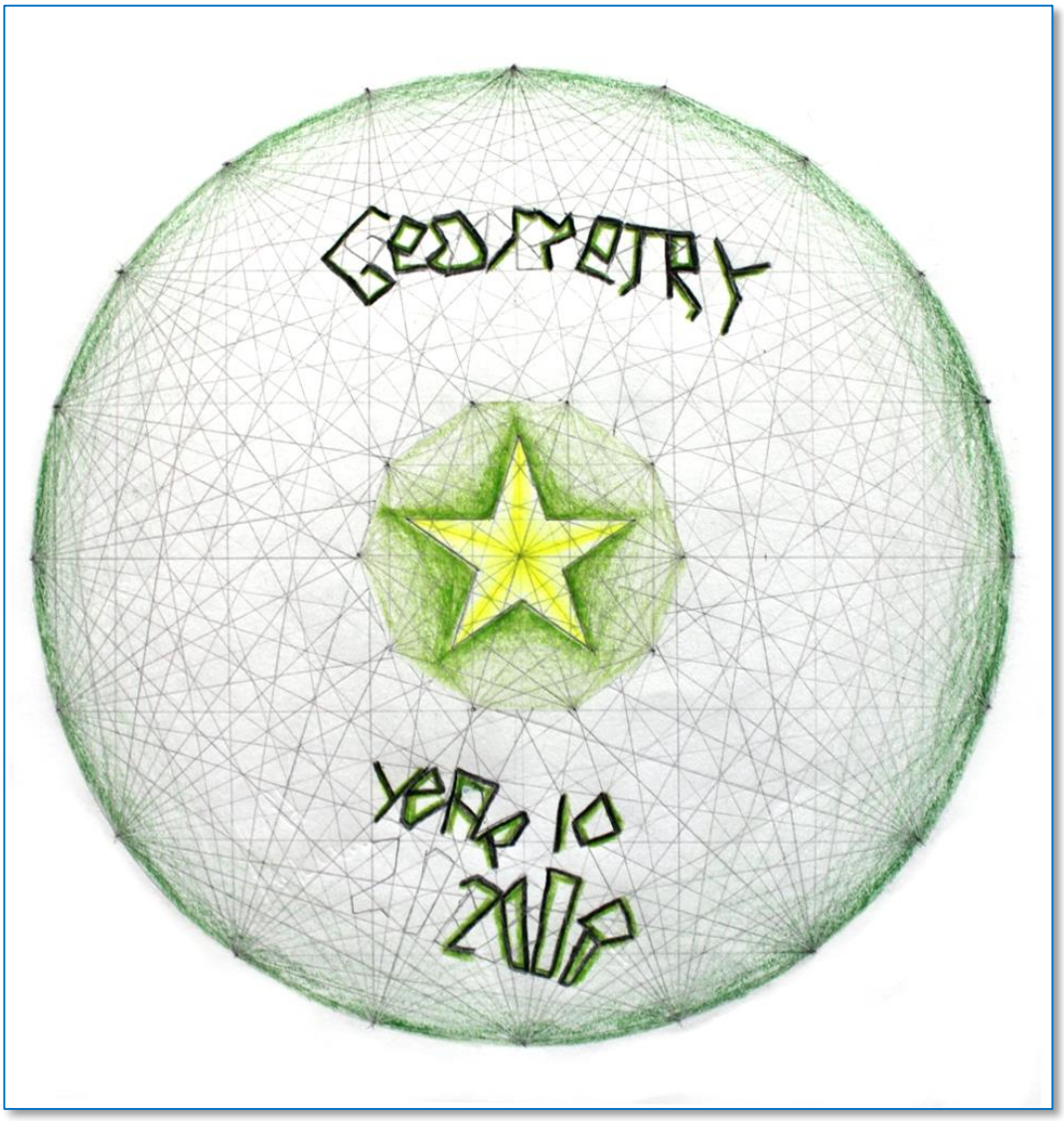
Original ACARA Recognition October 2011

Revisions included in this document:

April 2012	Numbering added to Content Descriptions and Achievement standards to enable cross-referencing
Sept 2014	Changes made to terminology relating to Aboriginal and Torres Strait Islander peoples, as per ACARA guidelines

MATHEMATICS
Extended Curriculum Topics
Stage 4: YEAR 10

Contents:


GEOMETRY
YEAR 10
2012

YEAR 10: DEVELOPMENTAL PROFILE OF THE 16 YEAR OLD STUDENT	
DEVELOPMENTAL STAGE	**CURRICULUM APPROACH**
PHYSICAL GROWTH	
In Class 10, the students reach 16 years of age. In dealing with their emerging sexuality and more specifically for boys, their growing awareness of physical power, 16 year olds are faced with a significant threshold experience which presents an opportunity for the healthy development of individuality.	The students are engaged in activities that demand both physical strength and intellectual prowess. Practical problem solving that requires an innovative approach, manual dexterity and skill is a way to draw the students into the world, while providing opportunities for healthy self expression, both as individuals and as part of a team.
SOCIO-EMOTIONAL DEVELOPMENT	
The sixteen year-old yearns to understand the world and how they can find purpose in it. The beginnings of the balance and harmony which was searched for in Class 9 begin to become visible. The development of greater clarity of thought and an increasing ability to form balanced judgments helps pupils to extricate themselves from the unstable nature of their emotional lives. There is a greater capacity for reflection, which can lead to self consciousness and the pain of growing existential awareness. The students begin to discover their own inner freedom to determine their pathway through life.	The study of Mathematics must be shown to be related to and useful in the world. This helps to evolve the quality of independent judgement that will allow the students to find their unique path. Tasks and activities are chosen which facilitate the process of the students' personalities becoming more individualised through the work, that is, the pupils' own activity helps them to find themselves.
COGNITIVE MATURATION	
The students' desire for knowledge broadens to incorporate a new intellectual focus. They desire to gather not only information about a topic, but also insight into how we know something may be so. There is a greater objectivity and clarity in thinking, bringing an increased ability to draw conclusions logically out of the formation of common sense judgments. Students begin to apply the conceptual tools of analytical thinking to practical situations and complex processes. They derive satisfaction from working with great accuracy, and often bring an increased order and neatness to the layout of their work.	The students are exposed to Mathematical experiences in which effort must be put into coming to grips analytically with laws that can be understood through thought. Emphasis is placed on working with accuracy, and the logical layout of sequential processes and algorithms develops objectivity and clarity in thinking. A level of judgement that is more theoretical is asked of the students, where general laws with predictive power can be appreciated and applied in the world.
MORAL CAPACITY	
The students in Class 10 increasingly develop the capacity to take responsibility for their own work and behaviour, and are able to make and follow through choices based on their own insight. Where the 15 year olds make strong judgements largely based on emotional responses, the 16 year old students become able to form more balanced opinions and are able to justify them articulately. They are increasingly able to develop empathy, and respond to the practical needs of those around them.	The students are brought experiences in which they notice the aspect of interdependence between disparate areas in Mathematics. This is mirrored in other subject areas, and through these experiences, the implications of social responsibility become evident to the students. The students are given opportunities to work independently on tasks and projects, which nourishes their growing ability to self direct and take an active role in their learning.

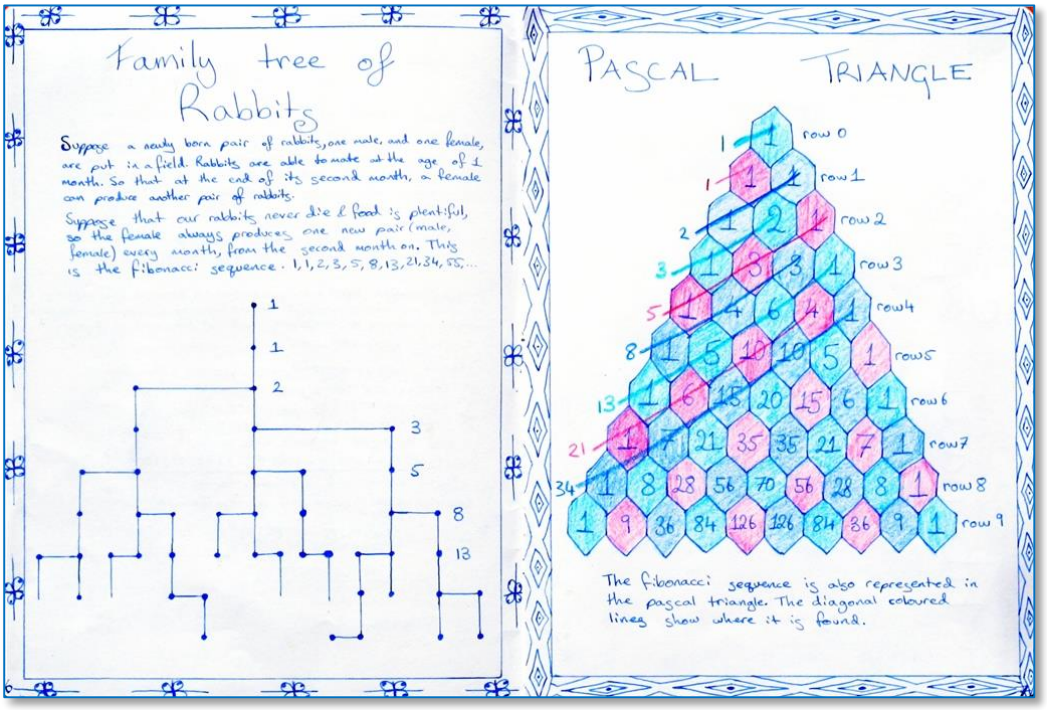
Mathematics 10.1 Sequences and Series

The Central Experience of the Content

This topic extends the student's concept of number beyond the finite. The Mathematical theory for Arithmetic, Geometric and Harmonic Sequences and Series is developed as a logical extension of the basic principles of number patterns. Practical applications of this theory are studied from sources as diverse as art, architecture and music, as well as the natural, built and business worlds.

Future Capacities

This topic brings the students to the realm of Mathematics that lies within but also extends beyond the boundaries of our direct experience. The patterns that express themselves in Mathematical Sequences find reflection in realms which can be experienced through our senses, such as nature, music, architecture and the human body. They form a continuum that extends to both the infinitesimal and the infinite. Through investigating patterns like the Fibonacci Sequence that give rise to the Golden Ratio, students can develop an appreciation for the role of Mathematics in describing the aesthetic elements of the world around them.



Content description

Mathematics 10.1 Topic: Sequences and Series

The Mathematical treatment of Arithmetic, Geometric and Harmonic Sequences and Series is presented as an extension of the basic principles of number patterns encountered in previous years. Students will learn to:

1. Understand and appreciate the historical development of this area of Mathematics and the biographies of those involved;
2. Investigate the many practical applications of this theory, including those in the world of finance, spirals and their occurrence in nature, the arts and the technological world;
3. Investigate the Fibonacci Sequence and discover its connection to the Golden Mean;
4. Experience and develop an understanding of the content of this topic both with and without the use of digital technologies.

Content Elaboration		
Learning Experiences	**Multi-modal and Artistic Activities**	**Conceptual Knowledge and Skills**
Students encounter the biography of a historical personality who investigated this particular area of Mathematics.	Students could research and report on the lives and work of Mathematicians such as Leonardo Fibonacci, Gauss, Pascal etc.	Students appreciate the significance of the contributions by historical personalities to the body of mathematical knowledge.
Students generate terms, sums and means of Sequences and Series by repetitive calculation or first principles.	Students could discover the formulae used to describe Sequences and Series, and then practise them in a diverse range of applications.	Students appreciate the power of Mathematics to describe number patterns.
Students perform simple and compound interest calculations.	Students could use a spreadsheet to calculate simple and compound interest on various investments, mortgage repayments, depreciation etc.	Students appreciate the power of technological tools to represent repetitive calculation processes in practical real world applications.
Students are introduced to the rabbit puzzle proposed by Fibonacci.	Students could represent the rabbit puzzle by laying out counters, drawing it etc.	Students discover the number pattern that leads to the Fibonacci Series.
Students generate Pascal's Triangle.	Students could investigate the pattern of Fibonacci numbers within Pascal's Triangle.	Students appreciate the power and elegance of Pascal's Triangle as a mathematical tool.
Students generate successive terms of the Fibonacci Series.	Students could find the value of the ratio of successive terms of the Fibonacci Series.	Students discover the connection between the Fibonacci Sequence and the Golden Ratio.
Students calculate the ratio between their navel and total height, and find the average value for the class.	Students could find and draw a plant which illustrates the Fibonacci numbers in its phyllotaxis, or investigate the proportions in the human form, or study the principles behind Greek architecture and the composition of certain Renaissance paintings.	Students have a direct experience of the connection between the Golden Mean and a human being's sense for harmonic proportions and beauty with reference to painting, architecture, sculpture and anatomy. Students also appreciate the power of Mathematics to describe the harmony inherent in nature.
Students investigate spiral forms in nature.	Students could construct spirals that represent different sequences eg. Archimedean, Logarithmic, Harmonic Spirals, and construct exponential and logarithmic curves.	Students develop an understanding of the connection between the Mathematical concept and its visual representation.
Students could listen to or play various musical progressions or scales.	Students discover that the Western system of progression of musical notes is in a logarithmic sequence with respect to their frequencies.	Students appreciate the way in which Mathematical concepts underlie and are woven through many of the Arts.

Mathematics 10.2 Trigonometry and Surveying

"For surveying it is enough if you first manage to teach the treatment and finding of the horizontal and show how to draw small features: vineyards, pastures, orchards… so that they have an idea of how one reproduces this on a map."

Rudolf Steiner (1921)

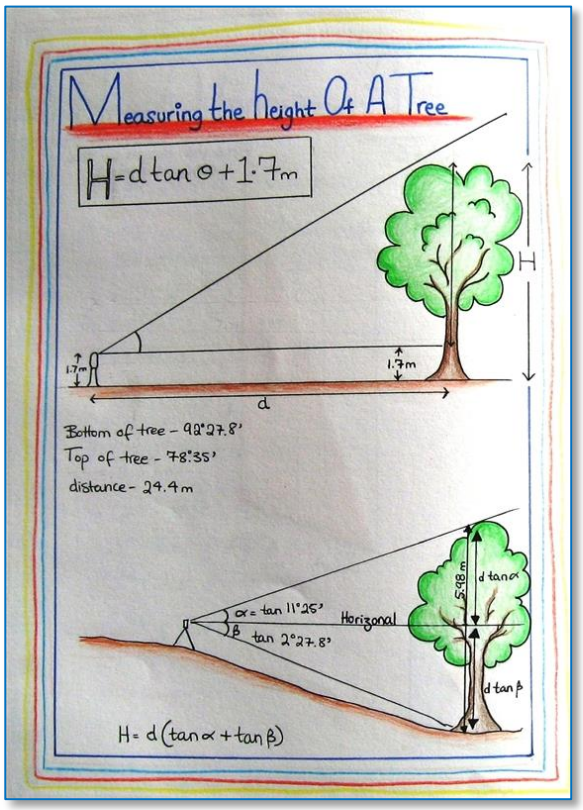
The Central Experience of the Content

This topic focuses on the use and understanding of Trigonometry and its applications to areas as diverse as surveying, mechanics, navigation, engineering, physics, astronomy, mapping, military operations and construction. A thorough picture is presented of the historical significance and development of Trigonometry and Surveying, with emphasis on practical work, applications, mathematical theory and worked examples.

Future Capacities

Australia has been surveyed and mapped by Indigenous peoples through their sacred song and oral ritual as long as there has been human habitation of the continent. Aboriginal and Torres Strait Islander peoples developed, recorded and transmitted an intimate knowledge of the land and their environment.

Elsewhere around the world, the Egyptians established farm boundaries five thousand years ago, and the builders of Stonehenge used simple surveying techniques five hundred years later. The basic principles of surveying have changed little since then, and students are brought a practical experience of an area of Mathematics that has contributed enormously to the knowledge human beings have gathered about the world around them.



Content Organiser

Mathematics 10.2 **Topic: Trigonometry and Surveying**

Students will learn to:

1. Appreciate the applications of Trigonometry to areas as diverse as surveying, mechanics, navigation, engineering, physics, astronomy, mapping, military operations and construction;
2. Produce a scale map of an area of ground by using information derived from the use of surveying equipment;
3. Use the basic Trigonometric ratios, the Sine and Cosine Rules to find unknown angles and lengths;
4. Use theodolites and other surveying equipment;
5. Gather information about the spatial relationships between the features of the site that are to be recorded;
6. Use surveying data to construct rough maps of the various areas covered, which are then collated to produce a final scale map;
7. Experience and develop an understanding of the content of this topic both with and without the use of digital technologies.

Content Elaboration

Learning Experiences	**Multi-modal and Artistic Activities**	**Conceptual Knowledge and Skills**
Students discover the historical development of Trigonometry and its application to surveying, mechanics, navigation, engineering, physics, astronomy, mapping, military operations and construction.	Students could research the work of early explorers and mapmakers in Australia and contrast this with the maps of the Aboriginal peoples which are recorded in their sacred song and oral ritual.	Students come to an understanding of the historical and cultural significance of this branch of Mathematics.
Students revise the trigonometric ratios, Sine, Cosine and Area Rules.	Students could apply the trigonometric ratios, Sine, Cosine and Area Rules to a variety of problems, including as many practical applications as possible.	Students develop an appreciation of the power of Trigonometry to describe and solve practical and geometric problems.
Students learn to set up and use a theodolite in order to read horizontal and vertical angles, and calculate distances using the staff.	Students could use the theory and techniques of tacheometry to obtain data to construct a scale map. This requires the recording of measurements and notes, the careful reading of the staff and subsequent calculations and scale drawings.	Students develop an appreciation for the complexity of the processes of land surveying that contribute to the production of a scale map.

Mathematics 10.3 Number and Algebra

The Central Experience of the Content

This topic allows students to consolidate and strengthen their understanding of Algebra, and discover areas in which Mathematical disciplines which previously appeared separate begin to overlap and merge. Students are also exposed to different number bases and their applications.

Future Capacities

The increased exposure to concepts that move out of the practical and into the abstract serves to nourish cognitive processes within the students that allow them develop confidence in the power of their thinking. This provides students with the impetus to become confident, creative individuals, who are enterprising, show initiative, explore ideas, and use their creative abilities to make discoveries about the worlds around and within them.

Content Organiser

Mathematics 10.3 Topic: Number and Algebra

Students will learn to:

1. Revise and extend their knowledge of the Algebra presented in previous years by working further in the realm of quadratics, inequalities and the manipulation of formulae;
2. Revise and extend their knowledge of Statistics and Probability presented in previous years;
3. Appreciate and understand the link that Analytical Geometry forms between Algebra and Geometry;
4. Use and apply mathematical operations in bases other than decimal;
5. Experience and develop an understanding of the content of this topic both with and without the use of digital technologies.

Content Elaboration		
Learning Experiences	**Multi-modal and Artistic Activities**	**Conceptual Knowledge and Skills**
Students revise previously encountered concepts in Algebra.	Students could apply the laws of Algebra to the simplification of increasingly complex polynomials, including practical examples where possible.	Students gain confidence in and an appreciation of the power and versatility of the basic Algebraic laws.
Students revise previously encountered work in Statistics and Probability	Students could extend their previous work with box plots, histograms, scatter plots, and bivariate data	Students deepen their understanding of the interpretation of visual representations of data.
Students collect and analyse reports in the media, especially those that make use of statistics in a persuasive manner	Students could investigate, evaluate and compare instances in which statistics is used in the media	Students become aware of the use of Mathematics as a persuasive or political tool

Content Elaboration		
Learning Experiences	**Multi-modal and Artistic Activities**	**Conceptual Knowledge and Skills**
Students practise the manipulation of formulae by changing the subject.	Students could apply the manipulation of formulae to increasingly complex problems, including surds, indices and practically based word problems.	Students develop an appreciation for the ability of Algebra to describe and deal with practical problems.
Students revise previously encountered factorisation concepts.	Students could apply the factorisation of quadratics to the solution of quadratic equations.	Students gain an appreciation of the power of factorisation as a mathematical tool.
Students encounter quadratic equations with non real or irrational roots.	Students could be presented with the quadratic formula as a means of solving quadratic equations, and apply it to increasingly complex problems.	Students gain an appreciation of the power of the quadratic formula as a mathematical tool.
Students are presented with problems such as gathering all the students into a group who are less than or equal to a certain height, age etc.	Students could encounter the mathematical treatment of the concept of inequality, and apply it to increasingly complex problems.	Students discover the situations in which it is useful to make use of inequalities.
Students generate tables of values given equations, including quadratics and inequalities.	Students could plot the graphs of these functions, and attempt to deduce the form of the general equation in each case.	Students come to an appreciation of the correspondence between the graphical and algebraic treatment of a problem.
Students plot two points on the Cartesian Plane, and attempt to find the distance between them.	Students could discover the distance formula, and apply it to increasingly complex problems.	By discovering Analytical Geometry, the students find the mathematical link between Algebra and Geometry.
Students encounter other concepts and formulae in Analytical Geometry, eg. midpoint, gradient, problems relating to parallel and perpendicular lines etc.	Students could practise these concepts and apply them to increasingly complex and practical problems.	Students develop an appreciation for the power and versatility of Analytical Geometry.
Students are challenged to attempt to convey the idea of a number if they are only allowed to count in binary.	Students discover the binary system, and can be introduced to other number bases, such as hexadecimal etc, and their applications.	Students come to an appreciation of the applications of different number bases.
Students are challenged to describe a method of adding numbers in a base other than decimal.	Students discover methods for using the four processes in other number bases	Students learn how to perform the four operations in different number bases.

Mathematics 10.4 Descriptive Geometry

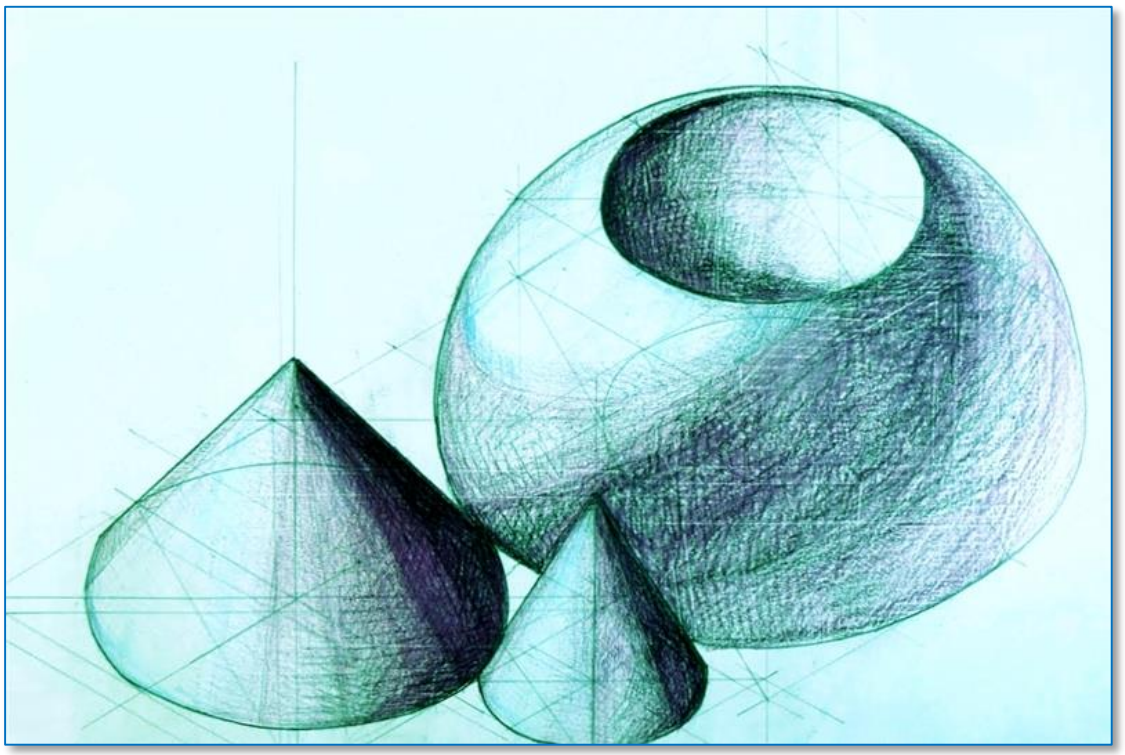
The Central Experience of the Content

In this topic, the students learn to apply the techniques and principles of Descriptive Geometry, becoming proficient at the representation of form from several viewpoints. This topic is integrated across other learning areas, finding reflection and application in art, design, materials and information technology lessons.

Future Capacities

Descriptive Geometry is a method through which three dimensional objects can be studied through two dimensional images. It provides insight into the structure and properties of objects that cannot be dealt with by solid geometry. Through the interplay between reality and its two dimensional representation, a dynamic movement is established between intuitive grasping and rigorous logical reasoning.

Apart from the benefits to the development of skills in the visualisation of two and three dimensional spatial orientation, the techniques of Descriptive Geometry are applied in fields as diverse as engineering, architecture, design and art.



Content Organiser

Mathematics 10.4 **Topic: Descriptive Geometry**

Students will learn to:

1. Develop and understanding of the historical development of Descriptive Geometry;
2. Progressively develop skills in representing three dimensional objects in two dimensions through the techniques of orthogonal projection;
3. Construct more complex forms and perform challenging constructions of real objects;
4. Use and apply technology to accelerate and simplify the process of generating and manipulating technical drawings of objects.

Content Elaboration

Learning Experiences	**Multi-modal and Artistic Activities**	**Conceptual Knowledge and Skills**
Students are presented with the biography of Gaspard Monge.	Students could research and present biographical details of Monge and other mathematicians who contributed to the development of Descriptive Geometry.	Students develop an appreciation for the significance of the contributions by historical personalities to the body of mathematical knowledge.
Students observe simple objects such as rectangular prisms, and attempt to represent them accurately from different viewpoints.	Students could work with increasingly complex objects, and attempt to establish some principles and techniques that could be used.	Students come to an understanding of the challenges of representing three dimensional objects in two dimensions.
Students are presented with the technique of moving circuitously around an object in 90° turns and viewing the object from each step.	Students discover and use the six standard principal views of the orthographic projection.	Students learn how to depict the six principal views of an object by orthographic projection.
Students practise the representation of the conic sections by orthographic projection.	Students could work with objects that incorporate curves or other complex structural detail, such as cams, cogs, screws etc.	Students become proficient at applying the techniques of Descriptive Geometry to represent complex objects.
Students are introduced to the use of Computer Aided Design systems.	Students could experiment with the use of CAD to generate and manipulate images of objects.	Students experience the power of technology to accelerate and simplify a representation process that is complex and time consuming by hand.

Achievement Standards Year 10

1. By the end of Year 10, students have discovered logarithms through the construction of spirals and the progression of musical notes. They apply the laws of logarithms to the simplification and solution of problems, and investigate number bases other than decimal, including performing the four operations in different number bases.

2. Students investigate the use of the quadratic formula and understand the implications of the value of the discriminant for both the nature of roots and the features of the corresponding parabolic graphs. They extend their previous work in the expansion, factorisation and simplification of algebraic expressions, and solve quadratic equations using a range of strategies. They are adept at the substitution of values into formulae, changing the subject of formulae, and encounter these in practical contexts.

3. Students approach simple and compound interest calculations from the perspective of sequences and series. They are familiar with arithmetic, geometric and harmonic sequences in both practical and theoretical contexts, investigating them both with and without the use of digital technologies. Students extend their understanding of the Fibonacci sequence and the Golden Ratio, and how these are reflected in nature, music, art, architecture and the human body. They investigate Archimedean, Logarithmic and Harmonic spirals, and construct exponential and logarithmic curves.

4. Students graph and solve linear and quadratic inequalities, and investigate the sketching of more complex non-linear relations, both with and without digital technologies. They investigate elements of analytical geometry, such as the distance between two points, gradients, the midpoint of a line and problems involving parallel and perpendicular lines, both with and without digital technologies. Students further extend their understanding of the relationship between the algebraic and graphical representation of rate problems, particularly in the context of displacement, velocity and acceleration.

5. Students discover and apply the principles of descriptive geometry, such as the six principal views of the orthographic projection, both with and without digital technologies. They review their previous work on the trigonometric ratios, sine, cosine and area rules, and apply these to the processing of data generated by surveying an area of ground in order to produce a scale map.

6. Students revise and extend previous work in Statistics and Probability eg from two-step to multi-step chance experiments. They deepen their awareness and understanding of the use of statistics as a persuasive tool in the media. Statistical literacy and critical awareness of the use of Mathematics is extended.

General Capabilities

Literacy

Students are able to integrate the development of literacy skills throughout the mathematical topics in year 10. In Mathematics they continually develop and extend their ability to present information in the form of tables, graphs and visual texts. Students encounter more text-based statements of mathematical problems, and topics such as 10.1 and 10.2 allow for the possibility of students generating research projects and written presentations. In particular, the study of surveying in topic 10.2 allows for the creation and interpretation of maps.

Numeracy

In year 10, students increasingly experience ways in which Mathematics can describe elements of both their immediate personal lives and the world around them. The study of Mathematics provides them with tools that nourish the depth and complexity of their thought processes, aid in the processing of large quantities of information, and encourage rational decision making. They are presented with many opportunities to develop confidence in their ability to describe, represent and solve problems, and apply mathematical thinking to other learning areas.

Information and communication technology (ICT) competence

In year 10, the students continue to make use of digital technologies in their study of Mathematics. They learn to use ICT appropriately and effectively in the representation and solution of problems. Digital technologies can engage students and allow for deeper understanding of mathematical concepts, but the primary focus remains on the development of robust thinking and problem solving skills, which can then be applied to the students' work with ICT.

ICT can be used in all topics in year 10, but is particularly useful in the constructions of tables and graphs, the representation of form in topics 10.1, 10.2 and 10.4. The study of binary and number bases other than decimal in topic 10.3 provides students with valuable insights into the functioning of computer systems.

Critical and creative thinking

Students in year 10 increasingly display an ability to make balanced judgements that can be articulately justified. They seek for deeper insight into situations, and apply the conceptual tools of analytical thinking to practical contexts and more complex processes. More accurate observation and deeper understanding allows the students to identify connections and make inferences about the more subtle aspects of a situation. They work with more accuracy and become more adept at dealing with problems requiring the application of a sequential progression of logic. ICT is increasingly used in Mathematical contexts, and students use technology confidently and responsibly as a tool to manage, interpret and represent data.

All the topics are imbued with a creative element that encourages the students to look at mathematics from a variety of perspectives. Creative thinking skills are encouraged as a means of developing original or alternative approaches to problem statement and solution. Geometry is appreciated both as an accurate visual and artistic representation of form, but also as a collection of theorems developed out of the application of sequential logic that can be employed to solve problems.

Ethical behaviour

At this age, students display a greater capacity for reflection and an increased existential awareness. They begin to gain a sense of the power of their inner freedom to determine their pathway through life. Students develop greater social responsibility and realise the impact and consequences of the courses of action that arise out of particular ideologies. There are many opportunities in Mathematics to engage with and develop personal values, ethical principles and moral integrity.

Personal and social competence

Students in year 10 are increasingly able to take responsibility for their own work and behaviour, while making choices based on their own insight into a situation. Students in year 10 display a more developed social conscience, and can respond to the needs of others out of empathy. Mathematics continues to offer them opportunities to engage consciously and responsibly with real social, environmental and economic issues.

Topics in Mathematics continue to be investigated both individually and in group contexts, allowing students to learn skills in self management, as well as the importance of contributing to the attainment of a collectively held goal. Students develop the ability to work both independently and co-operatively in teams, thereby nurturing positive social interactions. They are given opportunities to work independently on projects and tasks of greater scope, spanning a longer period of time. Mathematics continues to be presented as a quintessentially human endeavour that is intrinsic to the history, culture and development of the human being.

Intercultural understanding

Students appreciate that the evolution of Mathematics has taken place within the context of the development of human culture over the course of several different epochs of history. They are presented with the biographies and contributions of Mathematicians from cultures as diverse as the classical Greek and Mediterranean civilizations, Persian and Middle East cultures, Egyptian, Arabic and Islamic cultures, as well as European, Asian, African and Aboriginal and Torres Strait Islander cultures. Students learn to appreciate and respect the cultural differences between people and build a capacity for imaginative

empathy, which is understood to provide a firm foundation for moral conscience, ecological awareness and global citizenship.

Opportunities arise within all the topics in year 10 to expose students to the mathematical thinking and contributions of other cultures.

Cross-Curriculum Priorities

Histories and cultures of Aboriginal and Torres Strait Island peoples

It is possible for content selection for many of the topics in year 10 to include material from Aboriginal and Torres Strait Islander histories and culture. In topic 10.1, students could investigate geometric patterns employed by Aboriginal and Torres Strait Islander cultures in their art. In topic 10.2, students could investigate the ways in which Aboriginal and Torres Strait Islander cultures surveyed and mapped out the land on which they lived.

Asia and Australia's engagement with Asia

It is possible for content selection for the topics mentioned above to include material from Asian history and culture, in similar ways to the integration of Aboriginal and Torres Strait Islander histories and culture.

Sustainability

Students are exposed to scenarios, problems and situations in which they have the opportunity to consider ways in which more sustainable patterns of living can be developed. Mathematics provides understanding and skills that contribute to the evaluation, quantification and interpretation of information relating to social and environmental problems. Topics 10.1 and 10.2 are particularly suited to offer opportunities for investigating issues relating to sustainability.

Links to Other Learning Areas

In general the close interrelationship of subject areas in ASCF strengthens the crossover of the foundational skills students develop in Mathematics.

The Mathematics topics are aligned to other subject areas such as the link with Science, History, Art and English in topic 10.1; Art, Science, English and History in topic 10.2; Science and English in topic 10.3, and Art, History and Science in topic 10.4.