

Secondary Mathematics Syllabuses



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PART A INTRODUCTION

1 RATIONALE

Mathematics is an excellent vehicle for the development and improvement of a person's intellectual competence in logical reasoning, spatial visualisation, analysis and abstract thought. Students develop numeracy, reasoning, thinking skills, and problem solving skills through the learning and application of mathematics. These are valued not only in science and technology, but also in everyday living and in the workplace. The development of a highly skilled scientifically- and technologically-based manpower requires a strong grounding in mathematics. An emphasis on mathematics education will ensure that we have an increasingly competitive workforce to meet the challenges of the 21st century.

Mathematics is also a subject of enjoyment and excitement, which offers students opportunities for creative work and moments of enlightenment and joy. When ideas are discovered and insights gained, students are spurred to pursue mathematics beyond the classroom walls.

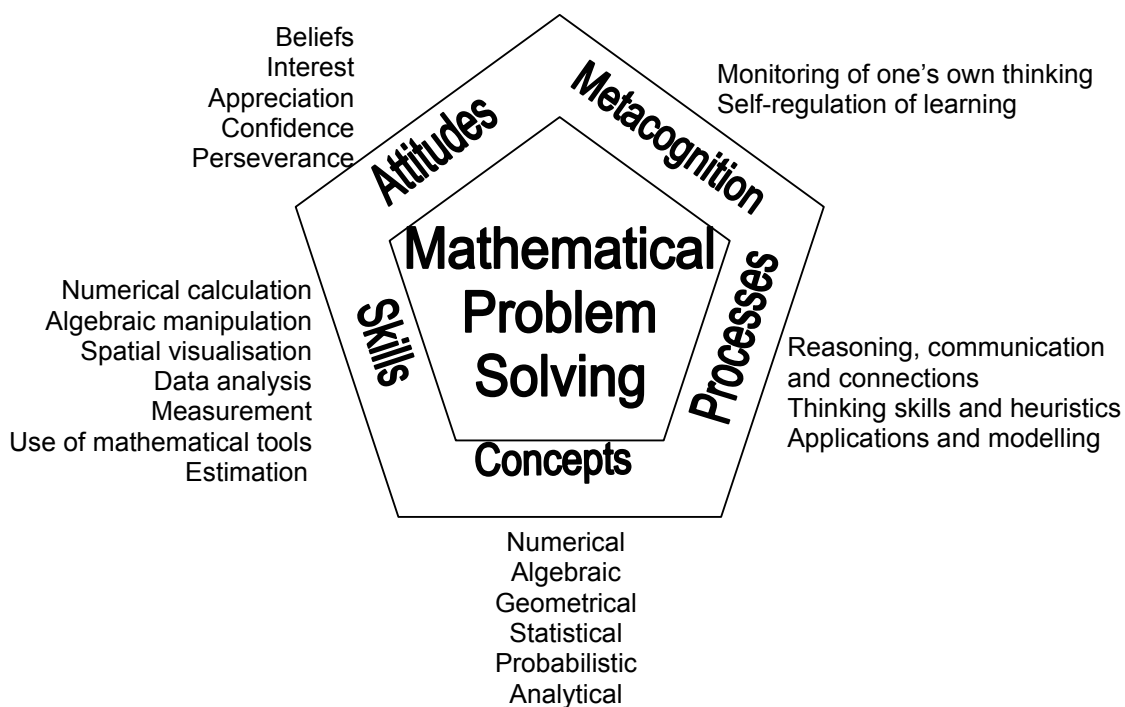
2 AIMS OF MATHEMATICS EDUCATION IN SCHOOLS

Mathematics education aims to enable students to:

- (1) Acquire the necessary mathematical concepts and skills for everyday life, and for continuous learning in mathematics and related disciplines.
- (2) Develop the necessary process skills for the acquisition and application of mathematical concepts and skills.
- (3) Develop the mathematical thinking and problem solving skills and apply these skills to formulate and solve problems.
- (4) Recognise and use connections among mathematical ideas, and between mathematics and other disciplines.
- (5) Develop positive attitudes towards mathematics.
- (6) Make effective use of a variety of mathematical tools (including information and communication technology tools) in the learning and application of mathematics.
- (7) Produce imaginative and creative work arising from mathematical ideas.
- (8) Develop the abilities to reason logically, to communicate mathematically, and to learn cooperatively and independently.

3 MATHEMATICS FRAMEWORK

This framework shows the underlying principles of an effective mathematics programme that is applicable to all levels, from the primary to A-levels. It sets the direction for the teaching, learning, and assessment of mathematics.



Mathematical problem solving is central to mathematics learning. It involves the acquisition and application of mathematics concepts and skills in a wide range of situations, including non-routine, open-ended and real-world problems.

The development of mathematical problem solving ability is dependent on five inter-related components, namely, *Concepts*, *Skills*, *Processes*, *Attitudes* and *Metacognition*.

3.1 CONCEPTS

Mathematical concepts cover numerical, algebraic, geometrical, statistical, probabilistic, and analytical concepts.

Students should develop and explore the mathematics ideas in depth, and see that mathematics is an integrated whole, not merely isolated pieces of knowledge.

They should be given a variety of learning experiences to help them develop a deep understanding of mathematical concepts, and to make sense of various mathematical ideas, as well as their connections and applications, in order to participate actively in learning mathematics and to become more confident in exploring and applying mathematics. The use of manipulatives (concrete materials), practical work, and use of technological aids should be part of the learning experiences of the students.

3.2 SKILLS

Mathematical skills include procedural skills for numerical calculation, algebraic manipulation, spatial visualisation, data analysis, measurement, use of mathematical tools, and estimation.

The development of skill proficiencies in students is essential in the learning and application of mathematics. Although students should become competent in the various mathematical skills, over-emphasising procedural skills without understanding the underlying mathematical principles should be avoided.

Skill proficiencies include the ability to use technology confidently, where appropriate, for exploration and problem solving. It is important also to incorporate the use of thinking skills and heuristics in the process of the development of skills proficiencies.

3.3 PROCESSES

Mathematical processes refer to the knowledge skills (or process skills) involved in the process of acquiring and applying mathematical knowledge. This includes reasoning, communication and connections, thinking skills and heuristics, and application and modelling.

Reasoning, communication and connections

Mathematical reasoning refers to the ability to analyse mathematical situations and construct logical arguments. It is a habit of mind that can be developed through the applications of mathematics in different contexts.

Communication refers to the ability to use mathematical language to express mathematical ideas and arguments precisely, concisely and logically. It helps students develop their own understanding of mathematics and sharpen their mathematical thinking.

Connections refer to the ability to see and make linkages among mathematical ideas, between mathematics and other subjects, and between mathematics and everyday life. This helps students make sense of what they learn in mathematics.

Mathematical reasoning, communication and connections should pervade all levels of mathematics learning, from the primary to A-levels.

Thinking skills and heuristics

Students should use various thinking skills and heuristics to help them solve mathematical problems. Thinking skills are skills that can be used in a thinking process, such as classifying, comparing, sequencing, analysing parts and wholes, identifying patterns and relationships, induction, deduction and spatial visualisation. Some examples of heuristics are listed below and grouped in four categories according to how they are used:

- To give a representation,
e.g. draw a diagram, make a list, use equations
- To make a calculated guess,
e.g. guess and check, look for patterns, make suppositions
- To go through the process,
e.g. act it out, work backwards, before-after
- To change the problem,
e.g. restate the problem, simplify the problem, solve part of the problem

Applications and modelling

Applications and modelling play a vital role in the development of mathematical understanding and competencies. It is important that students apply mathematical problem-solving skills and reasoning skills to tackle a variety of problems, including real-world problems.

Mathematical modelling is the process of formulating and improving a mathematical model to represent and solve real-world problems. Through mathematical modelling, students learn to use a variety of representations of data, and to select and apply appropriate mathematical methods and tools in solving real-world problems. The opportunity to deal with empirical data and use mathematical tools for data analysis should be part of the learning at all levels.

3.4 ATTITUDES

Attitudes refer to the affective aspects of mathematics learning such as:

- Beliefs about mathematics and its usefulness
- Interest and enjoyment in learning mathematics
- Appreciation of the beauty and power of mathematics
- Confidence in using mathematics
- Perseverance in solving a problem

Students' attitudes towards mathematics are shaped by their learning experiences. Making the learning of mathematics fun, meaningful and relevant goes a long way to inculcating positive attitudes towards the subject. Care and attention should be given to the design of the learning activities, to build confidence in and develop appreciation for the subject.

3.5 METACOGNITION

Metacognition, or “thinking about thinking”, refers to the awareness of, and the ability to control one's thinking processes, in particular the selection and use of problem-solving strategies. It includes monitoring of one's own thinking, and self-regulation of learning.

The provision of metacognitive experience is necessary to help students develop their problem solving abilities. The following activities may be used to develop the metacognitive awareness of students and to enrich their metacognitive experience:

- Expose students to general problem solving skills, thinking skills and heuristics, and how these skills can be applied to solve problems.
- Encourage students to think aloud the strategies and methods they use to solve particular problems.
- Provide students with problems that require planning (before solving) and evaluation (after solving).
- Encourage students to seek alternative ways of solving the same problem and to check the appropriateness and reasonableness of the answer.
- Allow students to discuss how to solve a particular problem and to explain the different methods that they use for solving the problem.

4 O LEVEL MATHEMATICS

Secondary One	
Topic/Sub-topics	Content
1 Numbers and Algebra	
Numbers and the four operations	Include: <ul style="list-style-type: none"> • primes and prime factorisation • finding HCF and LCM, squares, cubes, square roots and cube roots by prime factorisation • negative numbers, integers, rational numbers, real numbers and their four operations • calculations with the use of a calculator • representation and ordering of numbers on the number line • use of the symbols $<$, $>$, \leq, \geq • approximation and estimation (including rounding off numbers to a required number of decimal places or significant figures, estimating the results of computation, and concepts of rounding and truncation errors)
Ratio, rate and proportion	Include: <ul style="list-style-type: none"> • ratios involving rational numbers • writing a ratio in its simplest form • average rate • problems involving ratio and rate
Percentage	Include: <ul style="list-style-type: none"> • expressing one quantity as a percentage of another • comparing two quantities by percentage • percentages greater than 100% • increasing/decreasing a quantity by a given percentage • reverse percentages • problems involving percentages
Speed	Include: <ul style="list-style-type: none"> • concepts of speed, uniform speed and average speed • conversion of units (e.g. km/h to m/s) • problems involving speed, uniform speed and average speed

Secondary One	
Topic/Sub-topics	Content
Algebraic representation and formulae	Include: <ul style="list-style-type: none"> • using letters to represent numbers • interpreting notations: <ul style="list-style-type: none"> * ab as $a \times b$ * $\frac{a}{b}$ as $a \div b$ * a^2 as $a \times a$, a^3 as $a \times a \times a$, a^2b as $a \times a \times b$, ... * $3y$ as $y + y + y$ or $3 \times y$ * $\frac{3 \pm y}{5}$ as $(3 \pm y) \div 5$ or $\frac{1}{5} \times (3 \pm y)$ • evaluation of algebraic expressions and formulae • translation of simple real-world situations into algebraic expressions • recognising and representing number patterns (including finding an algebraic expression for the nth term)
Algebraic manipulation	Include: <ul style="list-style-type: none"> • addition and subtraction of linear algebraic expressions • simplification of linear algebraic expressions, e.g. <ul style="list-style-type: none"> * $-2(3x - 5) + 4x$ * $\frac{2x}{3} - \frac{3(x-5)}{2}$ • factorisation of linear algebraic expressions of the form <ul style="list-style-type: none"> * $ax + ay$ (where a is a constant) * $ax + bx + kay + kby$ (where a, b and k are constants)
Functions and graphs	Include: <ul style="list-style-type: none"> • cartesian coordinates in two dimensions • graph of a set of ordered pairs • linear relationships between two variables (linear functions) • the gradient of a linear graph as the ratio of the vertical change to the horizontal change (positive and negative gradients)
Solutions of equations and inequalities	Include: <ul style="list-style-type: none"> • solving linear equations in one unknown (including fractional coefficients) • solving simple inequality (e.g. $3x \leq 5$) • solving simple fractional equations that can be reduced to linear equations, e.g. <ul style="list-style-type: none"> * $\frac{x}{3} + \frac{x-2}{4} = 3$ * $\frac{3}{x-2} = 6$ • formulating a linear equation in one unknown to solve problems

Secondary One	
Topic/Sub-topics	Content
2 Geometry and Measurement	
Angles, triangles and polygons	<p>Include:</p> <ul style="list-style-type: none"> • right, acute, obtuse and reflex angles, complementary and supplementary angles, vertically opposite angles, adjacent angles on a straight line, adjacent angles at a point, interior and exterior angles • angles formed by two parallel lines and a transversal: corresponding angles, alternate angles, interior angles • properties of triangles and special quadrilaterals • classifying special quadrilaterals on the basis of their properties • angle sum of interior and exterior angles of any convex polygon • properties of regular pentagon, hexagon, octagon and decagon • properties of perpendicular bisectors of line segments and angle bisectors • construction of simple geometrical figures from given data (including perpendicular bisectors and angle bisectors) using compasses, ruler, set squares and protractors, where appropriate
Mensuration	<p>Include:</p> <ul style="list-style-type: none"> • area of parallelogram and trapezium • problems involving perimeter and area of composite plane figures (including triangle and circle) • volume and surface area of cube, cuboid, prism and cylinder • conversion between cm^2 and m^2, and between cm^3 and m^3 • problems involving volume and surface area of composite solids
3 Statistics and Probability	
Data handling	<p>Include:</p> <ul style="list-style-type: none"> • data collection methods such as: <ul style="list-style-type: none"> * taking measurements * conducting surveys * classifying data * reading results of observations/outcomes of events • construction and interpretation of: <ul style="list-style-type: none"> * tables * bar graphs * pictograms * line graphs * pie charts * histograms • purposes and use, advantages and disadvantages of the different forms of statistical representations • drawing simple inference from statistical diagrams <p>Exclude histograms with unequal intervals.</p>

Secondary Two	
Topic/Sub-topics	Content
1 Numbers and Algebra	
Ratio, rate and proportion	Include: <ul style="list-style-type: none"> map scales (distance and area) direct and inverse proportion
Algebraic manipulation	Include: <ul style="list-style-type: none"> expansion of the product of algebraic expressions changing the subject of a formula finding the value of an unknown quantity in a given formula recognising and applying the special products <ul style="list-style-type: none"> * $(a \pm b)^2 = a^2 \pm 2ab + b^2$ * $a^2 - b^2 = (a + b)(a - b)$ factorisation of algebraic expressions of the form <ul style="list-style-type: none"> * $a^2x^2 - b^2y^2$ * $a^2 \pm 2ab + b^2$ * $ax^2 + bx + c$ multiplication and division of simple algebraic fractions, e.g. <ul style="list-style-type: none"> * $\left(\frac{3a}{4b^2}\right)\left(\frac{5ab}{3}\right)$ * $\frac{3a}{4} \div \frac{9a^2}{10}$ addition and subtraction of algebraic fractions with linear or quadratic denominator, e.g. <ul style="list-style-type: none"> * $\frac{1}{x-2} + \frac{2}{x-3}$ * $\frac{1}{x^2-9} + \frac{2}{x-3}$ * $\frac{1}{x-3} + \frac{2}{(x-3)^2}$
Functions and graphs	Include: <ul style="list-style-type: none"> graphs of linear equations in two unknowns graphs of quadratic functions and their properties <ul style="list-style-type: none"> * positive or negative coefficient of x^2 * maximum and minimum points * symmetry

Secondary Two	
Topic/Sub-topics	Content
Solutions of equations	Include: <ul style="list-style-type: none"> • solving simultaneous linear equations in two unknowns by <ul style="list-style-type: none"> * substitution and elimination methods * graphical method • solving quadratic equations in one unknown by factorisation • formulating a pair of linear equations in two unknowns or a quadratic equation in one unknown to solve problems
Set language and notation	Include: <ul style="list-style-type: none"> • use of set language and the following notation: <ul style="list-style-type: none"> * Union of A and B $A \cup B$ * Intersection of A and B $A \cap B$ * Number of elements in set A $n(A)$ * "... is an element of ..." \in * "... is not an element of ..." \notin * Complement of set A A' * The empty set \emptyset * Universal set \mathcal{U} * A is a subset of B $A \subseteq B$ * A is a proper subset of B $A \subset B$ * A is not a subset of B $A \not\subseteq B$ * A is not a proper subset of B $A \not\subset B$ • union and intersection of two sets • Venn diagrams Exclude : <ul style="list-style-type: none"> • use of $n(A \cup B) = n(A) + n(B) - n(A \cap B)$ • cases involving three or more sets
2 Geometry and Measurement	
Congruence and similarity	Include: <ul style="list-style-type: none"> • congruent figures as figures that are identical in shape and size • matching sides and angles of two congruent polygons • similar figures as figures that have the same shape but different sizes • properties of similar polygons: <ul style="list-style-type: none"> * corresponding angles are equal * corresponding sides are proportional • enlargement and reduction of a plane figure by a scale factor • scale drawings • solving simple problems involving similarity and congruence

Secondary Two	
Topic/Sub-topics	Content
Pythagoras' theorem	Include: <ul style="list-style-type: none"> • use of Pythagoras' theorem • determining whether a triangle is right-angled given the lengths of three sides
Mensuration	Include: <ul style="list-style-type: none"> • volume and surface area of pyramid, cone and sphere
3 Statistics and Probability	
Data analysis	Include: <ul style="list-style-type: none"> • interpretation and analysis of: <ul style="list-style-type: none"> * dot diagrams * stem-and-leaf diagrams • mean, mode and median as averages • purposes and use of mean, mode and median • calculation of the mean for grouped data
Probability	Include: <ul style="list-style-type: none"> • probability as a measure of chance • probability of single events (including listing all the possible outcomes in a simple chance situation to calculate the probability)

Secondary Three/Four	
Topic/Sub-topics	Content
1 Numbers and Algebra	
Numbers and the four operations	<p>Include:</p> <ul style="list-style-type: none"> examples of very large and very small numbers such as mega/ million (10^6), giga/ billion (10^9), tera/ trillion (10^{12}), micro (10^{-6}), nano (10^{-9}) and pico (10^{-12}) use of standard form $A \times 10^n$, where n is an integer, and $1 \leq A < 10$ positive, negative, zero and fractional indices laws of indices
Functions and graphs	<p>Include:</p> <ul style="list-style-type: none"> sketching of the graphs of quadratic functions given in the form <ul style="list-style-type: none"> * $y = \pm(x - p)^2 + q$ * $y = \pm(x - a)(x - b)$ graphs of functions of the form $y = ax^n$ where $n = -2, -1, 0, 1, 2, 3$, and simple sums of not more than three of these graphs of exponential functions $y = ka^x$ where a is a positive integer estimation of gradients of curves by drawing tangents
Solutions of equations and inequalities	<p>Include:</p> <ul style="list-style-type: none"> solving quadratic equations in one unknown by: <ul style="list-style-type: none"> * use of formula * completing the square for $y = x^2 + px + q$ * graphical methods solving fractional equations that can be reduced to quadratic equations, e.g. <ul style="list-style-type: none"> * $\frac{6}{x+4} = x+3$ * $\frac{1}{x-2} + \frac{2}{x-3} = 5$ solving linear inequalities in one unknown, and representing the solution set on the number line

Secondary Three/Four	
Topic/Sub-topics	Content
Applications of mathematics in practical situations	<p>Include:</p> <ul style="list-style-type: none"> • problems derived from practical situations such as <ul style="list-style-type: none"> * utilities bills * hire-purchase * simple interest and compound interest * money exchange * profit and loss * taxation • use of data from tables and charts • interpretation and use of graphs in practical situations • drawing graphs from given data • distance-time and speed-time graphs <p>Exclude the use of the terms percentage profit and percentage loss.</p>
Matrices	<p>Include:</p> <ul style="list-style-type: none"> • display of information in the form of a matrix of any order • interpreting the data in a given matrix • product of a scalar quantity and a matrix • problems involving the calculation of the sum and product (where appropriate) of two matrices <p>Exclude:</p> <ul style="list-style-type: none"> • matrix representation of geometrical transformations • solving simultaneous linear equations using the inverse matrix method
2 Geometry and Measurement	
Congruence and similarity	<p>Include:</p> <ul style="list-style-type: none"> • determining whether two triangles are <ul style="list-style-type: none"> * congruent * similar • ratio of areas of similar plane figures • ratio of volumes of similar solids
Properties of circles	<p>Include:</p> <ul style="list-style-type: none"> • symmetry properties of circles: <ul style="list-style-type: none"> * equal chords are equidistant from the centre * the perpendicular bisector of a chord passes through the centre * tangents from an external point are equal in length * the line joining an external point to the centre of the circle bisects the angle between the tangents • angle properties of circles: <ul style="list-style-type: none"> * angle in a semicircle is a right angle * angle between tangent and radius of a circle is a right angle * angle at the centre is twice the angle at the circumference * angles in the same segment are equal * angles in opposite segments are supplementary
Trigonometry	<p>Include:</p> <ul style="list-style-type: none"> • use of trigonometric ratios (sine, cosine and tangent) of acute angles to calculate unknown sides and angles in right-angled triangles

Secondary Three/Four	
Topic/Sub-topics	Content
	<ul style="list-style-type: none"> • extending sine and cosine to obtuse angles • use of the formula $\frac{1}{2}ab\sin C$ for the area of a triangle • use of sine rule and cosine rule for any triangle • problems in 2 and 3 dimensions including those involving angles of elevation and depression and bearings <p>Exclude calculation of the angle between two planes or of the angle between a straight line and a plane.</p>
Mensuration	<p>Include:</p> <ul style="list-style-type: none"> • arc length and sector area as fractions of the circumference and area of a circle • area of a segment • use of radian measure of angle (including conversion between radians and degrees) • problems involving the arc length, sector area of a circle and area of a segment
Coordinate geometry	<p>Include:</p> <ul style="list-style-type: none"> • finding the gradient of a straight line given the coordinates of two points on it • finding the length of a line segment given the coordinates of its end points • interpreting and finding the equation of a straight line graph in the form $y = mx + c$ • geometric problems involving the use of coordinates <p>Exclude:</p> <ul style="list-style-type: none"> • condition for two lines to be parallel or perpendicular • midpoint of line segment • finding the area of quadrilateral given its vertices

Secondary Three/Four	
Topic/Sub-topics	Content
Vectors in two dimensions	<p>Include:</p> <ul style="list-style-type: none"> • use of notations: $\begin{pmatrix} x \\ y \end{pmatrix}$, \overrightarrow{AB}, \mathbf{a}, \overrightarrow{AB} and \mathbf{a} • directed line segments • translation by a vector • position vectors • magnitude of a vector $\begin{pmatrix} x \\ y \end{pmatrix}$ as $\sqrt{x^2 + y^2}$ • use of sum and difference of two vectors to express given vectors in terms of two coplanar vectors • multiplication of a vector by a scalar • geometric problems involving the use of vectors <p>Exclude:</p> <ul style="list-style-type: none"> • expressing a vector in terms of a unit vector • midpoint of line segment • solving vector equations with two unknown parameters
3 Statistics and Probability	
Data analysis	<p>Include:</p> <ul style="list-style-type: none"> • quartiles and percentiles • range, interquartile range and standard deviation as measures of spread for a set of data • interpretation and analysis of: <ul style="list-style-type: none"> * cumulative frequency diagrams * box-and-whisker plots • calculation of the standard deviation for a set of data (grouped and ungrouped) • using the mean and standard deviation to compare two sets of data
Probability	<p>Include:</p> <ul style="list-style-type: none"> • probability of simple combined events (including using possibility diagrams and tree diagrams, where appropriate) • addition and multiplication of probabilities • mutually exclusive events and independent events <p>Exclude use of $P(A \cup B) = P(A) + P(B) - P(A \cap B)$.</p>

5 N(A) LEVEL MATHEMATICS

N(A) Secondary One	
Topic/Sub-topics	Content
1 Numbers and Algebra	
Numbers and the four operations	Include: <ul style="list-style-type: none"> • primes and prime factorisation • finding HCF and LCM, squares, cubes, square roots and cube roots by prime factorisation • negative numbers, integers, rational numbers, real numbers and their four operations • calculations with the use of a calculator • representation and ordering of numbers on the number line • use of the symbols $<$, $>$, \leq, \geq • approximation and estimation (including rounding off numbers to a required number of decimal places or significant figures, estimating the results of computation, and concepts of rounding and truncation errors)
Ratio, rate and proportion	Include: <ul style="list-style-type: none"> • comparison between two or more quantities by ratio • relationship between ratio and fraction • dividing a quantity in a given ratio • ratios involving rational numbers • equivalent ratios • writing a ratio in its simplest form • average rate • problems involving ratio and rate
Percentage	Include: <ul style="list-style-type: none"> • expressing percentage as a fraction or decimal • expressing one quantity as a percentage of another • comparing two quantities by percentage • percentages greater than 100% • increasing/decreasing a quantity by a given percentage • finding percentage increase/decrease • reverse percentages • problems involving percentages
Speed	Include: <ul style="list-style-type: none"> • relationships between distance, time and speed • writing speed in different units (e.g. km/h, m/min, m/s and cm/s) • conversion of units (e.g. km/h to m/s) • calculation of speed, distance or time given the other two quantities • concepts of speed, uniform speed and average speed • problems involving speed, uniform speed and average speed

N(A) Secondary One	
Topic/Sub-topics	Content
Algebraic representation and formulae	Include: <ul style="list-style-type: none"> • using letters to represent numbers • interpreting notations: <ul style="list-style-type: none"> * ab as $a \times b$ * $\frac{a}{b}$ as $a \div b$ * a^2 as $a \times a$, a^3 as $a \times a \times a$, a^2b as $a \times a \times b$, ... * $3y$ as $y + y + y$ or $3 \times y$ * $\frac{3 \pm y}{5}$ as $(3 \pm y) \div 5$ or $\frac{1}{5} \times (3 \pm y)$ • evaluation of algebraic expressions and formulae • translation of simple real-world situations into algebraic expressions • recognising and representing number patterns (including finding an algebraic expression for the nth term)
Algebraic manipulation	Include: <ul style="list-style-type: none"> • addition and subtraction of linear algebraic expressions • simplification of linear algebraic expressions, e.g. <ul style="list-style-type: none"> * $-2(3x - 5) + 4x$ * $\frac{2x}{3} - \frac{3(x-5)}{2}$
2 Geometry and Measurement	
Angles, triangles and polygons	Include: <ul style="list-style-type: none"> • right, acute, obtuse and reflex angles, complementary and supplementary angles, vertically opposite angles, adjacent angles on a straight line, adjacent angles at a point, interior and exterior angles • angles formed by two parallel lines and a transversal: corresponding angles, alternate angles, interior angles
Mensuration	Include: <ul style="list-style-type: none"> • area of parallelogram and trapezium • problems involving perimeter and area of composite plane figures (including triangle and circle) • volume and surface area of cube, cuboid, prism and cylinder • conversion between cm^2 and m^2, and between cm^3 and m^3 • problems involving volume and surface area of composite solids

N(A) Secondary One	
Topic/Sub-topics	Content
3 Statistics and Probability	
Data handling	<p>Include:</p> <ul style="list-style-type: none"> • data collection methods such as: <ul style="list-style-type: none"> * taking measurements * conducting surveys * classifying data * reading results of observations/outcomes of events • construction and interpretation of: <ul style="list-style-type: none"> * tables * bar graphs * pictograms * line graphs * pie charts * histograms • purposes and use, advantages and disadvantages of the different forms of statistical representations • drawing simple inference from statistical diagrams <p>Exclude histograms with unequal intervals.</p>

N(A) Secondary Two	
Topic/Sub-topics	Content
1 Numbers and Algebra	
Ratio, rate and proportion	Include: <ul style="list-style-type: none"> map scales (distance and area) direct and inverse proportion
Algebraic manipulation	Include: <ul style="list-style-type: none"> expansion of the product of two linear algebraic expressions factorisation of linear algebraic expressions of the form <ul style="list-style-type: none"> * $ax + ay$ (where a is a constant) * $ax + bx + kay + kby$ (where a, b and k are constants) recognising and applying the special products <ul style="list-style-type: none"> * $(a \pm b)^2 = a^2 \pm 2ab + b^2$ * $a^2 - b^2 = (a + b)(a - b)$ factorisation of algebraic expressions of the form <ul style="list-style-type: none"> * $a^2x^2 - b^2y^2$ * $a^2 \pm 2ab + b^2$ * $ax^2 + bx + c$ multiplication and division of simple algebraic fractions, e.g. <ul style="list-style-type: none"> * $\left(\frac{3a}{4b^2}\right)\left(\frac{5ab}{3}\right)$ * $\frac{3a}{4} \div \frac{9a^2}{10}$
Functions and graphs	Include: <ul style="list-style-type: none"> cartesian coordinates in two dimensions graph of a set of ordered pairs linear relationships between two variables (linear functions) the gradient of a linear graph as the ratio of the vertical change to the horizontal change (positive and negative gradients) graphs of linear equations in two unknowns
Solutions of equations and inequalities	Include: <ul style="list-style-type: none"> solving linear equations in one unknown (including fractional coefficients) solving simple inequality (e.g. $3x \leq 5$) solving simple fractional equations that can be reduced to linear equations, e.g. <ul style="list-style-type: none"> * $\frac{x}{3} + \frac{x-2}{4} = 3$ * $\frac{3}{x-2} = 6$

N(A) Secondary Two	
Topic/Sub-topics	Content
1 Numbers and Algebra	
	<ul style="list-style-type: none"> • solving simultaneous linear equations in two unknowns by <ul style="list-style-type: none"> * substitution and elimination methods * graphical method • formulate a linear equation in one unknown or a pair of linear equations in two unknowns to solve problems
2 Geometry and Measurement	
Angles, triangles and polygons	Include: <ul style="list-style-type: none"> • properties of triangles and special quadrilaterals • classifying special quadrilaterals on the basis of their properties • angle sum of interior and exterior angles of any convex polygon • properties of regular pentagon, hexagon, octagon and decagon • properties of perpendicular bisectors of line segments and angle bisectors • construction of simple geometrical figures from given data (including perpendicular bisectors and angle bisectors) using compasses, ruler, set squares and protractors, where appropriate
Congruence and similarity	Include: <ul style="list-style-type: none"> • congruent figures as figures that are identical in shape and size • matching sides and angles of two congruent polygons
Mensuration	Include: <ul style="list-style-type: none"> • volume and surface area of pyramid, cone and sphere
3 Statistics and Probability	
Data analysis	Include: <ul style="list-style-type: none"> • interpretation and analysis of: <ul style="list-style-type: none"> * dot diagrams * stem-and-leaf diagrams • mean, mode and median as averages • purposes and use of mean, mode and median • calculation of the mean for grouped data
Probability	Include: <ul style="list-style-type: none"> • probability as a measure of chance • probability of single events (including listing all the possible outcomes in a simple chance situation to calculate the probability)

N(A) Secondary Three/Four	
Topic/Sub-topics	Content
<p><i>Certain parts of the syllabus have been underlined. These will only be tested in Section B of Paper 2 of the GCE 'N' Level (Syllabus A) examinations.</i></p>	
1 Numbers and Algebra	
Numbers and the four operations	<p>Include:</p> <ul style="list-style-type: none"> examples of very large and very small numbers such as mega/ million (10^6), giga/ billion (10^9), tera/ trillion (10^{12}), micro (10^{-6}), nano (10^{-9}) and pico (10^{-12}) use of standard form $A \times 10^n$, where n is an integer, and $1 \leq A < 10$ positive, negative, zero and fractional indices laws of indices
Algebraic manipulation	<p>Include:</p> <ul style="list-style-type: none"> expansion of the product of algebraic expressions changing the subject of a formula finding the value of an unknown quantity in a given formula addition and subtraction of algebraic fractions with linear or quadratic denominator, e.g. $* \frac{1}{x-2} + \frac{2}{x-3}$ $* \frac{1}{x^2-9} + \frac{2}{x-3}$ $* \frac{1}{x-3} + \frac{2}{(x-3)^2}$
Functions and graphs	<p>Include:</p> <ul style="list-style-type: none"> <u>graphs of quadratic functions and their properties</u> <ul style="list-style-type: none"> * <u>positive or negative coefficient of x^2</u> * <u>maximum and minimum points</u> * <u>symmetry</u> <u>sketching of the graphs of quadratic functions given in the form</u> <ul style="list-style-type: none"> * <u>$y = \pm(x-p)^2 + q$</u> * <u>$y = \pm(x-a)(x-b)$</u> <u>graphs of functions of the form $y = ax^n$ where $n = -2, -1, 0, 1, 2, 3$, and simple sums of not more than three of these</u> <u>graphs of exponential functions $y = ka^x$ where a is a positive integer</u> <u>estimation of gradients of curves by drawing tangents</u>

N(A) Secondary Three/Four	
Topic/Sub-topics	Content
<i>Certain parts of the syllabus have been underlined. These will only be tested in Section B of Paper 2 of the GCE 'N' Level (Syllabus A) examinations.</i>	
1 Numbers and Algebra	
Solutions of equations	Include: <ul style="list-style-type: none"> • solving quadratic equations in one unknown by <ul style="list-style-type: none"> * factorisation * use of formula * completing the square for $y = x^2 + px + q$ * <u>graphical methods</u> • solving fractional equations that can be reduced to quadratic equations, e.g. <ul style="list-style-type: none"> * $\frac{6}{x+4} = x+3$ * $\frac{1}{x-2} + \frac{2}{x-3} = 5$ • formulate a quadratic equation in one unknown to solve problems
Applications of mathematics in practical situations	Include: <ul style="list-style-type: none"> • problems derived from practical situations such as <ul style="list-style-type: none"> * utilities bills * hire-purchase * simple interest and compound interest * money exchange * profit and loss * taxation • use of data from tables and charts • interpretation and use of graphs in practical situations • drawing graphs from given data • <u>distance-time and speed-time graphs</u> <p>Exclude the use of the terms percentage profit and percentage loss.</p>
2 Geometry and Measurement	
Congruence and similarity	Include: <ul style="list-style-type: none"> • similar figures as figures that have the same shape but different sizes • properties of similar polygons: <ul style="list-style-type: none"> * corresponding angles are equal * corresponding sides are proportional • enlargement and reduction of a plane figure by a scale factor • scale drawings • solving simple problems involving similarity and congruence

N(A) Secondary Three/Four	
Topic/Sub-topics	Content
<i>Certain parts of the syllabus have been underlined. These will only be tested in Section B of Paper 2 of the GCE 'N' Level (Syllabus A) examinations.</i>	
2 Geometry and Measurement	
Properties of circles	Include: <ul style="list-style-type: none"> • <u>symmetry properties of circles:</u> <ul style="list-style-type: none"> * <u>equal chords are equidistant from the centre</u> * <u>the perpendicular bisector of a chord passes through the centre</u> * <u>tangents from an external point are equal in length</u> * <u>the line joining an external point to the centre of the circle bisects the angle between the tangents</u> • <u>angle properties of circles:</u> <ul style="list-style-type: none"> * <u>angle in a semicircle is a right angle</u> * <u>angle between tangent and radius of a circle is a right angle</u> * <u>angle at the centre is twice the angle at the circumference</u> * <u>angles in the same segment are equal</u> * <u>angles in opposite segments are supplementary</u>
Pythagoras' theorem and trigonometry	Include: <ul style="list-style-type: none"> • use of Pythagoras' theorem • determining whether a triangle is right-angled given the lengths of three sides • use of trigonometric ratios (sine, cosine and tangent) of acute angles to calculate unknown sides and angles in right-angled triangles • extending sine and cosine to obtuse angles • use of the formula $\frac{1}{2}ab \sin C$ for the area of a triangle • <u>use of sine rule and cosine rule for any triangle</u> • <u>problems in 2 and 3 dimensions including those involving angles of elevation and depression and bearings</u> <p>Exclude calculation of the angle between two planes or of the angle between a straight line and a plane.</p>
Mensuration	Include: <ul style="list-style-type: none"> • arc length and sector area as fractions of the circumference and area of a circle • area of a segment • <u>use of radian measure of angle (including conversion between radians and degrees)</u> • <u>problems involving the arc length, sector area of a circle and area of a segment</u>

N(A) Secondary Three/Four	
Topic/Sub-topics	Content
<i>Certain parts of the syllabus have been underlined. These will only be tested in Section B of Paper 2 of the GCE 'N' Level (Syllabus A) examinations.</i>	
2 Geometry and Measurement	
Coordinate geometry	<p>Include:</p> <ul style="list-style-type: none"> • finding the gradient of a straight line given the coordinates of two points on it • finding the length of a line segment given the coordinates of its end points • interpreting and finding the equation of a straight line graph in the form $y = mx + c$ • geometric problems involving the use of coordinates <p>Exclude:</p> <ul style="list-style-type: none"> • condition for two lines to be parallel or perpendicular • midpoint of line segment • finding the area of quadrilateral given its vertices
3 Statistics and Probability	
Data analysis	<p>Include:</p> <ul style="list-style-type: none"> • <u>quartiles and percentiles</u> • <u>range, interquartile range and standard deviation as measures of spread for a set of data</u> • <u>interpretation and analysis of:</u> <ul style="list-style-type: none"> * <u>cumulative frequency diagrams</u> * <u>box-and-whisker plots</u> • <u>calculation of the standard deviation for a set of data (grouped and ungrouped)</u> • <u>using the mean and standard deviation to compare two sets of data</u>
Probability	<p>Include:</p> <ul style="list-style-type: none"> • <u>probability of simple combined events (including using possibility diagrams and tree diagrams, where appropriate)</u> • <u>addition and multiplication of probabilities</u> • <u>mutually exclusive events and independent events</u> <p>Exclude use of $P(A \cup B) = P(A) + P(B) - P(A \cap B)$.</p>

6 N(T) LEVEL MATHEMATICS SYLLABUS

- * The syllabus consists of three content strands, namely, 'Numbers and Algebra', 'Geometry and Measurement', and 'Statistics and Probability', and a context strand called 'Integrative Contexts'.
- * Application of mathematics is an important emphasis of the content strands. The approach to teaching should involve meaningful contexts so that students can see and appreciate the relevance and applications of mathematics in their daily life and the world around them.
- * 'Integrative Contexts' are realistic contexts that naturally have practical applications of Mathematics, and the Mathematics can come from any part of the 'Content Outline'.

N(T) Secondary One	
Topic/Sub-topics	Content
1 Numbers and Algebra	
Numbers and the four operations	Include: <ul style="list-style-type: none"> • negative numbers, integers, and their four operations • four operations on fractions and decimals (including negative fractions and decimals) • calculations with the use of a calculator, including squares, cubes, square roots and cube roots • representation and ordering of numbers on the number line • use of the symbols $<$, $>$, \leq, \geq • rounding off numbers to a required number of decimal places or significant figures • estimating the results of computation
Ratio	Include: <ul style="list-style-type: none"> • comparison between two or more quantities by ratio • dividing a quantity in a given ratio • ratios involving fractions and decimals • equivalent ratios • writing a ratio in its simplest form • problems involving ratios
Percentage	Include: <ul style="list-style-type: none"> • expressing percentage as a fraction or decimal • finding the whole given a percentage part • expressing one quantity as a percentage of another • comparing two quantities by percentage • percentages greater than 100% • finding one quantity given the percentage and the other quantity • increasing/decreasing a quantity by a given percentage • finding percentage increase/decrease • problems involving percentages
Algebraic representation and formulae	Include: <ul style="list-style-type: none"> • using letters to represent numbers • interpreting notations: <ul style="list-style-type: none"> * ab as $a \times b$ * $\frac{a}{b}$ as $a \div b$ * a^2 as $a \times a$, a^3 as $a \times a \times a$, a^2b as $a \times a \times b$, ...

N(T) Secondary One	
Topic/Sub-topics	Content
	<ul style="list-style-type: none"> * $3y$ as $y + y + y$ or $3 \times y$ * $\frac{3 \pm y}{5}$ as $(3 \pm y) \div 5$ or $\frac{1}{5} \times (3 \pm y)$ <ul style="list-style-type: none"> • evaluation of algebraic expressions and formulae • translation of simple real-world situations into algebraic expressions • recognising and representing number patterns (including finding an algebraic expression for the nth term)
2 Geometry and Measurement	
Angles, triangles and quadrilaterals	Include: <ul style="list-style-type: none"> • right, acute, obtuse and reflex angles, complementary and supplementary angles, vertically opposite angles, adjacent angles on a straight line, adjacent angles at a point, interior and exterior angles • angles formed by two parallel lines and a transversal: corresponding angles, alternate angles, interior angles
Mensuration	Include: <ul style="list-style-type: none"> • area of triangle as $\frac{1}{2} \times \text{base} \times \text{height}$ • area and circumference of circle • area of parallelogram and trapezium • problems involving perimeter and area of composite plane figures • visualising and sketching cube and cuboid (including use of nets to visualise the surface area of these solids) • volume and surface area of cube and cuboid • conversion between cm^2 and m^2, and between cm^3 and m^3 • problems involving volume and surface area of composite solids
3 Statistics and Probability	
Data handling	Include: <ul style="list-style-type: none"> • data collection methods such as: <ul style="list-style-type: none"> * taking measurements * conducting surveys * classifying data * reading results of observations/ outcomes of events • construction and interpretation of: <ul style="list-style-type: none"> * tables * bar graphs * pictograms * line graphs * pie charts * histograms • purposes and use, advantages and disadvantages of the different forms of statistical representations • drawing simple inference from statistical diagrams Exclude histograms with unequal intervals.

N(T) Secondary Two	
Topic/Sub-topics	Content
1 Numbers and Algebra	
Rate	Include: <ul style="list-style-type: none"> • rates and average rates (including the concepts of speed and average speed) • conversion of units
Algebraic manipulation	Include: <ul style="list-style-type: none"> • addition and subtraction of linear algebraic expressions • simplification of linear algebraic expressions, e.g. $-2(3x - 5) + 4x, \quad \frac{2x}{3} - \frac{3(x - 5)}{2}$
Functions and graphs	Include: <ul style="list-style-type: none"> • cartesian coordinates in two dimensions • graph of a set of ordered pairs • linear relationships between two variables (linear functions) • the gradient of a linear graph as the ratio of the vertical change to the horizontal change (positive and negative gradients)
Solutions of equations	Include: <ul style="list-style-type: none"> • solving linear equations in one unknown (including fractional coefficients) • formulating a linear equation in one unknown to solve problems
2 Geometry and Measurement	
Angles, triangles and quadrilaterals	Include: <ul style="list-style-type: none"> • properties of triangles and special quadrilaterals • classifying special quadrilaterals on the basis of their properties • properties of perpendicular bisectors of line segments and angle bisectors • construction of simple geometrical figures from given data (including perpendicular bisectors and angle bisectors) using compasses, rulers, set squares and protractors where appropriate Exclude properties of polygons.
Congruence, similarity and transformations	Include: <ul style="list-style-type: none"> • congruent figures as figures that are identical in shape and size • matching sides and angles of two congruent polygons • similar figures as figures that have the same shape but different sizes • properties of similar polygons: <ul style="list-style-type: none"> * corresponding angles are equal * corresponding sides are proportional

N(T) Secondary Two	
Topic/Sub-topics	Content
Pythagoras' theorem	Include: <ul style="list-style-type: none"> • use of Pythagoras' theorem • determining whether a triangle is right-angled given the lengths of three sides
Mensuration	Include: <ul style="list-style-type: none"> • visualising and sketching prism and cylinder (including use of nets to visualise the surface area of these solids) • volume and surface area of prism and cylinder
3 Statistics and Probability	
Data analysis	Include: <ul style="list-style-type: none"> • interpretation and analysis of dot diagrams • purposes and use of averages: mean, mode and median • calculations of mean, mode and median for a set of ungrouped data
Probability	Include: <ul style="list-style-type: none"> • probability as a measure of chance • probability of single events (including listing all the possible outcomes in a simple chance situation to calculate the probability) Exclude probability of combined events: $P(A \text{ and } B)$, $P(A \text{ or } B)$.
4 Integrative Contexts	
Problems derived from practical real-life situations (The content should be distributed over 3 years, from Sec 2 to Sec 4)	Include: <ul style="list-style-type: none"> • practical situations such as <ul style="list-style-type: none"> * profit and loss * simple interest and compound interest * household finance (earnings, expenditures, budgeting, etc.) * payment/ subscription rates (hire-purchase, utilities bills, etc.) * money exchange * time schedules (including 24-hour clock) and time zone variation * designs (tiling patterns, models/structures, maps and plans, packagings, etc.) * everyday statistics (sport/ game statistics, household and market surveys, etc.) • tasks involving: <ul style="list-style-type: none"> * use of data from tables and charts * interpretation and use of graphs in practical situations * drawing graphs from given data * creating geometrical patterns and designs * interpretation and use of quantitative information Exclude use of the terms percentage profit and percentage loss.

N(T) Secondary Three/Four	
Topic/Sub-topics	Content
1 Numbers and Algebra	
Numbers and the four operations	<p>Include:</p> <ul style="list-style-type: none"> • use of index notation for integer powers • examples of very large and very small numbers such as mega / million (10^6), giga / billion (10^9), tera / trillion (10^{12}), micro (10^{-6}), nano (10^{-9}) and pico (10^{-12}) • use of standard form $A \times 10^n$, where n is an integer, and $1 \leq A < 10$ <p>Exclude:</p> <ul style="list-style-type: none"> • use of the terms 'rational numbers', 'irrational numbers' and 'real numbers' • primes and prime factorisation • fractional indices and surds
Ratio and proportion	<p>Include:</p> <ul style="list-style-type: none"> • map scales (distance and area) • direct and inverse proportion
Algebraic manipulation	<p>Include:</p> <ul style="list-style-type: none"> • expansion of the product of two linear algebraic expressions • multiplication and division of simple algebraic fractions, e.g. $\left(\frac{3a}{4b^2}\right)\left(\frac{5ab}{3}\right)$, $\frac{3a}{4} \div \frac{9a^2}{10}$ • changing the subject of a simple formula • finding the value of an unknown quantity in a given formula • factorisation of linear algebraic expressions of the form <ul style="list-style-type: none"> * $ax + ay$ (where a is a constant) * $ax + bx + kay + kby$ (where a, b and k are constants) • factorisation of quadratic expressions of the form $x^2 + px + q$ <p>Exclude:</p> <ul style="list-style-type: none"> • use of special products: $(a \pm b)^2 = a^2 \pm 2ab + b^2$ $a^2 - b^2 = (a + b)(a - b)$ • factorisation of algebraic expressions of the form <ul style="list-style-type: none"> * $a^2x^2 - b^2y^2$ * $a^2 \pm 2ab + b^2$ * $ax^2 + bx + c$, where $a \neq 1$ • addition and subtraction of algebraic fractions

N(T) Secondary Three/Four	
Topic/Sub-topics	Content
Functions and graphs	<p>Include:</p> <ul style="list-style-type: none"> • graphs of linear equations in two unknowns • graphs of quadratic functions and their properties <ul style="list-style-type: none"> * positive or negative coefficient of x^2 * maximum and minimum points * symmetry <p>Exclude sketching of graphs of quadratic functions.</p>
Solutions of equations	<p>Include:</p> <ul style="list-style-type: none"> • solving simple fractional equations that can be reduced to linear equations, e.g. $\frac{x}{3} + \frac{x-2}{4} = 3$ $\frac{3}{x-2} = 6$ • solving simultaneous linear equations in two unknowns by <ul style="list-style-type: none"> * substitution and elimination methods * graphical method • solving quadratic equations in one unknown by use of formula • formulating a quadratic equation in one unknown or a pair of linear equations in two unknowns to solve problems <p>Exclude solving quadratic equations by:</p> <ul style="list-style-type: none"> • method of completing the square • graphical methods
2 Geometry and Measurement	
Congruence, similarity and transformations	<p>Include:</p> <ul style="list-style-type: none"> • drawing on square grids the following transformations of simple plane figures <ul style="list-style-type: none"> * reflection about a given horizontal or vertical line * rotation about a given point through multiples of 90° clockwise/anticlockwise * translation represented by a given translation arrow * enlargement by a simple scale factor such as $\frac{1}{2}$, 2 and 3, given the centre of enlargement • scale drawings <p>Exclude:</p> <ul style="list-style-type: none"> • use of coordinates • negative scale factors

N(T) Secondary Three/Four	
Topic/Sub-topics	Content
Symmetry, tessellations and projections	<p>Include:</p> <ul style="list-style-type: none"> • line and rotational symmetry of plane figures • order of rotational symmetry • identifying the unit figure(s) of a tessellation and continuing a tessellation • orthographic projection drawings, including plan (top view), front, left and right views <p>Exclude symmetry of solids.</p>
Pythagoras' theorem and trigonometry	<p>Include:</p> <ul style="list-style-type: none"> • use of trigonometric ratios (sine, cosine and tangent) of acute angles to calculate unknown sides and angles in right-angled triangles (including problems involving angles of elevation and depression) • use of the formula $\frac{1}{2}ab \sin C$ for the area of a triangle (extending sine to obtuse angles) <p>Exclude:</p> <ul style="list-style-type: none"> • sine rule and cosine rule • bearings
Mensuration	<p>Include:</p> <ul style="list-style-type: none"> • visualising and sketching pyramid, cone and sphere (including use of nets to visualise the surface area of these solids, where applicable) • volume and surface area of pyramid, cone and sphere • arc length and sector area as fractions of the circumference and area of a circle <p>Exclude the radian measure of angle.</p>
3 Statistics and Probability	
Data analysis	<p>Include:</p> <ul style="list-style-type: none"> • percentiles, quartiles, range and interquartile range • interpretation and analysis of cumulative frequency diagrams

N(T) Secondary Three/Four	
Topic/Sub-topics	Content
4 Integrative Contexts	
Problems derived from practical real-life situations (The content should be distributed over 3 years, from Sec 2 to Sec 4)	<p>Include:</p> <ul style="list-style-type: none"> • practical situations such as <ul style="list-style-type: none"> * profit and loss * simple interest and compound interest * household finance (earnings, expenditures, budgeting, etc.) * payment/ subscription rates (hire-purchase, utilities bills, etc.) * money exchange * time schedules (including 24-hour clock) and time zone variation * designs (tiling patterns, models/structures, maps and plans, packagings, etc.) * everyday statistics (sport/ game statistics, household and market surveys, etc.) • tasks involving: <ul style="list-style-type: none"> * use of data from tables and charts * interpretation and use of graphs in practical situations * drawing graphs from given data * creating geometrical patterns and designs * interpretation and use of quantitative information <p>Exclude use of the terms percentage profit and percentage loss.</p>

7 O LEVEL ADDITIONAL MATHEMATICS

Knowledge of the content of O Level Mathematics syllabus is assumed in the syllabus below and will not be tested directly, but it may be required indirectly in response to questions on other topics.

O Level Additional Maths Secondary Three/Four	
Topic/Sub-topics	Content
Algebra	
Quadratic equations and inequalities	Include: <ul style="list-style-type: none"> conditions for a quadratic equation to have: <ol style="list-style-type: none"> two real roots two equal roots no real roots and related conditions for a given line to: <ol style="list-style-type: none"> intersect a given curve be a tangent to a given curve not intersect a given curve solution of quadratic inequalities, and the representation of the solution set on the number line conditions for $ax^2 + bx + c$ to be always positive (or always negative) relationships between the roots and coefficients of the quadratic equation $ax^2 + bx + c = 0$
Indices and surds	Include: <ul style="list-style-type: none"> four operations on indices and surds rationalising the denominator solving equations involving indices and surds
Polynomials	Include: <ul style="list-style-type: none"> multiplication and division of polynomials use of remainder and factor theorems factorisation of polynomials solving cubic equations
Simultaneous equations in two unknowns	Include: <ul style="list-style-type: none"> solving simultaneous equations with at least one linear equation, by substitution expressing a pair of linear equations in matrix form and solving the equations by inverse matrix method

O Level Additional Maths Secondary Three/Four	
Topic/Sub-topics	Content
Algebra	
Partial fractions	Include cases where the denominator is no more complicated than: <ul style="list-style-type: none"> • $(ax+b)(cx+d)$ • $(ax+b)(cx+d)^2$ • $(ax+b)(x^2+c^2)$
Binomial expansions	Include: <ul style="list-style-type: none"> • use of the Binomial Theorem for positive integer n • use of the notations $n!$ and $\binom{n}{r}$ • use of the general term $\binom{n}{r} a^{n-r} b^r$, $0 < r \leq n$ Exclude: <ul style="list-style-type: none"> • proof of the theorem • knowledge of the greatest term and properties of the coefficients
Exponential, logarithmic and modulus functions	Include: <ul style="list-style-type: none"> • functions a^x, e^x, $\log_a x$, $\ln x$ and their graphs • laws of logarithms • equivalence of $y = a^x$ and $x = \log_a y$ • change of base of logarithms • function x and graph of $f(x)$, where $f(x)$ is linear, quadratic or trigonometric • solving simple equations involving exponential, logarithmic and modulus functions

O Level Additional Maths Secondary Three/Four	
Topic/Sub-topics	Content
Geometry and Trigonometry	
Trigonometric functions, identities and equations	<p>Include:</p> <ul style="list-style-type: none"> • six trigonometric functions for angles of any magnitude (in degrees or radians) • principal values of $\sin^{-1} x$, $\cos^{-1} x$, $\tan^{-1} x$ • exact values of the trigonometric functions for special angles (30°, 45°, 60°) or $(\frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3})$ • amplitude, periodicity and symmetries related to the sine and cosine functions • graphs of $y = a \sin (bx) + c$, $y = a \sin \left(\frac{x}{b} \right) + c$, $y = a \cos (bx) + c$, $y = a \cos \left(\frac{x}{b} \right) + c$ and $y = a \tan (bx)$, where a and b are positive integers and c is an integer • use of the following <ul style="list-style-type: none"> * $\frac{\sin A}{\cos A} = \tan A$, $\frac{\cos A}{\sin A} = \cot A$, $\sin^2 A + \cos^2 A = 1$, $\sec^2 A = 1 + \tan^2 A$, $\operatorname{cosec}^2 A = 1 + \cot^2 A$ * the expansions of $\sin(A \pm B)$, $\cos(A \pm B)$ and $\tan(A \pm B)$ * the formulae for $\sin 2A$, $\cos 2A$ and $\tan 2A$ * the formulae for $\sin A \pm \sin B$ and $\cos A \pm \cos B$ * the expression for $a \cos \theta + b \sin \theta$ in the form $R \cos(\theta \pm \alpha)$ or $R \sin(\theta \pm \alpha)$ • simplification of trigonometric expressions • solution of simple trigonometric equations in a given interval • proofs of simple trigonometric identities <p>Exclude general solution of trigonometric equations.</p>

O Level Additional Maths Secondary Three/Four	
Topic/Sub-topics	Content
Geometry and Trigonometry	
Coordinate geometry in two dimensions	<p>Include:</p> <ul style="list-style-type: none"> • condition for two lines to be parallel or perpendicular • midpoint of line segment • finding the area of rectilinear figure given its vertices • graphs of equations <ul style="list-style-type: none"> * $y = ax^n$, where n is a simple rational number * $y^2 = kx$ • coordinate geometry of the circle with the equation $(x - a)^2 + (y - b)^2 = r^2$ and $x^2 + y^2 + 2gx + 2fy + c = 0$ • transformation of given relationships, including $y = ax^n$ and $y = kb^x$, to linear form to determine the unknown constants from the straight line graph <p>Exclude:</p> <ul style="list-style-type: none"> • finding the equation of the circle passing through three given points • intersection of two circles
Proofs in plane geometry	<p>Include:</p> <ul style="list-style-type: none"> • symmetry and angle properties of triangles, special quadrilaterals and circles[♦] • midpoint theorem and intercept theorem for triangles • tangent-chord theorem (alternate segment theorem), intersecting chords theorem and tangent-secant theorem for circles • use of above properties and theorems

[♦] These are properties learnt in O Level Mathematics.

O Level Additional Maths Secondary Three/Four	
Topic/Sub-topics	Content
Calculus	
Differentiation and integration	<p>Include:</p> <ul style="list-style-type: none"> • derivative of $f(x)$ as the gradient of the tangent to the graph of $y = f(x)$ at a point • derivative as rate of change • use of standard notations $f'(x)$, $f''(x)$, $\frac{dy}{dx}$, $\frac{d^2y}{dx^2}$ [$= \frac{d}{dx}(\frac{dy}{dx})$] • derivatives of x^n, for any rational n, $\sin x$, $\cos x$, $\tan x$, e^x, and $\ln x$, together with constant multiples, sums and differences • derivatives of composite functions • derivatives of products and quotients of functions • increasing and decreasing functions • stationary points (maximum and minimum turning points and stationary points of inflexion) • use of second derivative test to discriminate between maxima and minima • applying differentiation to gradients, tangents and normals, connected rates of change and maxima and minima problems • integration as the reverse of differentiation • integration of x^n for any rational n, $\sin x$, $\cos x$, $\sec^2 x$ and e^x, together with constant multiples, sums and differences • integration of $(ax + b)^n$ for any rational n, $\sin(ax + b)$, $\cos(ax + b)$ and $e^{(ax+b)}$ • definite integral as area under a curve • evaluation of definite integrals • finding the area of a region bounded by a curve and lines parallel to the coordinate axes • finding areas of regions below the x-axis • application of differentiation and integration to problems involving displacement, velocity and acceleration of a particle moving in a straight line with variable or constant acceleration <p>Exclude:</p> <ul style="list-style-type: none"> • differentiation of functions defined implicitly and parametrically • finding the area of a region between a curve and an oblique line, or between two curves • use of formulae for motion with constant acceleration

8 N(A) LEVEL ADDITIONAL MATHEMATICS

Knowledge of the content of N Level Mathematics Syllabus A and the following additional topics are assumed.

1. Solution of equations and inequalities
 - solution of simple linear inequalities in one unknown, and the representation of the solution set on the number line.
2. Matrices
 - display information in the form of a matrix;
 - product of a scalar quantity and a matrix;
 - problems involving the calculation of the sum and product of two matrices.

Material in the N-Level Mathematics Syllabus A and the above topics, which are not repeated in the syllabus below, will not be tested directly but may be required indirectly in response to questions on other topics.

N (A) Level Additional Maths Secondary Three/Four	
Topic/Sub-topics	Content
Algebra	
Quadratic equations and inequalities	Include: <ul style="list-style-type: none"> • conditions for a quadratic equation to have: <ol style="list-style-type: none"> (i) two real roots (ii) two equal roots (iii) no real roots and related conditions for a given line to: <ol style="list-style-type: none"> (i) intersect a given curve (ii) be a tangent to a given curve (iii) not intersect a given curve • solution of quadratic inequalities, and the representation of the solution set on the number line • conditions for $ax^2 + bx + c$ to be always positive (or always negative) • relationships between the roots and coefficients of the quadratic equation $ax^2 + bx + c = 0$
Indices and surds	Include: <ul style="list-style-type: none"> • four operations on indices and surds • rationalising the denominator • solving equations involving indices and surds
Polynomials	Include: <ul style="list-style-type: none"> • multiplication and division of polynomials • use of remainder and factor theorems • factorisation of polynomials • solving cubic equations
Simultaneous equations in two unknowns	Include: <ul style="list-style-type: none"> • solving simultaneous equations with at least one linear equation, by substitution • expressing a pair of linear equations in matrix form and solving the equations by inverse matrix method

N (A) Level Additional Maths Secondary Three/Four	
Topic/Sub-topics	Content
Algebra	
Binomial expansions	<p>Include:</p> <ul style="list-style-type: none"> use of the Binomial Theorem for positive integer n use of the notations $n!$ and $\binom{n}{r}$ use of the general term $\binom{n}{r} a^{n-r} b^r$, $0 < r \leq n$ <p>Exclude:</p> <ul style="list-style-type: none"> proof of the theorem knowledge of the greatest term and properties of the coefficients
Geometry and Trigonometry	
Trigonometric functions, identities and equations	<p>Include:</p> <ul style="list-style-type: none"> six trigonometric functions for angles of any magnitude (in degrees or radians) principal values of $\sin^{-1} x$, $\cos^{-1} x$, $\tan^{-1} x$ exact values of the trigonometric functions for special angles (30°, 45°, 60°) or $(\frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3})$ amplitude, periodicity and symmetries related to the sine and cosine functions graphs of $y = a \sin (bx) + c$, $y = a \sin \left(\frac{x}{b} \right) + c$, $y = a \cos (bx) + c$, $y = a \cos \left(\frac{x}{b} \right) + c$ and $y = a \tan (bx)$, where a and b are positive integers and c is an integer use of the following <ul style="list-style-type: none"> * $\frac{\sin A}{\cos A} = \tan A$, $\frac{\cos A}{\sin A} = \cot A$, $\sin^2 A + \cos^2 A = 1$, $\sec^2 A = 1 + \tan^2 A$, $\operatorname{cosec}^2 A = 1 + \cot^2 A$ * the expansions of $\sin (A \pm B)$, $\cos (A \pm B)$ and $\tan (A \pm B)$ * the formulae for $\sin 2A$, $\cos 2A$ and $\tan 2A$ simplification of trigonometric expressions solution of simple trigonometric equations in a given interval proofs of simple trigonometric identities <p>Exclude general solution of trigonometric equations.</p>

N (A) Level Additional Maths Secondary Three/Four	
Topic/Sub-topics	Content
Geometry and Trigonometry	
Coordinate geometry in two dimensions	<p>Include:</p> <ul style="list-style-type: none"> • condition for two lines to be parallel or perpendicular • midpoint of line segment • finding the area of rectilinear figure given its vertices • graphs of equations <ul style="list-style-type: none"> * $y = ax^n$, where n is a simple rational number * $y^2 = kx$ • coordinate geometry of the circle with the equation $(x - a)^2 + (y - b)^2 = r^2$ and $x^2 + y^2 + 2gx + 2fy + c = 0$ <p>Exclude:</p> <ul style="list-style-type: none"> • finding the equation of the circle passing through three given points • intersection of two circles
Calculus	
Differentiation and integration	<p>Include:</p> <ul style="list-style-type: none"> • derivative of $f(x)$ as the gradient of the tangent to the graph of $y = f(x)$ at a point • derivative as rate of change • use of standard notations $f'(x)$, $f''(x)$, $\frac{dy}{dx}$, $\frac{d^2y}{dx^2}$ [$= \frac{d}{dx} \left(\frac{dy}{dx} \right)$] • derivatives of x^n, for any rational n, together with constant multiples, sums and differences • derivatives of composite functions • derivatives of products and quotients of functions • increasing and decreasing functions • stationary points (maximum and minimum turning points and stationary points of inflexion) • use of second derivative test to discriminate between maxima and minima • applying differentiation to gradients, tangents and normals, connected rates of change and maxima and minima problems • integration as the reverse of differentiation • integration of x^n, for any rational n, (excluding $n = -1$), together with constant multiples, sums and differences • integration of $(ax + b)^n$ for any rational n (excluding $n = -1$) • definite integral as area under a curve • evaluation of definite integrals • finding the area of a region bounded by a curve and lines parallel to the coordinate axes <p>Exclude:</p> <ul style="list-style-type: none"> • differentiation of functions defined implicitly and parametrically • finding areas of regions below the x-axis • finding the area of a region between a curve and an oblique line, or between two curves