MATHEMATICS APPLICATIONS

ATAR COURSE

Year 11 syllabus

IMPORTANT INFORMATION

This syllabus is effective from 1 January 2020.

Users of this syllabus are responsible for checking its currency.

Syllabuses are formally reviewed by the School Curriculum and Standards Authority on a cyclical basis, typically every five years.

Content

Overview of mathematics courses

There are six mathematics courses. Each course is organised into four units. Unit 1 and Unit 2 are taken in Year 11 and Unit 3 and Unit 4 in Year 12. The ATAR course examination for each of the three ATAR courses is based on Unit 3 and Unit 4 only.

The courses are differentiated, each focusing on a pathway that will meet the learning needs of a particular group of senior secondary students.

Mathematics Preliminary is a course which focuses on the practical application of knowledge, skills and understandings to a range of environments that will be accessed by students with special education needs. Grades are not assigned for these units. Student achievement is recorded as 'completed' or 'not completed'. This course provides the opportunity for students to prepare for post-school options of employment and further training.

Mathematics Foundation is a course which focuses on building the capacity, confidence and disposition to use mathematics to meet the numeracy standard for the Western Australian Certificate of Education (WACE). It provides students with the knowledge, skills and understanding to solve problems across a range of contexts, including personal, community and workplace/employment. This course provides the opportunity for students to prepare for post-school options of employment and further training.

Mathematics Essential is a General course which focuses on using mathematics effectively, efficiently and critically to make informed decisions. It provides students with the mathematical knowledge, skills and understanding to solve problems in real contexts for a range of workplace, personal, further learning and community settings. This course provides the opportunity for students to prepare for post-school options of employment and further training.

Mathematics Applications is an ATAR course which focuses on the use of mathematics to solve problems in contexts that involve financial modelling, geometric and trigonometric analysis, graphical and network analysis, and growth and decay in sequences. It also provides opportunities for students to develop systematic strategies based on the statistical investigation process for answering questions that involve analysing univariate and bivariate data, including time series data.

Mathematics Methods is an ATAR course which focuses on the use of calculus and statistical analysis. The study of calculus provides a basis for understanding rates of change in the physical world, and includes the use of functions, their derivatives and integrals, in modelling physical processes. The study of statistics develops students' ability to describe and analyse phenomena that involve uncertainty and variation.

Mathematics Specialist is an ATAR course which provides opportunities, beyond those presented in the Mathematics Methods ATAR course, to develop rigorous mathematical arguments and proofs, and to use mathematical models more extensively. The Mathematics Specialist ATAR course contains topics in functions and calculus that build on and deepen the ideas presented in the Mathematics Methods ATAR course, as well as demonstrate their application in many areas. This course also extends understanding and knowledge of statistics and introduces the topics of vectors, complex numbers and matrices. The Mathematics Specialist course is the only ATAR mathematics course that should not be taken as a stand-alone course.

Rationale

Mathematics is the study of order, relation and pattern. From its origins in counting and measuring, it has evolved in highly sophisticated and elegant ways to become the language now used to describe many aspects of the world in the twenty-first century. Statistics are concerned with collecting, analysing, modelling and interpreting data in order to investigate and understand real world phenomena and solve practical problems in context. Together, mathematics and statistics provide a framework for thinking and a means of communication that is powerful, logical, concise and precise.

The Mathematics Applications ATAR course is designed for students who want to extend their mathematical skills beyond Year 10 level but whose future studies or employment pathways do not require knowledge of calculus. The course is designed for students who have a wide range of educational and employment aspirations, including continuing their studies at university or TAFE.

The proficiency strands of the Year 7–10 curriculum – Understanding, Fluency, Problem-solving and Reasoning – continue to be relevant and are inherent in all aspects of this course. Each of these proficiencies is essential and are mutually reinforcing. Fluency, for example, might include learning to perform routine calculations efficiently and accurately, or being able to recognise quickly from a problem description the appropriate mathematical process or model to apply. Understanding that a single mathematical process can be used in seemingly different situations helps students to see the connections between different areas of study and encourages the transfer of learning. This is an important part of learning the art of mathematical problem-solving. In performing such analyses, reasoning is required at each decision-making step and in drawing appropriate conclusions. Presenting the analysis in a logical and clear manner to explain the reasoning used is also an integral part of the learning process.

Throughout the course, there is an emphasis on the use and application of digital technologies.

Aims

The Mathematics Applications ATAR course aims to develop students':

- understanding of concepts and techniques drawn from the topic areas of number and algebra, geometry and trigonometry, graphs and networks, and statistics

- ability to solve applied problems using concepts and techniques drawn from the topic areas of number and algebra, geometry and trigonometry, graphs and networks, and statistics

- reasoning and interpretive skills in mathematical and statistical contexts

- capacity to communicate the results of a mathematical or statistical problem-solving activity in a concise and systematic manner using appropriate mathematical and statistical language

- capacity to choose and use technology appropriately and efficiently.

Organisation

This course is organised into a Year 11 syllabus and a Year 12 syllabus. The cognitive complexity of the syllabus content increases from Year 11 to Year 12.

Structure of the syllabus

The Year 11 syllabus is divided into two units, each of one semester duration, which are typically delivered as a pair. The notional time for each unit is 55 class contact hours.

Organisation of content

Unit 1

Contains the three topics:

- Consumer arithmetic

- Algebra and matrices

- Shape and measurement.

'Consumer arithmetic' reviews the concepts of rate and percentage change in the context of earning and managing money, and provides a context for the use of spread sheets. 'Algebra and matrices' continues the Year 7–10 study of algebra and introduces the new topic of matrices. The emphasis of this topic is the symbolic representation and manipulation of information from real-life contexts using algebra and matrices. 'Shape and measurement' extends the knowledge and skills students developed in the Year 7–10 curriculum with the concept of similarity and associated calculations involving simple and compound geometric shapes. The emphasis in this topic is on applying these skills in a range of practical contexts, including those involving three-dimensional shapes.

Unit 2

Contains the three topics:

- Univariate data analysis and the statistical investigation process

- Applications of trigonometry

- Linear equations and their graphs.

'Univariate data analysis and the statistical investigation process' develop students' ability to organise and summarise univariate data in the context of conducting a statistical investigation. 'Applications of trigonometry' extends students' knowledge of trigonometry to solve practical problems involving non-right-angled triangles in both two and three dimensions, including problems involving the use of angles of elevation and depression and bearings in navigation. 'Linear equations and their graphs' uses linear equations and straight-line graphs, as well as linear-piece-wise and step graphs, to model and analyse practical situations.

Each unit includes:

- a unit description – a short description of the focus of the unit

- learning outcomes – a set of statements describing the learning expected as a result of studying the unit

- unit content – the content to be taught and learned.

Role of technology

It is assumed that students will be taught this course with an extensive range of technological applications and techniques. These have the potential to enhance the teaching and learning of mathematics. However, students also need to continue to develop skills that do not depend on technology. The ability to choose when and when not to use some form of technology, and the ability to work flexibly with technology, are important skills in this course.

Progression from the Year 7–10 curriculum

This syllabus provides students with a breadth of mathematical and statistical experience that encompasses and builds on all three strands of the Year 7–10 Mathematics curriculum. It is expected that students will have covered the Year 10 mathematics content to a satisfactory level.

Representation of the general capabilities

The general capabilities encompass the knowledge, skills, behaviours and dispositions that will assist students to live and work successfully in the twenty-first century. Teachers may find opportunities to incorporate the capabilities into the teaching and learning program for the Mathematics Applications ATAR course. The general capabilities are not assessed unless they are identified within the specified unit content.

Literacy

Literacy skills and strategies enable students to express, interpret, and communicate complex mathematical information, ideas and processes. Mathematics provides a specific and rich context for students to develop their ability to read, write, visualise and talk about complex situations involving a range of mathematical ideas. Students can apply and further develop their literacy skills and strategies by shifting between verbal, graphic, numerical and symbolic forms of representing problems in order to formulate, understand and solve problems and communicate results. This process of translation across different systems of representation is essential for complex mathematical reasoning and expression. Students learn to communicate their findings in different ways, using multiple systems of representation and data displays to illustrate the relationships they have observed or constructed.

Numeracy

Students who undertake this course will continue to develop their numeracy skills at a more sophisticated level, making decisions about the relevant mathematics to use, following through with calculations selecting appropriate methods and being confident of their results. This course contains topics that will equip students for the ever-increasing demands of the information age, developing the skills of critical evaluation of numerical information in its various forms of collection and presentation. Students will enhance their numerical operation skills via engagement with consumer arithmetic problems, mensuration and trigonometric calculations, algebraic modelling and analysis of practical situations, and the statistical analysis of univariate data.

Information and communication technology capability

Students use information and communication technology (ICT) both to develop theoretical mathematical understanding and to apply mathematical knowledge to a range of problems. They use software aligned with areas of work and society with which they may be involved, such as for statistical analysis, generation of algorithms, manipulation and complex calculation. They use digital tools to make connections between mathematical theory, practice and application; for example, to use data, to address problems, and to operate systems in authentic situations.

Critical and creative thinking

Students compare predictions with observations when evaluating a theory. They check the extent to which their theory-based predictions match observations. They assess whether, if observations and predictions don't match, it is due to a flaw in theory or method of applying the theory to make predictions – or both. They revise, or reapply their theory more skilfully, recognising the importance of self-correction in the building of useful and accurate theories and making accurate predictions.

Personal and social capability

Students develop personal and social competence in mathematics through setting and monitoring personal and academic goals, taking initiative, building adaptability, communication, teamwork and decision making. The elements of personal and social competence relevant to mathematics mainly include the application of mathematical skills for their decision making, life-long learning, citizenship and self-management. In addition, students will work collaboratively in teams and independently as part of their mathematical explorations and investigations.

Ethical understanding

Students develop ethical understanding in mathematics through decision making connected with ethical dilemmas that arise when engaged in mathematical calculation and the dissemination of results and the social responsibility associated with teamwork and attribution of input.

The areas relevant to mathematics include issues associated with ethical decision-making as students work collaboratively in teams and independently as part of their mathematical explorations and investigations. Acknowledging errors rather than denying findings and/or evidence involves resilience and ethical understanding. They develop increasingly advanced communication, research, and presentation skills to express viewpoints.

Intercultural understanding

Students understand mathematics as a socially constructed body of knowledge that uses universal symbols but has its origin in many cultures. Students understand that some languages make it easier to acquire mathematical knowledge than others. Students also understand that there are many culturally diverse forms of mathematical knowledge, including diverse relationships to number and that diverse cultural spatial abilities and understandings are shaped by a person's environment and language.

Representation of the cross-curriculum priorities

The cross-curriculum priorities address contemporary issues which students face in a globalised world. Teachers may find opportunities to incorporate the priorities into the teaching and learning program for the Mathematics Applications ATAR course. The cross-curriculum priorities are not assessed unless they are identified within the specified unit content.

Aboriginal and Torres Strait Islander histories and cultures

Mathematics courses value the histories, cultures, traditions and languages of Aboriginal and Torres Strait Islander Peoples' past and ongoing contributions to contemporary Australian society and culture. Through the study of mathematics within relevant contexts, opportunities will allow for the development of students' understanding and appreciation of the diversity of Aboriginal and Torres Strait Islander Peoples' histories and cultures.

Asia and Australia's engagement with Asia

There are strong social, cultural and economic reasons for Australian students to engage with the countries of Asia and with the past and ongoing contributions made by the peoples of Asia in Australia. It is through the study of mathematics in an Asian context that students engage with Australia's place in the region. By analysing relevant data, students have opportunities to further develop an understanding of the diverse nature of Asia's environments and traditional and contemporary cultures.

Sustainability

Each of the mathematics courses provides the opportunity for the development of informed and reasoned points of view, discussion of issues, research and problem solving. Teachers are therefore encouraged to select contexts for discussion that are connected with sustainability. Through the analysis of data, students have the opportunity to research and discuss sustainability and learn the importance of respecting and valuing a wide range of world perspectives.

Unit 1

Unit description

This unit has three topics: 'Consumer arithmetic', 'Algebra and matrices', and 'Shape and measurement'.

'Consumer arithmetic' reviews the concepts of rate and percentage change in the context of earning and managing money and provides a fertile ground for the use of spread sheets.

'Algebra and matrices' continues the Year 7–10 curriculum study of algebra and introduces the topic of matrices. The emphasis of this topic is the symbolic representation and manipulation of information from real-life contexts using algebra and matrices.

'Shape and measurement' builds on and extends the knowledge and skills students developed in the Year 7–10 curriculum with the concept of similarity and associated calculations involving simple geometric shapes. The emphasis in this topic is on applying these skills in a range of practical contexts, including those involving three-dimensional shapes.

Classroom access to the technology necessary to support the computational aspects of the topics in this unit is assumed.

Learning outcomes

By the end of this unit, students:

- understand the concepts and techniques in consumer arithmetic , algebra and matrices, and shape and measurement

- apply reasoning skills and solve practical problems in consumer arithmetic, algebra and matrices, and shape and measurement

- communicate their arguments and strategies when solving problems using appropriate mathematical language

- interpret mathematical information and ascertain the reasonableness of their solutions to problems

- choose and use technology appropriately and efficiently.

Unit content

This unit includes the knowledge, understandings and skills described below.

Topic 1.1: Consumer arithmetic (20 hours)

Applications of rates and percentages

1.1.1   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

1.1.2   calculate payments based on government allowances and pensions

1.1.3   prepare a personal budget for a given income taking into account fixed and discretionary spending

1.1.4   compare prices and values using the unit cost method

1.1.5   apply percentage increase or decrease in contexts, including determining the impact of inflation on costs and wages over time, calculating percentage mark-ups and discounts, calculating GST, calculating profit or loss in absolute and percentage terms, and calculating simple and compound interest

1.1.6   use currency exchange rates to determine the cost in Australian dollars of purchasing a given amount of a foreign currency, or the value of a given amount of foreign currency, when converted to Australian dollars

1.1.7   calculate the dividend paid on a portfolio of shares given the percentage dividend or dividend paid for each share, and compare share values by calculating a price-to-earnings ratio

Use of spread sheets

1.1.8   use a spreadsheet to display examples of the above computations when multiple or repeated computations are required; for example, preparing a wage-sheet displaying the weekly earnings of workers in a fast food store where hours of employment and hourly rates of pay may differ, preparing a budget, or investigating the potential cost of owning and operating a car over a year

Topic 1.2: Algebra and matrices (15 hours)

Linear and non-linear expressions

1.2.1   substitute numerical values into algebraic expressions, and evaluate (with the aid of technology where complicated numerical manipulation is required)

1.2.2   determine the value of the subject of a formula, given the values of the other pronumerals in the formula (transposition not required)

1.2.3   use a spreadsheet or an equivalent technology to construct a table of values from a formula, including tables for formulas with two variable quantities; for example, a table displaying the body mass index (BMI) of people of different weights and heights

Matrices and matrix arithmetic

1.2.4   use matrices for storing and displaying information that can be presented in rows and columns; for example, databases, links in social or road networks

1.2.5   recognise different types of matrices (row, column, square, zero, identity) and determine their size

1.2.6   perform matrix addition, subtraction, multiplication by a scalar, and matrix multiplication, including determining the power of a matrix using technology with matrix arithmetic capabilities when appropriate

1.2.7   use matrices, including matrix products and powers of matrices, to model and solve problems; for example, costing or pricing problems, squaring a matrix to determine the number of ways pairs of people in a communication network can communicate with each other via a third person

Topic 1.3: Shape and measurement (20 hours)

Pythagoras' theorem

1.3.1   use Pythagoras' theorem to solve practical problems in two dimensions and for simple applications in three dimensions

Mensuration

1.3.2   solve practical problems requiring the calculation of perimeters and areas of circles, sectors of circles, triangles, rectangles, parallelograms and composites

1.3.3   calculate the volumes of standard three-dimensional objects, such as spheres, rectangular prisms, cylinders, cones, pyramids and composites in practical situations, for example, the volume of water contained in a swimming pool

1.3.4   calculate the surface areas of standard three-dimensional objects, such as spheres, rectangular prisms, cylinders, cones, pyramids and composites in practical situations; for example, the surface area of a cylindrical food container

Similar figures and scale factors

1.3.5   review the conditions for similarity of two-dimensional figures, including similar triangles

1.3.6   use the scale factor for two similar figures to solve linear scaling problems

1.3.7   obtain measurements from scale drawings, such as maps or building plans, to solve problems

1.3.8   obtain a scale factor and use it to solve scaling problems involving the calculation of the areas of similar figures and surface areas and volumes of similar solids

Unit 2

Unit description

This unit has three topics: 'Univariate data analysis and the statistical process', 'Linear equations and their graphs', and 'Applications of trigonometry'.

'Univariate data analysis and the statistical process' develops students' ability to organise and summarise univariate data in the context of conducting a statistical investigation.

'Linear equations and their graphs' uses linear equations and straight-line graphs, as well as linear-piece-wise and step graphs to model and analyse practical situations.

'Applications of trigonometry' extends students' knowledge of trigonometry to solve practical problems involving non-right- angled triangles in both two and three dimensions, including problems involving the use of angles of elevation and depression and bearings in navigation.

Classroom access to the technology necessary to support the graphical, computational and statistical aspects of this unit is assumed.

Learning outcomes

By the end of this unit, students:

- understand the concepts and techniques used in univariate data analysis and the statistical process, linear equations and their graphs, and applications of trigonometry

- apply reasoning skills and solve practical problems in univariate data analysis and the statistical process, linear equations and their graphs, and the applications of trigonometry

- implement the statistical investigation process in contexts requiring the analysis of univariate data

- communicate their arguments and strategies, when solving mathematical and statistical problems, using appropriate mathematical or statistical language

- interpret mathematical and statistical information, and ascertain the reasonableness of their solutions to problems and answers to statistical questions

- choose and use technology appropriately and efficiently.

Unit content

This unit includes the knowledge, understandings and skills described below.

Topic 2.1: Univariate data analysis and the statistical investigation process (25 hours)

The statistical investigation process

2.1.1   review the statistical investigation process; identifying a problem and posing a statistical question, collecting or obtaining data, analysing the data, interpreting and communicating the results

Making sense of data relating to a single statistical variable

2.1.2   classify a categorical variable as ordinal, such as income level (high, medium, low) or nominal, such as place of birth (Australia, overseas) and use tables and bar charts to organise and display data

2.1.3   classify a numerical variable as discrete, such as the number of rooms in a house, or continuous, such as the temperature in degrees Celsius

2.1.4   with the aid of an appropriate graphical display (chosen from dot plot, stem plot, bar chart or histogram), describe the distribution of a numerical data set in terms of modality (uni or multimodal), shape (symmetric versus positively or negatively skewed), location and spread and outliers, and interpret this information in the context of the data

2.1.5   determine the mean and standard deviation of a data set using technology and use these statistics as measures of location and spread of a data distribution, being aware of their limitations

2.1.6   use the number of deviations from the mean (standard scores) to describe deviations from the mean in normally distributed data sets

2.1.7   calculate quantiles for normally distributed data with known mean and standard deviation in practical situations

2.1.8   use the 68%, 95%, 99.7% rule for data one, two and three standard deviations from the mean in practical situations

2.1.9   calculate probabilities for normal distributions with known mean μ and standard deviation σ in practical situations

Comparing data for a numerical variable across two or more groups

2.1.10   construct and use parallel box plots (including the use of the 'Q1 − 1.5 x IQR' and 'Q3 + 1.5 x IQR' criteria for identifying possible outliers) to compare groups in terms of location (median), spread (IQR and range) and outliers, and interpret and communicate the differences observed in the context of the data

2.1.11   compare groups on a single numerical variable using medians, means, IQRs, ranges or standard deviations, and as appropriate; interpret the differences observed in the context of the data and report the findings in a systematic and concise manner

2.1.12   implement the statistical investigation process to answer questions that involve comparing the data for a numerical variable across two or more groups; for example, are Year 11 students the fittest in the school?

Topic 2.2: Applications of trigonometry (10 hours)

2.2.1   use trigonometric ratios to determine the length of an unknown side, or the size of an unknown angle in a right-angled triangle

2.2.2   determine the area of a triangle, given two sides and an included angle by using the rule $area = \frac{1}{2}\,absinC$, or given three sides by using Heron's rule, and solve related practical problems

2.2.3   solve problems involving non-right-angled triangles using the sine rule (acute triangles only when determining the size of an angle) and the cosine rule

2.2.4   solve practical problems involving right-angled and non-right-angled triangles, including problems involving angles of elevation and depression and the use of bearings in navigation

Topic 2.3: Linear equations and their graphs (20 hours)

Linear equations

2.3.1   identify and solve linear equations (with the aid of technology where complicated manipulations are required)

2.3.2   develop a linear formula from a word description and solve the resulting equation

Straight-line graphs and their applications

2.3.3   construct straight-line graphs both with and without the aid of technology

2.3.4   determine the slope and intercepts of a straight-line graph from both its equation and its plot

2.3.5   construct and analyse a straight-line graph to model a given linear relationship; for example, modelling the cost of filling a fuel tank of a car against the number of litres of petrol required.

2.3.6   interpret, in context, the slope and intercept of a straight-line graph used to model and analyse a practical situation

Simultaneous linear equations and their applications

2.3.7   solve a pair of simultaneous linear equations graphically or algebraically, using technology when appropriate

2.3.8   solve practical problems that involve determining the point of intersection of two straight-line graphs; for example, determining the break-even point where cost and revenue are represented by linear equations

Piece-wise linear graphs and step graphs

2.3.9   sketch piece-wise linear graphs and step graphs, using technology when appropriate

2.3.10   interpret piece-wise linear and step graphs used to model practical situations; for example, the tax paid as income increases, the change in the level of water in a tank over time when water is drawn off at different intervals and for different periods of time, the charging scheme for sending parcels of different weights through the post

School-based assessment

The Western Australian Certificate of Education (WACE) Manual contains essential information on principles, policies and procedures for school-based assessment that needs to be read in conjunction with this syllabus.

Teachers design school-based assessment tasks to meet the needs of students. The table below provides details of the assessment types for the Mathematics Applications ATAR Year 11 syllabus and the weighting for each assessment type.

Assessment table – Year 11

Type of assessment	Weighting
Response Students respond using knowledge of mathematical facts, concepts and terminology, applying problem-solving skills and algorithms. Response tasks can include: tests, assignments, quizzes and observation checklists. Tests are administered under controlled and timed conditions.	40%
Investigation Students use the mathematical thinking process and the statistical investigation process to plan, research, conduct and communicate, the findings of an investigation/project. They can investigate problems identifying the underlying mathematics, or select, adapt and apply models and procedures to solve problems. This assessment type provides for the assessment of the mathematical thinking process and statistical investigation process using course-related knowledge and modelling skills. The 'Consumer Arithmetic' and 'Univariate Data' topics are recommended as suitable content areas for investigation. Evidence can include: observation and interview, written work or multimedia presentations.	20%
Examination Students apply mathematical understanding and skills to analyse, interpret and respond to questions and situations. Examinations provide for the assessment of conceptual understandings, knowledge of mathematical facts and terminology, problem-solving skills, and the use of algorithms. Examination questions can range from those of a routine nature, assessing lower level concepts, through to those that require responses at the highest level of conceptual thinking. Typically conducted at the end of each semester and/or unit. In preparation for Unit 3 and Unit 4, the examination should reflect the examination design brief included in the ATAR Year 12 syllabus for this course. Where a combined assessment outline is implemented, the Semester 2 examination should assess content from both Unit 1 and Unit 2. However, the combined weighting of Semester 1 and Semester 2 should reflect the respective weightings of the course content as a whole.	40%

Teachers are required to use the assessment table to develop an assessment outline for the pair of units (or for a single unit where only one is being studied).

The assessment outline must:

- include a set of assessment tasks

- include a general description of each task

- indicate the unit content to be assessed

- indicate a weighting for each task and each assessment type

- include the approximate timing of each task (for example, the week the task is conducted, or the issue and submission dates for an extended task).

In the assessment outline for the pair of units:

- each assessment type must be included at least twice

- the response type must include a minimum of two tests.

In the assessment outline where a single unit is being studied:

- each assessment type must be included at least once

- the response type must include at least one test.

The set of assessment tasks must provide a representative sampling of the content for Unit 1 and Unit 2.

Assessment tasks not administered under test/controlled conditions require appropriate validation/authentication processes. This may include observation, annotated notes, checklists, interview, presentations or in-class tasks assessing related content and processes.

Grading

Schools report student achievement in terms of the following grades:

Grade	Interpretation
A	Excellent achievement
B	High achievement
C	Satisfactory achievement
D	Limited achievement
E	Very low achievement

The teacher prepares a ranked list and assigns the student a grade for the pair of units (or for a unit where only one unit is being studied). The grade is based on the student's overall performance as judged by reference to a set of pre-determined standards. These standards are defined by grade descriptions and annotated work samples. The grade descriptions for the Mathematics Applications ATAR Year 11 syllabus are provided in Appendix 1. They can also be accessed, together with annotated work samples, through the Guide to Grades link on the course page of the Authority website at www.scsa.wa.edu.au

To be assigned a grade, a student must have had the opportunity to complete the education program, including the assessment program (unless the school accepts that there are exceptional and justifiable circumstances).

Refer to the WACE Manual for further information about the use of a ranked list in the process of assigning grades.

Appendix 1 – Grade descriptions Year 11

<table>
<tr>
<td rowspan="5">A</td>
<td>Identifies and organises relevant information
Identifies and organises relevant information that is complex; for example, developing a linear formula from a word description, interpreting word problems to determine the appropriate pension allowance or dividend amount for a share portfolio.
Uses scale to calculate appropriate areas and volumes of similar shapes and solids, drawing geometrical diagrams from descriptive passages.</td>
</tr>
<tr>
<td>Chooses effective models and methods and carries through the methods correctly
Solves extended unstructured problems; for example, adding the correct information to a given geometry diagram or recognising gradient and intercept as part of linear graph used to model a practical situation.
Carries extended responses through; for example, developing a diagram and using the result to solve related problems or using extended tables or a spreadsheet to find patterns both in the rows and columns.
Determines the effects of changed conditions; for example, recognising the effects of change of gradient or intercept on a linear graph.</td>
</tr>
<tr>
<td>Follows mathematical conventions and attends to accuracy
Defines and uses variables appropriately in solving algebraic problems and in representing and analysing statistical data.
Decides at which point to round in an extended response and determines the degree of accuracy based upon the context or units used when solving problems requiring trigonometry or measurement calculations.</td>
</tr>
<tr>
<td>Links mathematical results to data and contexts to reach reasonable conclusions
Generalises mathematical structures and applies appropriate processes, such as, the statistical investigative process, to answer questions in context.
Makes appropriate use of the scale on maps.
Recognises specified conditions and attends to units in extended responses.</td>
</tr>
<tr>
<td>Communicates mathematical reasoning, results and conclusions
Shows clear steps in reasoning; for example, when solving a problem using matrices. Justifies conclusions with a statement which links to results.
Translates solution into language of the original problem.</td>
</tr>
</table>

<table>
<tr>
<td rowspan="4">B</td>
<td>Identifies and organises relevant information
Identifies and organises relevant information that is concentrated or scattered; for example, accurately labelling 2-D or simple 3-D diagrams with part information included; completing tables of values to look for a pattern or preparing a wage-sheet; and identifying the correct information from a given geometry diagram.</td>
</tr>
<tr>
<td>Chooses effective models and methods and carries the methods through correctly
Recognises the correct function model and reads the correct values from a graph.
Carries through and solves multi-step linear equations; extracts correct information from a network diagram; extracts correct information from an extended table of values; applies appropriate matrix algebra to solve costing/pricing problems or communication network problems.
Generalises obvious mathematical structures; for example, using interpolation/extrapolation appropriately in graphing, finding obvious number patterns in tables of values.</td>
</tr>
<tr>
<td>Follows mathematical conventions and attends to accuracy.
Applies conventions for diagrams and graphs including accurately labelling angles and sides in an extended 2D diagram.
Rounds to specified accuracies; for example, when calculating price-to-earnings share ratios or performing currency conversions.
Checks results and makes adjustments where necessary.</td>
</tr>
<tr>
<td>Links mathematical results to data and contexts to reach reasonable conclusions
Recognises specified conditions and attends to units in extended problems.
Links and processes more than one piece of information which may be scattered, such as, comparing data across two or more groups and drawing reasonable conclusions.</td>
</tr>
</table>

Communicates mathematical reasoning, results and conclusions

Shows the main steps in reasoning; for example, when solving trigonometric ratio problems from set diagrams. Uses routine methods in labelling networks to show results.

Shows main steps in finding a solution to a problem; for example, using Pythagoras' theorem to solve a 2D practical problem.

C

Identifies and organises relevant information

Identifies and organises relevant information that is grouped together or is relatively narrow in scope; for example, makes direct substitution of values into linear equations/formulas.

Selects the correct sides when using trigonometric ratios on a diagram that is supplied.

Identifies the key parameters of a normally distributed data set.

Identifies the need to determine the point of intersection of two straight line graphs to solve a cost/revenue break-even point problem.

Chooses effective models and methods and carries the methods through correctly

Answers structured questions that require short responses; for example, solves two-step linear equations.

Completes missing values in a table of a given linear function or step-graph.

Applies mathematics in practised ways; for example, chooses the correct trigonometric ratio for a supplied diagram or to solve a right-triangle problem.

Calculates specific cases of generalisations; for example, substitutes values into a given formulas, such as, trigonometric ratios, and evaluates the unknown angle or side.

Carries a single thread of reasoning through; for example, applies the area formula,

$Area\ \Delta ABC = \frac{1}{2} \times 7 \times 6 \times sin23^o$.

Uses a calculator appropriately for calculations.

Follows mathematical conventions and attends to accuracy

Applies the rule of Order of Operations to equations; for example, Pythagoras' theorem.

Applies conventions for diagrams and labels sides and angles in geometry.

Sets up graphs neatly and accurately and labels histograms appropriately with the scales marked.

Rounds to suit contexts; for example, shows dollar calculations to two decimal places and rounds distance to a sensible level with measurement questions.

Accurately plots and labels given points when graphing linear functions.

Links mathematical results to data and contexts to reach reasonable conclusions

Recognises specified conditions and attends to units in short responses; for example, expresses the answer using the units defined in the question or links trigonometric ratios to distances on a diagram.

Links data to the respective numbers in a matrix.

Communicates mathematical reasoning, results and conclusions

Shows working, including intermediate steps and/or expressions entered into a calculator, when setting out short responses.

Uses the 'left hand side = right hand side' convention properly in short responses.

Makes comparisons between groups of data, communicating observations in context.

D

Identifies and organises relevant information

Identifies and organises relevant information that is grouped together and narrow in scope; for example, plotting points on a Cartesian plane or making single value substitutions in a short response.

Identifies the appropriate parameters to describe a numerical dataset.

Chooses effective models and methods and carries the methods through correctly

Answers structured questions that are familiar or require short responses; for example, drawing single geometric figures by connecting points on a Cartesian plane.

Substitutes into appropriate mensuration formulas to evaluate volume/area of standard shapes/objects.

Makes single-step, common sense connections; for example, recognises the use of the constant in a linear equation within a context.

Uses a calculator to complete practised processes, such as, determining the mean or standard deviation of a data set.

	Follows mathematical conventions and attends to accuracy Plots graphs with a poor degree of accuracy, or labels diagrams and given points with little detail. Rounds to suit contexts in short answer questions, but only when prompted.
	Links mathematical results to data and contexts to reach reasonable conclusions Recognises specified conditions and attends to units in short responses only in familiar and practised questions. Links calculation results to a context in obvious ways; for example, when linking the calculation of a weekly wage to an hourly rate.
	Communicates mathematical reasoning, results and conclusions Shows working but only in familiar and practised contexts; for example, when calculating the area of a triangle using a provided formula and obvious dimensions.

E	Does not meet the requirements of a D grade and/or has completed insufficient assessment tasks to be assigned a higher grade.

Appendix 2 – Glossary

This glossary is provided to enable a common understanding of the key terms in this syllabus.

Unit 1	
Consumer arithmetic	
Compound interest	The interest earned by investing a sum of money (the principal) is compound interest if each successive interest payment is added to the principal for the purpose of calculating the next interest payment. For example, if the principal P earns compound interest at the rate of i % per period, then after n periods the total amount accrued is $P(1 + \frac{i}{100})^n$. When plotted on a graph, the total amount accrued is seen to grow exponentially.
CPI	The Consumer Price Index (CPI) is a measure of changes, over time, in retail prices of a constant basket of goods and services representative of consumption expenditure by resident households in Australian metropolitan areas.
Government allowances and pensions	The appropriate government allowances and pensions to consider include allowances for youth, tertiary study and travel. The emphasis is on researching, determining and calculating amounts of allowances and pensions considered appropriate for students, depending on interests, needs, backgrounds and location. Detailed knowledge of conditions of eligibility etc. are not required.
GST	The GST (Goods and Services Tax) is a broad sales tax of 10% on most goods and services transactions in Australia.
Price to earnings ratio (of a share)	The price to earnings ratio of a share (P/E ratio) is defined as : $$P/E\ ratio = \frac{Market\ price\ per\ share}{Annual\ earnings\ per\ share}$$
Simple interest	Simple interest is the interest accumulated when the interest payment in each period is a fixed fraction of the principal. For example, if the principle P earns simple interest at the rate of i % per period, then after n periods the accumulated simple interest is $nP \frac{i}{100}$ When plotted on a graph, the total amount accrued is seen to grow linearly.
Algebra and matrices	
Algebra	
Linear equation	A linear equation in one variable x is an equation of the form $ax + b = 0$, for example, $3x + 1 = 0$. A linear equation in two variables for example, x and y is an equation of the form $ax + by + c = 0$, for example, $2x - 3y + 5 = 0$.

Matrices	
Addition of matrices	If A and B are matrices of the same size (order) and the elements of A are a_{ij} and the elements of B are b_{ij}, then the elements of $A + B$ are $a_{ij} + b_{ij}$ For example, if $A = \begin{bmatrix} 2 & 1 \\ 0 & 3 \\ 1 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} 5 & 1 \\ 2 & 1 \\ 1 & 6 \end{bmatrix}$ then $A + B = \begin{bmatrix} 7 & 2 \\ 2 & 4 \\ 2 & 10 \end{bmatrix}$
Elements (entries) of a matrix	The symbol a_{ij} represents the (i, j) element occurring in the ith row and the jth column. For example, a general 3×2 matrix is: $\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ a_{31} & a_{32} \end{bmatrix}$ where a_{32} is the element in the third row and the second column.
Identity matrix	A multiplicative identity matrix is a square matrix in which all of the elements in the leading diagonal are 1's and the remaining elements are 0's. Identity matrices are designated by the letter I. For example, $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ and $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ are both identity matrices. There is an identity matrix for each size (or order) of a square matrix. When clarity is needed, the order is written with a subscript: I_n
Leading diagonal	The leading diagonal of a square matrix is the diagonal that runs from the top left corner to the bottom right corner of the matrix.
Matrix (matrices)	A matrix is a rectangular array of elements or entities displayed in rows and columns. For example, $A = \begin{bmatrix} 2 & 1 \\ 0 & 3 \\ 1 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 8 & 0 \\ 2 & 5 & 7 \end{bmatrix}$ are both matrices with six elements. Matrix A is said to be a 3×2 matrix (three rows and two columns) while B is said to be a 2×3 matrix (two rows and three columns). A square matrix has the same number of rows and columns. A column matrix (or vector) has only one column. A row matrix (or vector) has only one row.

Matrix multiplication	Matrix multiplication is the process of multiplying a matrix by another matrix. For example, forming the product $$\begin{bmatrix} 1 & 8 & 0 \\ 2 & 5 & 7 \end{bmatrix} \begin{bmatrix} 2 & 1 \\ 0 & 3 \\ 1 & 4 \end{bmatrix} = \begin{bmatrix} 2 & 25 \\ 11 & 45 \end{bmatrix}$$ The multiplication is defined by $$1 \times 2 + 8 \times 0 + 0 \times 1 = 2$$ $$1 \times 1 + 8 \times 3 + 0 \times 4 = 25$$ $$2 \times 2 + 5 \times 0 + 7 \times 1 = 11$$ $$2 \times 1 + 5 \times 3 + 7 \times 4 = 45$$ This is an example of the process of matrix multiplication. The product AB of two matrices A and B of size $m \times n$ and $p \times q$ respectively is defined if $n = p$. If $n = p$ the resulting matrix has size $m \times q$. If $A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ a_{31} & a_{32} \end{bmatrix}$ and $B = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \end{bmatrix}$ then $AB = \begin{bmatrix} a_{11}b_{11} + a_{12}b_{21} & a_{11}b_{12} + a_{12}b_{22} & a_{11}b_{13} + a_{12}b_{23} \\ a_{21}b_{11} + a_{22}b_{21} & a_{21}b_{12} + a_{22}b_{22} & a_{21}b_{13} + a_{22}b_{23} \\ a_{31}b_{11} + a_{32}b_{21} & a_{31}b_{12} + a_{32}b_{22} & a_{31}b_{13} + a_{32}b_{23} \end{bmatrix}$
Order (of a matrix)	See Size (of a matrix)
Scalar multiplication (matrices)	Scalar multiplication is the process of multiplying a matrix by a scalar (number). For example, forming the product $$10 \begin{bmatrix} 2 & 1 \\ 0 & 3 \\ 1 & 4 \end{bmatrix} = \begin{bmatrix} 20 & 10 \\ 0 & 30 \\ 10 & 40 \end{bmatrix}$$ is an example of the process of scalar multiplication. In general, for the matrix A with elements a_{ij}, the elements of kA are ka_{ij}
Size (of a matrix)	Two matrices are said to have the same size (or order) if they have the same number of rows and columns. A matrix with m rows and n columns is said to be a $m \times n$ matrix. For example, the matrices $$\begin{bmatrix} 1 & 8 & 0 \\ 2 & 5 & 7 \end{bmatrix} \text{ and } \begin{bmatrix} 3 & 4 & 5 \\ 6 & 7 & 8 \end{bmatrix}$$ have the same size. They are both 2×3 matrices.
Zero matrix	A zero matrix is a matrix with all of its entries equal to zero. For example: $$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \text{ and } \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$ are zero matrices.

Shape and measurement

Area of a triangle	The general rule for determining the area of a triangle is: $$area = \frac{1}{2} \, base \, \times height$$
Heron's rule	Heron's rule is a rule for determining the area of a triangle, given the lengths of its sides. The area A of a triangle of side lengths a, b and c is given by $A = \sqrt{s(s-a)(s-b)(s-c)}$ where $s = \frac{1}{2}(a+b+c)$.

Scale factor	A scale factor is a number that scales, or multiplies, some quantity. In the equation $y = kx$, k is the scale factor for x. If two or more figures are similar, their sizes can be compared. The scale factor is the ratio of the length of one side on one figure to the length of the corresponding side on the other figure. It is a measure of magnification; the change of size.

Unit 2

Univariate data analysis and the statistical investigation process

Categorical variable	A categorical variable is a variable whose values are categories. Examples include blood groups (A, B, AB or O) or house construction type (brick, concrete, timber, steel, other). Categories may have numerical labels, for example, the numbers worn by players in a sporting team, but these labels have no numerical significance. They merely serve as labels.
Categorical data	Data associated with a categorical variable is called categorical data.
Continuous data	Data associated with a continuous variable is called continuous data.
Continuous variable	A continuous variable is a numerical variable that can take any value that lies within an interval. In practice, the values taken are subject to the accuracy of the measurement instrument used to obtain these values. Examples include height, reaction time, and systolic blood pressure.
Discrete data	Discrete data is data associated with a discrete variable. Discrete data is sometimes called count data.
Discrete variable	A discrete variable is a numerical variable that can take only integer values. Examples include the number of people in a car, the number of decayed teeth in 18 year old males and so on.
Five-number summary	A five-number summary is a method of summarising a set of data using the minimum value, the lower or first-quartile (Q_1), the median, the upper or third-quartile (Q_3) and the maximum value. Forms the basis for a box-plot.
Location	Location is the notion of central or 'typical value' in a sample distribution. See also mean, median and mode.
Mean	The arithmetic mean of a list of numbers is the sum of the data values divided by the number of values in the list. In everyday language, the arithmetic mean is commonly called the average. For example, for the following list of five numbers 2, 3, 3, 6, 8, the mean equals $$\frac{2+3+3+6+8}{5} = \frac{22}{5} = 4.4$$ In more general language, the mean of n observations $x_1, x_2, ..., x_n$ is $\bar{x} = \frac{\sum x_i}{n}$
Median	The median is the value in a set of ordered data values that divides the data into two parts of equal size. When there are an odd number of data values, the median is the middle value. When there is an even number of data values, the median is the average of the two central values.
Mode	The mode is the most frequently occurring value in a data set.

Normally distributed data	Normally distributed data is associated with a continuous variable which forms the characteristic bell-shaped distribution. The mean and standard deviation of such a continuous data set are key parameters determining the shape of the underlying distribution of the data set.
Outlier	An outlier in a set of data is an observation that appears to be inconsistent with the remainder of that set of data. An outlier is a surprising observation.
Standard deviation	The standard deviation is a measure of the variability, or spread, of a data set. It gives an indication of the degree to which the individual data values are spread around their mean. Calculation of standard deviation may be done via the use of appropriate technology.
Statistical investigation process	The statistical investigation process is a cyclical process that begins with the need to solve a real-world problem and aims to reflect the way statisticians work. One description of the statistical investigation process in terms of four steps is as follows. Step 1.　Clarify the problem and formulate one or more questions that can be answered with data. Step 2.　Design and implement a plan to collect or obtain appropriate data. Step 3.　Select and apply appropriate graphical or numerical techniques to analyse the data. Step 4.　Interpret the results of this analysis and relate the interpretation to the original question; communicate findings in a systematic and concise manner.

Applications of trigonometry

Angle of elevation	The angle a line makes above a plane.
Angle of depression	The angle a line makes below a plane.
Bearings (compass and true)	A bearing is the direction of a fixed point, or the path of an object, from the point of observation. Compass bearings are specified as angles either side of north or south. For example, a compass bearing of N50°E is found by facing north and moving through an angle of 50° to the east. True (or three figure) bearings are measured in degrees from the north line. Three figures are used to specify the direction. Thus the direction of north is specified as 000°, east is specified as 090°, south is specified as 180°, and north-west is specified as 315°.
Cosine rule	For a triangle of side lengths a, b and c and angles A, B and C, the cosine rule states that $$c^2 = a^2 + b^2 - 2ab \cos C$$

Sine rule	For a triangle of side lengths a, b and c and angles A, B and C, the sine rule states that $$\frac{a}{sinA} = \frac{b}{sinB} = \frac{c}{sinC}$$
Triangulation	Triangulation is the process of determining the location of a point by measuring angles to it from known points at either end of a fixed baseline, rather than measuring distances to the point directly. The point can then be fixed as the third point of a triangle with one known side and two known angles.

Linear equations (relations) and graphs

Break-even point	The break-even point is the point at which revenue begins to exceed the cost of production.
Linear graph	A linear graph is a graph of a linear equation with two variables. If the linear equation is written in the form $y = a + bx$, then a represents the y-intercept and b represents the slope (or gradient) of the linear graph.
Piece-wise-linear graph	A piece-wise-linear graph consisting of one or more non-overlapping line segments. Sometimes called a line segment graph. Example:
Slope (gradient)	The slope or gradient of a line describes its steepness, incline, or grade. Slope is normally described by the ratio of the 'rise' divided by the 'run' between two points on a line. See also Linear graph.
Step graph	A graph consisting of one or more non-overlapping horizontal line segments that follow a step-like pattern.