



The John Roan School Sixth Form

The best in everyone™

Part of United Learning

A-Level Maths

Exam board: Edexcel

Course code: 9MA0

Student Handbook

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Inspired

Confident

Ambitious

The John Roan School ensures that ***all*** students achieve the ***highest possible academic outcomes*** and develop into ***responsible citizens***, so they are able to lead ***happy*** and fulfilled lives.

At The John Roan Sixth Form, students will be ***inspired*** by our commitment to their destinations.

They will feel ***confident*** in their abilities and prospects because of our teaching and curriculum and they will be ***ambitious*** because of the opportunities we provide.

Curriculum: Welcome to Maths

Curriculum Aims (KS5)

The purpose of the maths curriculum is to provide a secure understanding of mathematical concepts, from basic principles of mathematics to complex topics that combine several areas of study into a single question about the world around them. We interrogate patterns and quantify relationships. Students develop their knowledge of how to construct and present mathematical arguments; apply their mathematical skills to make logical and reasoned decisions in solving problems in both pure and applied mathematics. Students problem-solve and communicate their mathematical solutions with the aid of acquired skills and technology such as with graphical calculators. The curriculum promotes retention of knowledge and a depth of learning rather than an accelerated curriculum, resulting in pupils who are confident in taking their studies further into university and beyond.

Mathematics, as a fundamental part of human thought and logic, is an effective way to build mental discipline and help increase the confidence of our pupils to thrive in all settings of society. It is a hierarchical subject, so we prioritise depth over acceleration to ensure students are continually developing and building on their knowledge. Mathematics is a dynamic, engaging, and problem-solving discipline which promotes passion and creative thinking. Through regular retrieval, interleaving and independent practice, students develop their confidence and efficient methods to thrive within this exciting and extensive subject.

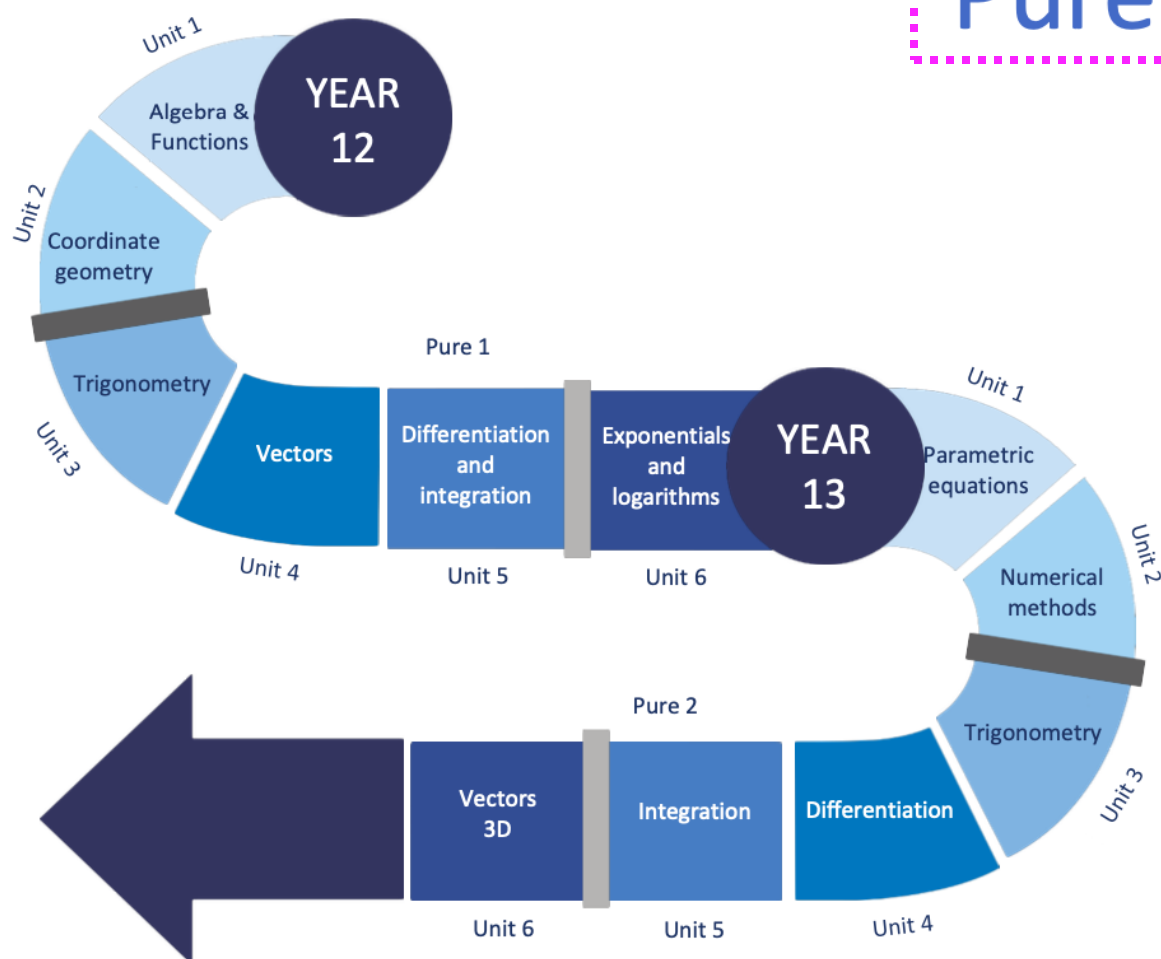
Here we explore the John Roan curriculum principles in the context of the A Level Maths curriculum:

- **Entitlement:** All pupils in maths are exposed to problem solving and rich problems from the very first maths lesson until the last. We teach in the hope that all students will continue with maths in some form at university or career. This ensures that all pupils can access all areas of maths and focus on developing their skills.
- **Coherence:** Our curriculum has been carefully sequenced to ensure that knowledge is revisited without having a spiral curriculum, and to ensure that classic misconceptions between topic areas are avoided.
- **Mastery:** Mathematical concepts are taught in-depth and continually revisited through careful interleaving of content into future teaching topics. The focus on retention of knowledge is at the core of the maths curriculum; the mastery approach supports this.
- **Adaptability:** Teachers have developed a well thought through and resourced curriculum and have the autonomy to adapt these as needed to support their class. We purposefully plan our scaffolding such that student support is gradually and appropriately removed throughout the 2 years to support their independence and confidence.
- **Representation:** Maths is universal, providing all pupils with an elegant and logical way of viewing the world. Where our resources include names and places, these have been selected to be inclusive. We believe that a secure understanding of maths is an essential starting point for all young people.
- **Education with character:** Mathematics is a common language in which all pupils can solve, analyse, and problem solve. Our curriculum supports pupils to build logical reasoning, critical thinking and is mentally rigorous.

A Level Maths

Key Stage 5

Pure



Inspired

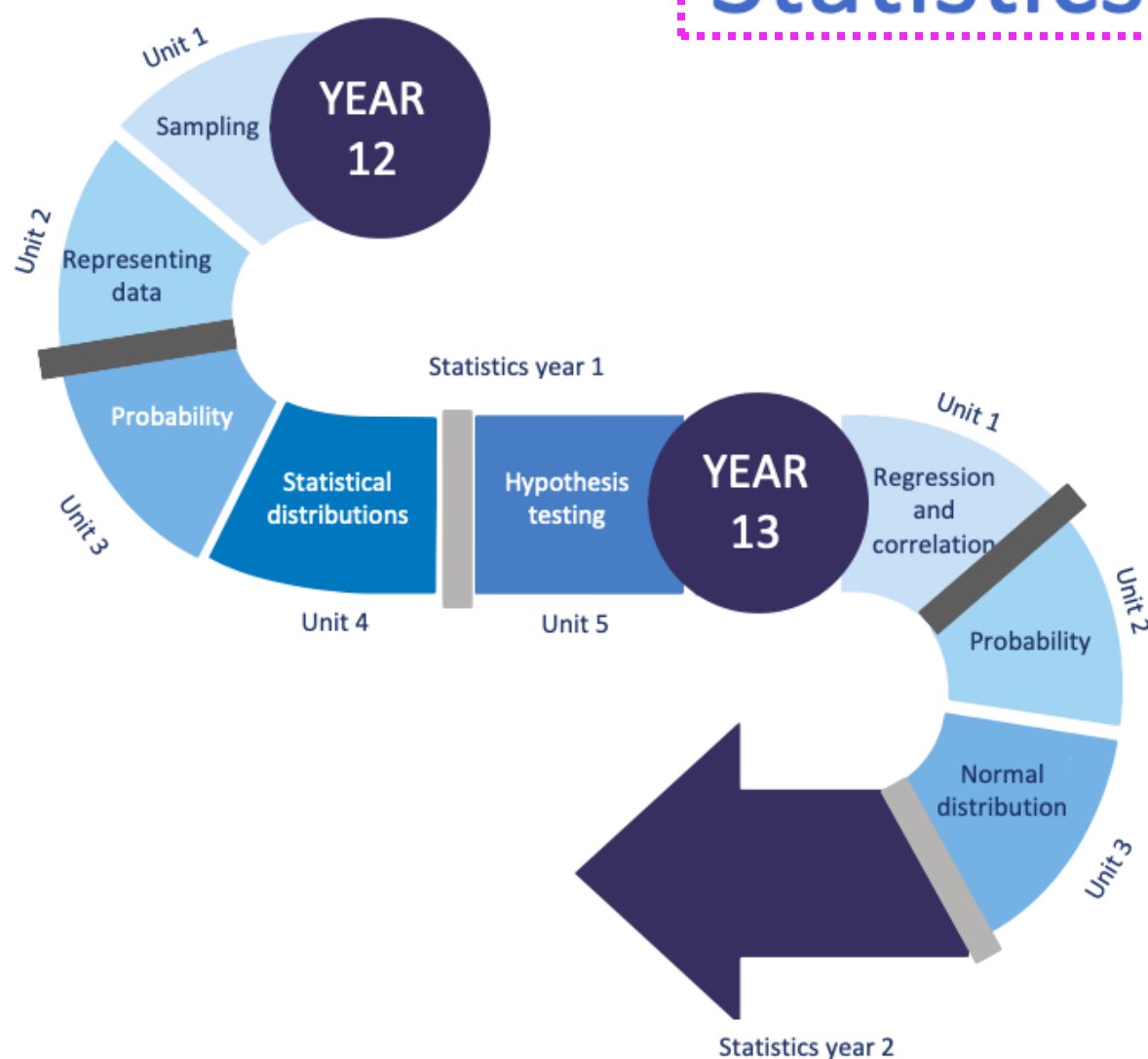
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A Level Maths

Key Stage 5

Statistics



Key



Mid-Year Assessments



End of Year Assessments

Inspired

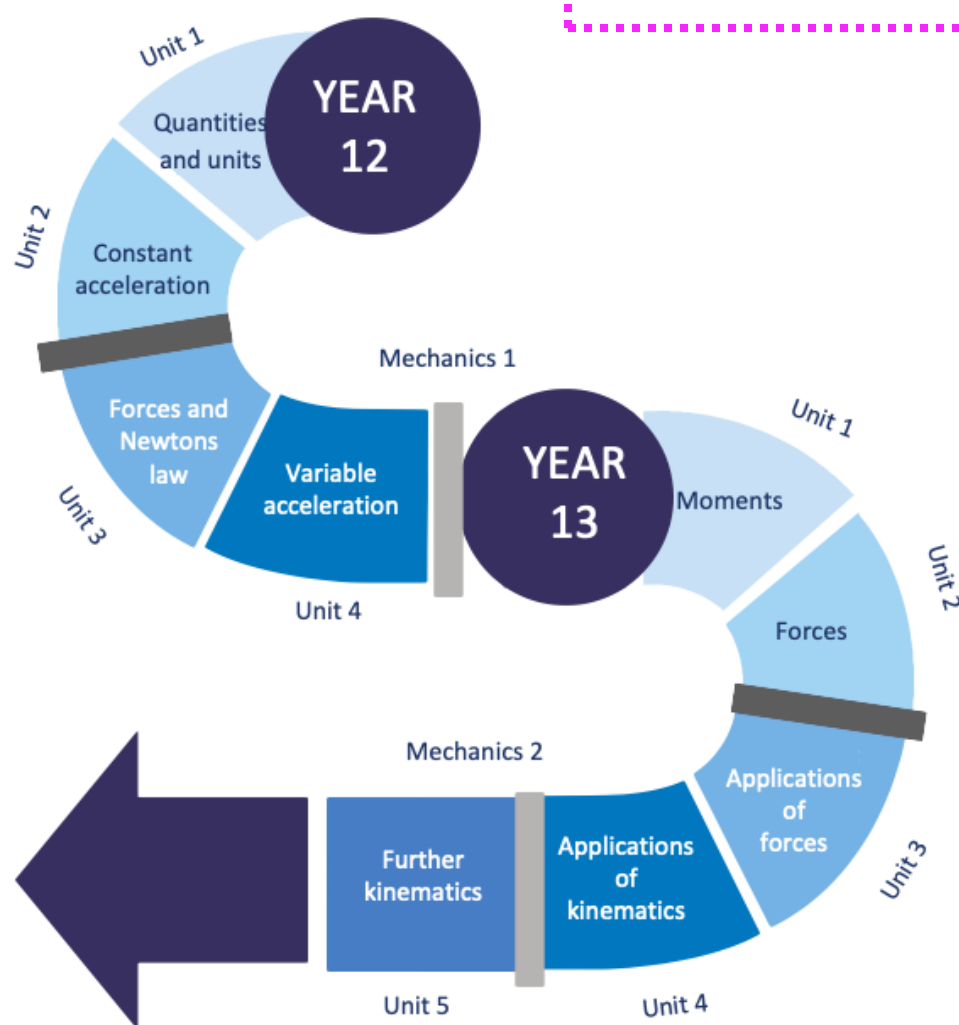
Confident

Ambitious

A Level Maths

Key Stage 5

Mechanics



Key



Mid-Year Assessments



End of Year Assessments

Inspired

Confident

Ambitious



How we organise our work in A-Level Maths

- We use our ring binder to contain all of our notes and packets
- We use our exercise book for homework completion and independent practice
- We use dividers to separate our folder work into sections
- We summarise our key knowledge of each unit onto a one page summary
- We keep our assessments separately at the back of the folder including our 'Corrections and Reflections' DIRT work
- We take pride in our folder, keeping it safe and up to date at all times
- We keep our ringbinder in the classroom and use a folder to take relevant pieces of homework or classwork home.



Exam Specification: Pure

In bold are topics covered in the AS. Pure makes up Papers 1 & 2

Topics	What students need to learn:		
	Content		Guidance
1 Proof	1.1 Understand and use the structure of mathematical proof, proceeding from given assumptions through a series of logical steps to a conclusion; use methods of proof, including: Proof by deduction Proof by exhaustion Disproof by counter example Proof by contradiction (including proof of the irrationality of $\sqrt{2}$ and the infinity of primes, and application to unfamiliar proofs).		Examples of proofs: Proof by deduction e.g. using completion of the square, prove that $n^2 - 6n + 10$ is positive for all values of n or, for example, differentiation from first principles for small positive integer powers of x or proving results for arithmetic and geometric series. This is the most commonly used method of proof throughout this specification Proof by exhaustion Given that p is a prime number such that $3 < p < 25$, prove by exhaustion, that $(p - 1)(p + 1)$ is a multiple of 12. Disproof by counter example e.g. show that the statement "$n^2 - n + 1$ is a prime number for all values of n" is untrue



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Topics	What students need to learn:		
	Content	Guidance	
2 Algebra and functions	2.1	Understand and use the laws of indices for all rational exponents.	$a^m \times a^n = a^{m+n}$, $a^m \div a^n = a^{m-n}$, $(a^m)^n = a^{mn}$ The equivalence of $a^{\frac{m}{n}}$ and $\sqrt[n]{a^m}$ should be known.
	2.2	Use and manipulate surds, including rationalising the denominator.	Students should be able to simplify algebraic surds using the results $(\sqrt{x})^2 = x$, $\sqrt{xy} = \sqrt{x}\sqrt{y}$ and $(\sqrt{x} + \sqrt{y})(\sqrt{x} - \sqrt{y}) = x - y$
	2.3	Work with quadratic functions and their graphs. The discriminant of a quadratic function, including the conditions for real and repeated roots. Completing the square. Solution of quadratic equations including solving quadratic equations in a function of the unknown.	The notation $f(x)$ may be used Need to know and to use $b^2 - 4ac > 0$, $b^2 - 4ac = 0$ and $b^2 - 4ac < 0$ $ax^2 + bx + c = a\left(x + \frac{b}{2a}\right)^2 + \left(c - \frac{b^2}{4a}\right)$ Solution of quadratic equations by factorisation, use of the formula, use of a calculator or completing the square. These functions could include powers of x , trigonometric functions of x , exponential and logarithmic functions of x .
	2.4	Solve simultaneous equations in two variables by elimination and by substitution, including one linear and one quadratic equation.	This may involve powers of 2 in one unknown or in both unknowns, e.g. solve $y = 2x + 3$, $y = x^2 - 4x + 8$ or $2x - 3y = 6$, $x^2 - y^2 + 3x = 50$



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Topics	What students need to learn:		
	Content	Guidance	
2 Algebra and functions <i>continued</i>	2.5 Solve linear and quadratic inequalities in a single variable and interpret such inequalities graphically, including inequalities with brackets and fractions. Express solutions through correct use of 'and' and 'or', or through set notation. Represent linear and quadratic inequalities such as $y > x + 1$ and $y > ax^2 + bx + c$ graphically.	e.g. solving $ax + b > cx + d$, $px^2 + qx + r \geq 0$, $px^2 + qx + r < ax + b$ and interpreting the third inequality as the range of x for which the curve $y = px^2 + qx + r$ is below the line with equation $y = ax + b$ These would be reducible to linear or quadratic inequalities e.g. $\frac{a}{x} < b$ becomes $ax < bx^2$ So, e.g. $x < a$ or $x > b$ is equivalent to $\{x : x < a\} \cup \{x : x > b\}$ and $\{x : c < x\} \cap \{x : x < d\}$ is equivalent to $x > c$ and $x < d$ Shading and use of dotted and solid line convention is required.	
	2.6 Manipulate polynomials algebraically, including expanding brackets and collecting like terms, factorisation and simple algebraic division; use of the factor theorem. Simplify rational expressions, including by factorising and cancelling, and algebraic division (by linear expressions only).	Only division by $(ax + b)$ or $(ax - b)$ will be required. Students should know that if $f(x) = 0$ when $x = \frac{b}{a}$, then $(ax - b)$ is a factor of $f(x)$. Students may be required to factorise cubic expressions such as $x^3 + 3x^2 - 4$ and $6x^3 + 11x^2 - x - 6$. Denominators of rational expressions will be linear or quadratic, e.g. $\frac{1}{ax + b}, \frac{ax + b}{px^2 + qx + r}, \frac{x^3 + a^3}{x^2 - a^2}$	

Topics	What students need to learn:		
	Content	Guidance	
2 Algebra and functions <i>continued</i>	2.7 Understand and use graphs of functions; sketch curves defined by simple equations including polynomials The modulus of a linear function. $y = \frac{a}{x} \quad \text{and} \quad y = \frac{a}{x^2}$ (including their vertical and horizontal asymptotes) Interpret algebraic solution of equations graphically; use intersection points of graphs to solve equations. Understand and use proportional relationships and their graphs.	Graph to include simple cubic and quartic functions, e.g. sketch the graph with equation $y = x^3(2x - 1)^2$ Students should be able to sketch the graph of $y = ax + b$ They should be able to use their graph. For example, sketch the graph with equation $y = 2x - 1$ and use the graph to solve the equation $2x - 1 = x$ or the inequality $2x - 1 > x$ The asymptotes will be parallel to the axes e.g. the asymptotes of the curve with equation $y = \frac{2}{x+a} + b$ are the lines with equations $y = b$ and $x = -a$ Express relationship between two variables using proportion "∝" symbol or using equation involving constant e.g. the circumference of a semicircle is directly proportional to its diameter so $C ∝ d$ or $C = kd$ and the graph of C against d is a straight line through the origin with gradient k.	



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Topics	What students need to learn:		
	Content	Guidance	
2 Algebra and functions <i>continued</i>	2.8	Understand and use composite functions; inverse functions and their graphs.	The concept of a function as a one-one or many-one mapping from $\mathbb{R}$ (or a subset of $\mathbb{R}$) to $\mathbb{R}$. The notation $f: x \mapsto$ and $f(x)$ will be used. Domain and range of functions. Students should know that fg will mean 'do g first, then f' and that if f^{-1} exists, then $f^{-1}f(x) = ff^{-1}(x) = x$ They should also know that the graph of $y = f^{-1}(x)$ is the image of the graph of $y = f(x)$ after reflection in the line $y = x$
	2.9	Understand the effect of simple transformations on the graph of $y = f(x)$, including sketching associated graphs: $y = af(x)$, $y = f(x) + a$, $y = f(x + a)$, $y = f(ax)$ and combinations of these transformations	Students should be able to find the graphs of $y = f(x)$ and $y = f(-x)$, given the graph of $y = f(x)$. Students should be able to apply a combination of these transformations to any of the functions in the A Level specification (quadratics, cubics, quartics, reciprocal, $\frac{a}{x^2}$, x, $\sin x$, $\cos x$, $\tan x$, e^x and a^x) and sketch the resulting graph. Given the graph of $y = f(x)$, students should be able to sketch the graph of, e.g. $y = 2f(3x)$, or $y = f(-x) + 1$, and should be able to sketch (for example) $y = 3 + \sin 2x, y = -\cos\left(x + \frac{\pi}{4}\right)$
	2.10	Decompose rational functions into partial fractions (denominators not more complicated than squared linear terms and with no more than 3 terms, numerators constant or linear).	Partial fractions to include denominators such as $(ax + b)(cx + d)(ex + f)$ and $(ax + b)(cx + d)^2$. Applications to integration, differentiation and series expansions.



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Topics	What students need to learn:		
	Content	Guidance	
2 Algebra and functions <i>continued</i>	2.11	Use of functions in modelling, including consideration of limitations and refinements of the models.	For example, use of trigonometric functions for modelling tides, hours of sunlight, etc. Use of exponential functions for growth and decay (see Paper 1, Section 6.7). Use of reciprocal function for inverse proportion (e.g. pressure and volume).
3 Coordinate geometry in the (x,y) plane	3.1	Understand and use the equation of a straight line, including the forms $y - y_1 = m(x - x_1)$ and $ax + by + c = 0$; Gradient conditions for two straight lines to be parallel or perpendicular. Be able to use straight line models in a variety of contexts.	To include the equation of a line through two given points, and the equation of a line parallel (or perpendicular) to a given line through a given point. $m' = m$ for parallel lines and $m' = -\frac{1}{m}$ for perpendicular lines For example, the line for converting degrees Celsius to degrees Fahrenheit, distance against time for constant speed, etc.
	3.2	Understand and use the coordinate geometry of the circle including using the equation of a circle in the form $(x - a)^2 + (y - b)^2 = r^2$ Completing the square to find the centre and radius of a circle; use of the following properties: - the angle in a semicircle is a right angle - the perpendicular from the centre to a chord bisects the chord - the radius of a circle at a given point on its circumference is perpendicular to the tangent to the circle at that point.	Students should be able to find the radius and the coordinates of the centre of the circle given the equation of the circle, and vice versa. Students should also be familiar with the equation $x^2 + y^2 + 2fx + 2gy + c = 0$ Students should be able to find the equation of a circumcircle of a triangle with given vertices using these properties. Students should be able to find the equation of a tangent at a specified point, using the perpendicular property of tangent and radius.



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Topics	What students need to learn:		
	Content		Guidance
3 Coordinate geometry in the (x, y) plane <i>continued</i>	3.3	Understand and use the parametric equations of curves and conversion between Cartesian and parametric forms.	For example: $x = 3\cos t$, $y = 3\sin t$ describes a circle centre O radius 3 $x = 2 + 5\cos t$, $y = -4 + 5\sin t$ describes a circle centre $(2, -4)$ with radius 5 $x = 5t$, $y = \frac{5}{t}$ describes the curve $xy = 25$ (or $y = \frac{25}{x}$) $x = 5t$, $y = 3t^2$ describes the quadratic curve $25y = 3x^2$ and other familiar curves covered in the specification. Students should pay particular attention to the domain of the parameter t, as a specific section of a curve may be described.
	3.4	Use parametric equations in modelling in a variety of contexts.	A shape may be modelled using parametric equations or students may be asked to find parametric equations for a motion. For example, an object moves with constant velocity from $(1, 8)$ at $t = 0$ to $(6, 20)$ at $t = 5$. This may also be tested in Paper 3, section 7 (kinematics).
4 Sequences and series	4.1	Understand and use the binomial expansion of $(a + bx)^n$ for positive integer n; the notations $n!$ and nC_r link to binomial probabilities. Extend to any rational n, including its use for approximation; be aware that the expansion is valid for $\left \frac{bx}{a} \right < 1 \text{ (proof not required)}$	Use of Pascal's triangle. Relation between binomial coefficients. Also be aware of alternative notations such as $\binom{n}{r}$ and nC_r. Considered further in Paper 3 Section 4.1. May be used with the expansion of rational functions by decomposition into partial fractions May be asked to comment on the range of validity.



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Topics	What students need to learn:		
	Content		Guidance
4 Sequences and series <i>continued</i>	4.2	Work with sequences including those given by a formula for the n th term and those generated by a simple relation of the form $x_{n+1} = f(x_n)$; increasing sequences; decreasing sequences; periodic sequences.	For example $u_n = \frac{1}{3n+1}$ describes a decreasing sequence as $u_{n+1} < u_n$ for all integer n $u_n = 2^n$ is an increasing sequence as $u_{n+1} > u_n$ for all integer n $u_{n+1} = \frac{1}{u_n}$ for $n > 1$ and $u_1 = 3$ describes a periodic sequence of order 2
	4.3	Understand and use sigma notation for sums of series.	Knowledge that $\sum_{i=1}^n 1 = n$ is expected
	4.4	Understand and work with arithmetic sequences and series, including the formulae for n th term and the sum to n terms	The proof of the sum formula for an arithmetic sequence should be known including the formula for the sum of the first n natural numbers.
	4.5	Understand and work with geometric sequences and series, including the formulae for the n th term and the sum of a finite geometric series; the sum to infinity of a convergent geometric series, including the use of $ r < 1$; modulus notation	The proof of the sum formula should be known. Given the sum of a series students should be able to use logs to find the value of n . The sum to infinity may be expressed as S_∞
	4.6	Use sequences and series in modelling.	Examples could include amounts paid into saving schemes, increasing by the same amount (arithmetic) or by the same percentage (geometric) or could include other series defined by a formula or a relation.



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		Content	Guidance
5 Trigonometry	5.1	Understand and use the definitions of sine, cosine and tangent for all arguments; the sine and cosine rules; the area of a triangle in the form $\frac{1}{2}ab \sin C$ Work with radian measure, including use for arc length and area of sector.	Use of x and y coordinates of points on the unit circle to give cosine and sine respectively, including the ambiguous case of the sine rule. Use of the formulae $s = r\theta$ and $A = \frac{1}{2}r^2\theta$ for arc lengths and areas of sectors of a circle.
	5.2	Understand and use the standard small angle approximations of sine, cosine and tangent $\sin \theta \approx \theta$, $\cos \theta \approx 1 - \frac{\theta^2}{2}$, $\tan \theta \approx \theta$ Where θ is in radians.	Students should be able to approximate, e.g. $\frac{\cos 3x - 1}{x \sin 4x}$ when x is small, to $-\frac{9}{8}$
	5.3	Understand and use the sine, cosine and tangent functions; their graphs, symmetries and periodicity. Know and use exact values of sin and cos for $0, \frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}, \frac{\pi}{2}, \pi$ and multiples thereof, and exact values of tan for $0, \frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}, \pi$ and multiples thereof.	Knowledge of graphs of curves with equations such as $y = \sin x$, $y = \cos(x + 30^\circ)$, $y = \tan 2x$ is expected.
	5.4	Understand and use the definitions of secant, cosecant and cotangent and of arcsin, arccos and arctan; their relationships to sine, cosine and tangent; understanding of their graphs; their ranges and domains.	Angles measured in both degrees and radians.



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Topics	What students need to learn:		
	Content	Guidance	
5 Trigonometry <i>continued</i>	5.5	Understand and use $\tan \theta = \frac{\sin \theta}{\cos \theta}$ Understand and use $\sin^2 \theta + \cos^2 \theta = 1$ $\sec^2 \theta = 1 + \tan^2 \theta$ and $\operatorname{cosec}^2 \theta = 1 + \cot^2 \theta$	These identities may be used to solve trigonometric equations and angles may be in degrees or radians. They may also be used to prove further identities.
	5.6	Understand and use double angle formulae; use of formulae for $\sin (A \pm B)$, $\cos (A \pm B)$, and $\tan (A \pm B)$, understand geometrical proofs of these formulae. Understand and use expressions for $a \cos \theta + b \sin \theta$ in the equivalent forms of $r \cos (\theta \pm \alpha)$ or $r \sin (\theta \pm \alpha)$	To include application to half angles. Knowledge of the $\tan (\frac{1}{2} \theta)$ formulae will not be required. Students should be able to solve equations such as $a \cos \theta + b \sin \theta = c$ in a given interval.
	5.7	Solve simple trigonometric equations in a given interval, including quadratic equations in $\sin$, $\cos$ and $\tan$ and equations involving multiples of the unknown angle.	Students should be able to solve equations such as $\sin (x + 70^\circ) = 0.5$ for $0 < x < 360^\circ$, $3 + 5 \cos 2x = 1$ for $-180^\circ < x < 180^\circ$ $6 \cos^2 x + \sin x - 5 = 0$, $0 \leq x < 360^\circ$ These may be in degrees or radians and this will be specified in the question.
	5.8	Construct proofs involving trigonometric functions and identities.	Students need to prove identities such as $\cos x \cos 2x + \sin x \sin 2x = \cos x$.
	5.9	Use trigonometric functions to solve problems in context, including problems involving vectors, kinematics and forces.	Problems could involve (for example) wave motion, the height of a point on a vertical circular wheel, or the hours of sunlight throughout the year. Angles may be measured in degrees or in radians.



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Topics	What students need to learn:		
	Content	Guidance	
6 Exponentials and logarithms	6.1	Know and use the function a^x and its graph, where a is positive. Know and use the function e^x and its graph.	Understand the difference in shape between $a < 1$ and $a > 1$ To include the graph of $y = e^{ax+b} + c$
	6.2	Know that the gradient of e^{kx} is equal to ke^{kx} and hence understand why the exponential model is suitable in many applications.	Realise that when the rate of change is proportional to the y value, an exponential model should be used.
	6.3	Know and use the definition of $\log_e x$ as the inverse of a^x, where a is positive and $x \geq 0$. Know and use the function $\ln x$ and its graph. Know and use $\ln x$ as the inverse function of e^x	$a \neq 1$ Solution of equations of the form $e^{ax+b} = p$ and $\ln(ax+b) = q$ is expected.
	6.4	Understand and use the laws of logarithms: $\log_a x + \log_a y = \log_a (xy)$ $\log_a x - \log_a y = \log_a \left(\frac{x}{y} \right)$ $k \log_a x = \log_a x^k$ (including, for example, $k = -1$ and $k = -\frac{1}{2}$)	Includes $\log_e a = 1$
	6.5	Solve equations of the form $a^x = b$	Students may use the change of base formula. Questions may be of the form, e.g. $2^{3x-1} = 3$
	6.6	Use logarithmic graphs to estimate parameters in relationships of the form $y = ax^n$ and $y = kb^x$, given data for x and y	Plot $\log y$ against $\log x$ and obtain a straight line where the intercept is $\log a$ and the gradient is n Plot $\log y$ against x and obtain a straight line where the intercept is $\log k$ and the gradient is $\log b$



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Topics	What students need to learn:		
	Content	Guidance	
6 Exponentials and logarithms <i>continued</i>	6.7 Understand and use exponential growth and decay; use in modelling (examples may include the use of e in continuous compound interest, radioactive decay, drug concentration decay, exponential growth as a model for population growth); consideration of limitations and refinements of exponential models.	Students may be asked to find the constants used in a model. They need to be familiar with terms such as initial, meaning when $t = 0$. They may need to explore the behaviour for large values of t or to consider whether the range of values predicted is appropriate. Consideration of an improved model may be required.	
7 Differentiation	7.1 Understand and use the derivative of $f(x)$ as the gradient of the tangent to the graph of $y = f(x)$ at a general point (x, y); the gradient of the tangent as a limit; interpretation as a rate of change sketching the gradient function for a given curve second derivatives differentiation from first principles for small positive integer powers of x and for $\sin x$ and $\cos x$	Know that $\frac{dy}{dx}$ is the rate of change of y with respect to x. The notation $f'(x)$ may be used for the first derivative and $f''(x)$ may be used for the second derivative. Given for example the graph of $y = f(x)$, sketch the graph of $y = f'(x)$ using given axes and scale. This could relate speed and acceleration for example. For example, students should be able to use, for $n = 2$ and $n = 3$, the gradient expression $\lim_{h \rightarrow 0} \left(\frac{(x+h)^n - x^n}{h} \right)$ Students may use δx or h	



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Topics	What students need to learn:		
	Content	Guidance	
7 Differentiation <i>continued</i>	7.1 <i>cont.</i> Understand and use the second derivative as the rate of change of gradient; connection to convex and concave sections of curves and points of inflection.	Use the condition $f''(x) > 0$ implies a minimum and $f''(x) < 0$ implies a maximum for points where $f'(x) = 0$ Know that at an inflection point $f''(x)$ changes sign. Consider cases where $f''(x) = 0$ and $f''(x) = 0$ where the point may be a minimum, a maximum or a point of inflection (e.g. $y = x^n, n > 2$)	
	7.2 Differentiate x^n, for rational values of n, and related constant multiples, sums and differences. Differentiate e^{kx} and a^{kx} , $\sin kx$, $\cos kx$, $\tan kx$ and related sums, differences and constant multiples. Understand and use the derivative of $\ln x$	For example, the ability to differentiate expressions such as $(2x + 5)(x - 1)$ and $\frac{x^2 + 3x - 5}{4x^2}, x > 0$, is expected. Knowledge and use of the result $\frac{d}{dx}(a^{kx}) = ka^{kx} \ln a$ is expected.	
	7.3 Apply differentiation to find gradients, tangents and normals maxima and minima and stationary points. points of inflection Identify where functions are increasing or decreasing.	Use of differentiation to find equations of tangents and normals at specific points on a curve. To include applications to curve sketching. Maxima and minima problems may be set in the context of a practical problem. To include applications to curve sketching.	



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Topics	What students need to learn:		
	Content		Guidance
7 Differentiation <i>continued</i>	7.4	Differentiate using the product rule, the quotient rule and the chain rule, including problems involving connected rates of change and inverse functions.	Differentiation of cosec x , cot x and sec x . Differentiation of functions of the form $x = \sin y$, $x = 3 \tan 2y$ and the use of $\frac{dy}{dx} = \frac{1}{\left(\frac{dx}{dy}\right)}$ Use of connected rates of change in models, e.g. $\frac{dV}{dt} = \frac{dV}{dr} \times \frac{dr}{dt}$ Skill will be expected in the differentiation of functions generated from standard forms using products, quotients and composition, such as $2x^4 \sin x$, $\frac{e^{3x}}{x}$, $\cos^2 x$ and $\tan^2 2x$.
	7.5	Differentiate simple functions and relations defined implicitly or parametrically, for first derivative only.	The finding of equations of tangents and normals to curves given parametrically or implicitly is required.
	7.6	Construct simple differential equations in pure mathematics and in context, (contexts may include kinematics, population growth and modelling the relationship between price and demand).	Set up a differential equation using given information. For example: In a simple model, the rate of decrease of the radius of the mint is inversely proportional to the square of the radius.
8 Integration	8.1	Know and use the Fundamental Theorem of Calculus	Integration as the reverse process of differentiation. Students should know that for indefinite integrals a constant of integration is required.
	8.2	Integrate x^n (excluding $n = -1$) and related sums, differences and constant multiples. Integrate e^{kx} , $\frac{1}{x}$, $\sin kx$, $\cos kx$ and related sums, differences and constant multiples.	For example, the ability to integrate expressions such as $\frac{1}{2}x^2 - 3x^{-\frac{1}{2}}$ and $\frac{(x+2)^2}{x^2}$ is expected. Given $f'(x)$ and a point on the curve, students should be able to find an equation of the curve in the form $y = f(x)$. To include integration of standard functions such as $\sin 3x$, $\sec^2 2x$, $\tan x$, e^{5x} , $\frac{1}{2x}$. Students are expected to be able to use trigonometric identities to integrate, for example, $\sin^2 x$, $\tan^2 x$, $\cos^2 3x$.

Inspired

Confident

Ambitious



Exam Specification: Pure

In bold are topics covered in the AS. Pure makes up Papers 1 & 2

Topics	What students need to learn:	
	Content	Guidance
8 Integration <i>continued</i>	8.3	Evaluate definite integrals; use a definite integral to find the area under a curve and the area between two curves Students will be expected to be able to evaluate the area of a region bounded by a curve and given straight lines, or between two curves. This includes curves defined parametrically. For example, find the finite area bounded by the curve $y = 6x - x^2$ and the line $y = 2x$ Or find the finite area bounded by the curve $y = x^2 - 5x + 6$ and the curve $y = 4 - x^2$.
	8.4	Understand and use integration as the limit of a sum. Recognise $\int_a^b f(x) dx = \lim_{\delta x \rightarrow 0} \sum_{x=a}^b f(x) \delta x$
	8.5	Carry out simple cases of integration by substitution and integration by parts; understand these methods as the inverse processes of the chain and product rules respectively (Integration by substitution includes finding a suitable substitution and is limited to cases where one substitution will lead to a function which can be integrated; integration by parts includes more than one application of the method but excludes reduction formulae.) Students should recognise integrals of the form $\int \frac{f'(x)}{f(x)} dx = \ln f(x) + c$. The integral $\int \ln x dx$ is required
	8.6	Integrate using partial fractions that are linear in the denominator. Integration of rational expressions such as those arising from partial fractions, e.g. $\frac{2}{3x+5}$ Note that the integration of other rational expressions, such as $\frac{x}{x^2+5}$ and $\frac{2}{(2x-1)^4}$ is also required (see previous paragraph).



Exam Specification: Pure

In bold are topics covered in the AS. Pure makes up Papers 1 & 2

Topics	What students need to learn:		
	Content		Guidance
8 Integration <i>continued</i>	8.7	Evaluate the analytical solution of simple first order differential equations with separable variables, including finding particular solutions (Separation of variables may require factorisation involving a common factor.)	Students may be asked to sketch members of the family of solution curves.
	8.8	Interpret the solution of a differential equation in the context of solving a problem, including identifying limitations of the solution; includes links to kinematics.	The validity of the solution for large values should be considered.
9 Numerical methods	9.1	Locate roots of $f(x) = 0$ by considering changes of sign of $f(x)$ in an interval of x on which $f(x)$ is sufficiently well behaved. Understand how change of sign methods can fail.	Students should know that sign change is appropriate for continuous functions in a small interval. When the interval is too large sign may not change as there may be an even number of roots. If the function is not continuous, sign may change but there may be an asymptote (not a root).
	9.2	Solve equations approximately using simple iterative methods; be able to draw associated cobweb and staircase diagrams.	Understand that many mathematical problems cannot be solved analytically, but numerical methods permit solution to a required level of accuracy. Use an iteration of the form $x_{n+1} = f(x_n)$ to find a root of the equation $x = f(x)$ and show understanding of the convergence in geometrical terms by drawing cobweb and staircase diagrams.
	9.3	Solve equations using the Newton-Raphson method and other recurrence relations of the form $x_{n+1} = g(x_n)$ Understand how such methods can fail.	For the Newton-Raphson method, students should understand its working in geometrical terms, so that they understand its failure near to points where the gradient is small.



Exam Specification: Pure

In bold are topics covered in the AS. Pure makes up Papers 1 & 2

Topics	What students need to learn:		
	Content		Guidance
9 Numerical methods <i>continued</i>	9.4	Understand and use numerical integration of functions, including the use of the trapezium rule and estimating the approximate area under a curve and limits that it must lie between.	For example, evaluate $\int_0^1 \sqrt{2x+1} \, dx$ using the values of $\sqrt{2x+1}$ at $x = 0, 0.25, 0.5, 0.75$ and 1 and use a sketch on a given graph to determine whether the trapezium rule gives an over-estimate or an under-estimate.
	9.5	Use numerical methods to solve problems in context.	Iterations may be suggested for the solution of equations not soluble by analytic means.
10 Vectors	10.1	Use vectors in two dimensions and in three dimensions	Students should be familiar with column vectors and with the use of $\mathbf{i}$ and $\mathbf{j}$ unit vectors in two dimensions and $\mathbf{i}, \mathbf{j}$ and $\mathbf{k}$ unit vectors in three dimensions.
	10.2	Calculate the magnitude and direction of a vector and convert between component form and magnitude/direction form.	Students should be able to find a unit vector in the direction of $\mathbf{a}$, and be familiar with the notation $\mathbf{a}$.
	10.3	Add vectors diagrammatically and perform the algebraic operations of vector addition and multiplication by scalars, and understand their geometrical interpretations.	The triangle and parallelogram laws of addition. Parallel vectors.
	10.4	Understand and use position vectors; calculate the distance between two points represented by position vectors.	$\vec{OB} - \vec{OA} = \vec{AB} = \mathbf{b} - \mathbf{a}$ The distance d between two points (x_1, y_1) and (x_2, y_2) is given by $d^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2$ In three dimensions, the distance d between two points (x_1, y_1, z_1) and (x_2, y_2, z_2) is given by $d^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2$



Exam Specification: Pure

In bold are topics covered in the AS. Pure makes up Papers 1 & 2

Topics	What students need to learn:		
	Content		Guidance
10 Vectors <i>continued</i>	10.5	Use vectors to solve problems in pure mathematics and in context (including forces).	For example, finding position vector of the fourth corner of a shape (e.g. parallelogram) $ABCD$ with three given position vectors for the corners A, B and C. Contexts such as velocity, displacement, kinematics and forces will be covered in Paper 3, Sections 6.1, 7.3 and 8.1 – 8.4



Exam Specification: Applied

In bold are topics covered in the AS. Applied makes up Paper 3

Topics	What students need to learn:		
	Content		Guidance
1 Statistical sampling	1.1	Understand and use the terms 'population' and 'sample'. Use samples to make informal inferences about the population. Understand and use sampling techniques, including simple random sampling and opportunity sampling. Select or critique sampling techniques in the context of solving a statistical problem, including understanding that different samples can lead to different conclusions about the population.	Students will be expected to comment on the advantages and disadvantages associated with a census and a sample. Students will be expected to be familiar with: simple random sampling, stratified sampling, systematic sampling, quota sampling and opportunity (or convenience) sampling.
2 Data presentation and interpretation	2.1	Interpret diagrams for single-variable data, including understanding that area in a histogram represents frequency. Connect to probability distributions.	Students should be familiar with histograms, frequency polygons, box and whisker plots (including outliers) and cumulative frequency diagrams.

In bold are topics covered in the AS. Applied makes up Paper 3

Topics	What students need to learn:		
		Content	Guidance
2 Data presentation and interpretation <i>continued</i>	2.2	Interpret scatter diagrams and regression lines for bivariate data, including recognition of scatter diagrams which include distinct sections of the population (calculations involving regression lines are excluded). Understand informal interpretation of correlation. Understand that correlation does not imply causation.	Students should be familiar with the terms explanatory (independent) and response (dependent) variables. Use of interpolation and the dangers of extrapolation. Variables other than x and y may be used. Use to make predictions within the range of values of the explanatory variable. Change of variable may be required, e.g. using knowledge of logarithms to reduce a relationship of the form $y = ax^n$ or $y = kb^x$ into linear form to estimate a and n or k and b . Use of terms such as positive, negative, zero, strong and weak are expected.
	2.3	Interpret measures of central tendency and variation, extending to standard deviation. Be able to calculate standard deviation, including from summary statistics.	Data may be discrete, continuous, grouped or ungrouped. Understanding and use of coding. Measures of central tendency: mean, median, mode. Measures of variation: variance, standard deviation, range and interpercentile ranges. Use of linear interpolation to calculate percentiles from grouped data is expected. Students should be able to use the statistic x $S_{xx} = \sum (x - \bar{x})^2 = \sum x^2 - \frac{(\sum x)^2}{n}$ Use of standard deviation = $\sqrt{\frac{S_{xx}}{n}}$ (or equivalent) is expected but the use of $S = \sqrt{\frac{S_{xx}}{n-1}}$ (as used on spreadsheets) will be accepted.



Exam Specification: Applied

In bold are topics covered in the AS. Applied makes up Paper 3

Topics	What students need to learn:		
	Content	Guidance	
2 Data presentation and interpretation <i>continued</i>	2.4	Recognise and interpret possible outliers in data sets and statistical diagrams. Select or critique data presentation techniques in the context of a statistical problem. Be able to clean data, including dealing with missing data, errors and outliers.	Any rule needed to identify outliers will be specified in the question. For example, use of $Q_1 - 1.5 \times \text{IQR}$ and $Q_3 + 1.5 \times \text{IQR}$ or $\text{mean} \pm 3 \times \text{standard deviation}$. Students will be expected to draw simple inferences and give interpretations to measures of central tendency and variation. Significance tests, other than those mentioned in Section 5, will not be expected. For example, students may be asked to identify possible outliers on a box plot or scatter diagram.
	3.1	Understand and use mutually exclusive and independent events when calculating probabilities. Link to discrete and continuous distributions.	Venn diagrams or tree diagrams may be used. Set notation to describe events may be used. Use of $P(B A) = \frac{P(A \cap B)}{P(A)}$, $P(A B) = \frac{P(A \cap B)}{P(B)}$, $P(A \cap B) = P(A)P(B)$ in connection with independent events. No formal knowledge of probability density functions is required but students should understand that area under the curve represents probability in the case of a continuous distribution.
3 Probability	3.2	Understand and use conditional probability, including the use of tree diagrams, Venn diagrams, two-way tables. Understand and use the conditional probability formula $P(A B) = \frac{P(A \cap B)}{P(B)}$	Understanding and use of $P(A') = 1 - P(A),$ $P(A \cup B) = P(A) + P(B) - P(A \cap B),$ $P(A \cap B) = P(A)P(B A).$



Exam Specification: Applied

In bold are topics covered in the AS. Applied makes up Paper 3

Topics	What students need to learn:		
	Content	Guidance	
3 Probability <i>continued</i>	3.3	Modelling with probability, including critiquing assumptions made and the likely effect of more realistic assumptions.	For example, questioning the assumption that a die or coin is fair.
4 Statistical distributions	4.1	Understand and use simple, discrete probability distributions (calculation of mean and variance of discrete random variables is excluded), including the binomial distribution, as a model; calculate probabilities using the binomial distribution.	Students will be expected to use distributions to model a real-world situation and to comment critically on the appropriateness. Students should know and be able to identify the discrete uniform distribution. The notation $X \sim B(n, p)$ may be used. Use of a calculator to find individual or cumulative binomial probabilities.
	4.2	Understand and use the Normal distribution as a model; find probabilities using the Normal distribution Link to histograms, mean, standard deviation, points of inflection and the binomial distribution.	The notation $X \sim N(\mu, \sigma^2)$ may be used. Knowledge of the shape and the symmetry of the distribution is required. Knowledge of the probability density function is not required. Derivation of the mean, variance and cumulative distribution function is not required. Questions may involve the solution of simultaneous equations. Students will be expected to use their calculator to find probabilities connected with the normal distribution. Students should know that the points of inflection on the normal curve are at $x = \mu \pm \sigma$. The derivation of this result is not expected. Students should know that when n is large and p is close to 0.5 the distribution $B(n, p)$ can be approximated by $N(np, np[1 - p])$ The application of a continuity correction is expected.



Exam Specification: Applied

In bold are topics covered in the AS. Applied makes up Paper 3

Topics	What students need to learn:		
	Content		Guidance
4 Statistical distributions <i>continued</i>	4.3	Select an appropriate probability distribution for a context, with appropriate reasoning, including recognising when the binomial or Normal model may not be appropriate.	Students should know under what conditions a binomial distribution or a Normal distribution might be a suitable model.
5 Statistical hypothesis testing	5.1	Understand and apply the language of statistical hypothesis testing, developed through a binomial model: null hypothesis, alternative hypothesis, significance level, test statistic, 1-tail test, 2-tail test, critical value, critical region, acceptance region, p-value; extend to correlation coefficients as measures of how close data points lie to a straight line. and be able to interpret a given correlation coefficient using a given p-value or critical value (calculation of correlation coefficients is excluded).	An informal appreciation that the expected value of a binomial distribution is given by np may be required for a 2-tail test. Students should know that the product moment correlation coefficient r satisfies $r \leq 1$ and that a value of $r = \pm 1$ means the data points all lie on a straight line. Students will be expected to calculate a value of r using their calculator but use of the formula is not required. Hypotheses should be stated in terms of ρ with a null hypothesis of $\rho = 0$ where ρ represents the population correlation coefficient. Tables of critical values or a p-value will be given.



Exam Specification: Applied

In bold are topics covered in the AS. Applied makes up Paper 3

Topics	What students need to learn:		
	Content	Guidance	
5 Statistical hypothesis testing <i>continued</i>	5.2 Conduct a statistical hypothesis test for the proportion in the binomial distribution and interpret the results in context. Understand that a sample is being used to make an inference about the population and appreciate that the significance level is the probability of incorrectly rejecting the null hypothesis.	Hypotheses should be expressed in terms of the population parameter p A formal understanding of Type I errors is not expected.	
	5.3 Conduct a statistical hypothesis test for the mean of a Normal distribution with known, given or assumed variance and interpret the results in context.	Students should know that: If $X \sim N(\mu, \sigma^2)$ then $\bar{X} \sim N\left(\mu, \frac{\sigma^2}{n}\right)$ and that a test for μ can be carried out using: $\frac{\bar{X} - \mu}{\sigma / \sqrt{n}} \sim N(0, 1^2).$ No proofs required. Hypotheses should be stated in terms of the population mean μ . Knowledge of the Central Limit Theorem or other large sample approximations is not required.	
6 Quantities and units in mechanics	6.1 Understand and use fundamental quantities and units in the S.I. system: length, time, mass. Understand and use derived quantities and units: velocity, acceleration, force, weight, moment.	Students may be required to convert one unit into another e.g. km h^{-1} into m s^{-1}	



Exam Specification: Applied

In bold are topics covered in the AS. Applied makes up Paper 3

Topics	What students need to learn:		
	Content	Guidance	
7 Kinematics	7.1	Understand and use the language of kinematics: position; displacement; distance travelled; velocity; speed; acceleration.	Students should know that distance and speed must be positive.
	7.2	Understand, use and interpret graphs in kinematics for motion in a straight line: displacement against time and interpretation of gradient; velocity against time and interpretation of gradient and area under the graph.	Graphical solutions to problems may be required.
	7.3	Understand, use and derive the formulae for constant acceleration for motion in a straight line. Extend to 2 dimensions using vectors.	Derivation may use knowledge of sections 7.2 and/or 7.4 Understand and use suvat formulae for constant acceleration in 2-D, e.g. $\mathbf{v} = \mathbf{u} + \mathbf{at}$, $\mathbf{r} = \mathbf{ut} + \frac{1}{2}\mathbf{at}^2$ with vectors given in $\mathbf{i} - \mathbf{j}$ or column vector form. Use vectors to solve problems.
	7.4	Use calculus in kinematics for motion in a straight line: $\mathbf{v} = \frac{d\mathbf{r}}{dt}, \quad \mathbf{a} = \frac{d\mathbf{v}}{dt} = \frac{d^2\mathbf{r}}{dt^2}$ $\mathbf{r} = \int \mathbf{v} \, dt, \quad \mathbf{v} = \int \mathbf{a} \, dt$ Extend to 2 dimensions using vectors.	The level of calculus required will be consistent with that in Sections 7 and 8 in the Pure Mathematics content. Differentiation and integration of a vector with respect to time. e.g. Given $\mathbf{r} = t^3\mathbf{i} + t^{\frac{3}{2}}\mathbf{j}$, find $\dot{\mathbf{r}}$ and $\ddot{\mathbf{r}}$ at a given time.
	7.5	Model motion under gravity in a vertical plane using vectors; projectiles.	Derivation of formulae for time of flight, range and greatest height and the derivation of the equation of the path of a projectile may be required.



Exam Specification: Applied

In bold are topics covered in the AS. Applied makes up Paper 3

Topics	What students need to learn:		
	Content		Guidance
8 Forces and Newton's laws	8.1	Understand the concept of a force; understand and use Newton's first law.	Normal reaction, tension, thrust or compression, resistance.
	8.2	Understand and use Newton's second law for motion in a straight line (restricted to forces in two perpendicular directions or simple cases of forces given as 2-D vectors); extend to situations where forces need to be resolved (restricted to 2 dimensions).	Problems will involve motion in a straight line with constant acceleration in scalar form, where the forces act either parallel or perpendicular to the motion. Problems may involve motion in a straight line with constant acceleration in vector form, where the forces are given in $\mathbf{i} - \mathbf{j}$ form or as column vectors. Extend to problems where forces need to be resolved, e.g. a particle moving on an inclined plane.
	8.3	Understand and use weight and motion in a straight line under gravity; gravitational acceleration, g , and its value in S.I. units to varying degrees of accuracy. (The inverse square law for gravitation is not required and g may be assumed to be constant, but students should be aware that g is not a universal constant but depends on location.)	The default value of g will be 9.8 m s^{-2} but some questions may specify another value, e.g. $g = 10 \text{ m s}^{-2}$

Exam Specification: Applied

In bold are topics covered in the AS. Applied makes up Paper 3

Topics	What students need to learn:		
	Content		Guidance
8 Forces and Newton's laws <i>continued</i>	8.4	Understand and use Newton's third law; equilibrium of forces on a particle and motion in a straight line (restricted to forces in two perpendicular directions or simple cases of forces given as 2-D vectors); application to problems involving smooth pulleys and connected particles; resolving forces in 2 dimensions; equilibrium of a particle under coplanar forces.	Connected particle problems could include problems with particles in contact e.g. lift problems. Problems may be set where forces need to be resolved, e.g. at least one of the particles is moving on an inclined plane.
	8.5	Understand and use addition of forces; resultant forces; dynamics for motion in a plane.	Students may be required to resolve a vector into two components or use a vector diagram, e.g. problems involving two or more forces, given in magnitude-direction form.
	8.6	Understand and use the $F \leq \mu R$ model for friction; coefficient of friction; motion of a body on a rough surface; limiting friction and statics.	An understanding of $F = \mu R$ when a particle is moving. An understanding of $F \leq \mu R$ in a situation of equilibrium.
9 Moments	9.1	Understand and use moments in simple static contexts.	Equilibrium of rigid bodies. Problems involving parallel and non-parallel coplanar forces, e.g. ladder problems.



Assessment

Content and assessment overview

The Pearson Edexcel Level 3 Advanced GCE in Mathematics consists of three externally-examined papers.

Students must complete all assessment in May/June in any single year.

Paper 1: Pure Mathematics 1 (*Paper code: 9MA0/01)

Paper 2: Pure Mathematics 2 (*Paper code: 9MA0/02)

Each paper is:

2-hour written examination

33.33% of the qualification

100 marks

Content overview

- Topic 1 – Proof
- Topic 2 – Algebra and functions
- Topic 3 – Coordinate geometry in the (x, y) plane
- Topic 4 – Sequences and series
- Topic 5 – Trigonometry
- Topic 6 – Exponentials and logarithms
- Topic 7 – Differentiation
- Topic 8 – Integration
- Topic 9 – Numerical methods
- Topic 10 – Vectors

Assessment overview

- Paper 1 and Paper 2 may contain questions on any topics from the Pure Mathematics content.
- Students must answer all questions.
- Calculators can be used in the assessment.



Assessment

Paper 3: Statistics and Mechanics (*Paper code: 9MA0/03)

2-hour written examination

33.33% of the qualification

100 marks

Content overview

Section A: Statistics

- Topic 1 – Statistical sampling
- Topic 2 – Data presentation and interpretation
- Topic 3 – Probability
- Topic 4 – Statistical distributions
- Topic 5 – Statistical hypothesis testing

Section B: Mechanics

- Topic 6 – Quantities and units in mechanics
- Topic 7 – Kinematics
- Topic 8 – Forces and Newton's laws
- Topic 9 – Moments

Assessment overview

- Paper 3 will contain questions on topics from the Statistics content in Section A and Mechanics content in Section B.
- Students must answer all questions.
- Calculators can be used in the assessment.



Mark Schemes

The following excerpts are taken directly from the mark scheme guidance produced by Edexcel and is useful for students to be familiar with.

The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

These are some of the traditional marking abbreviations that will appear in the mark schemes.

- bod – benefit of doubt
- ft – follow through
- the symbol $\checkmark$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- * The answer is printed on the paper
- ☐ The second mark is dependent on gaining the first mark

Where a candidate has made multiple responses and indicates which response they wish to submit, examiners should mark this response.

If there are several attempts at a question which have not been crossed out, examiners should mark the final answer which is the answer that is the most complete.

Ignore wrong working or incorrect statements following a correct answer.



Mark Schemes

The mark scheme given depends on the question, but the below includes a couple of examples of mark schemes for questions so you can see the format in which they are given.

Question	Scheme	Marks	AOs
1 (a)	$\left\{ \frac{dy}{dx} = \right\} 2x^2 - 7x - 4$	M1 A1	1.1b 1.1b
		(2)	
(b)	Attempts to solve $\left\{ \frac{dy}{dx} = \right\} 2x^2 - 7x - 4 \dots 0$ e.g., $(2x+1)(x-4) = 0$ leading to $x = \dots$ and $x = \dots$	M1	1.1b
	Correct critical values $x = -\frac{1}{2}, 4$	A1	1.1b
	Chooses inside region for their critical values	dM1	1.1b
	Accept either $-\frac{1}{2} < x < 4$ or $-\frac{1}{2} \leq x \leq 4$	A1	1.1b
		(4)	
(6 marks)			
Notes:			
(a)			
M1: Decreases the power of x by one for at least one of their terms. Look for $x^n \rightarrow \dots x^{n-1}$ Allow for $5 \rightarrow 0$			
A1: $\left\{ \frac{dy}{dx} = \right\} 2x^2 - 7x - 4$			
(b)			
M1: Sets their $\frac{dy}{dx} \dots 0$ where $\dots$ may be an equality or an inequality and proceeds to find two values for x from a 3TQ using the usual rules. This may be implied by their critical values.			
A1: Correct critical values $x \dots -\frac{1}{2}, 4$ These may come directly from a calculator and might only be seen on a sketch.			
dM1: Chooses the inside region for their critical values.			
A1: Accept either $-\frac{1}{2} < x < 4$ or $-\frac{1}{2} \leq x \leq 4$ but not, e.g., $-\frac{1}{2} < x \leq 4$ Condone, e.g., $x > -\frac{1}{2}, x < 4$ or $x > -\frac{1}{2}$ and $x < 4$ or $\{x : x > -\frac{1}{2}\} \cap \{x : x < 4\}$ or $x \in \left(-\frac{1}{2}, 4\right)$ or $x \in \left[-\frac{1}{2}, 4\right]$			
Note: You may see $x < -\frac{1}{2}, x < 4$ in their initial work before $-\frac{1}{2} < x < 4$. Condone this so long as it is clear that the $-\frac{1}{2} < x < 4$ is their final answer.			



Mark Schemes

Question	Scheme		Marks	AOs
3(a)	$15 - 3^2 - 2 \times 3 = 0 *$		B1*	1.1b
			(1)	
3(b)	Differentiate v wrt t		M1	2.1
	$-2t - 2$		A1	1.1b
	$8 \text{ (m s}^{-2}\text{)}$		A1	1.1b
			(3)	
3(c)	Integrate v w.r.t. t		M1	1.1b
	$15t - \frac{1}{3}t^3 - t^2$		A1	1.1b
	Total distance = $\left[15t - \frac{1}{3}t^3 - t^2\right]_0^3 - \left[15t - \frac{1}{3}t^3 - t^2\right]_3^4$ OR $s_3 + (s_3 - s_4)$ where s_3 means the value of their integral when $t = 3$. N.B. Allow the negative of this.		M1	3.1a
	$\frac{94}{3} \text{ (m)}$		A1	1.1b
			(4)	
(8 marks)				
Notes:				
3a	B1*	Correct expression, correctly evaluated to give 0 OR $0 = 15 - t^2 - 2t$ $t = 3$		
3b	M1	Differentiate v , with at least two powers decreasing by 1		
	A1	Correct expression		
	A1	cao (must be positive)		
		N.B. If they give 8 as their answer, without any working, this can score all 3 marks.		
3c	M1	Integrate v , with at least two powers increasing by 1 (allow if only two terms integrated) .		
	A1	Correct expression. Ignore (+ C)		
	M1	Complete method to find the total distance or displacement		
	A1	Accept 31(m) or better, must be positive		
		N.B. If the indefinite integral $(15t - \frac{1}{3}t^3 - t^2)$ is never seen, they score nothing, even if the correct answer appears, as this indicates they have used a calculator to do the whole question.		



Key Formulae

Formulae that students are expected to know for A Level Mathematics are given below and will not appear in the booklet *Mathematical Formulae and Statistical Tables*, which will be provided for use with the paper.

Pure Mathematics

Quadratic Equations

$$ax^2 + bx + c = 0 \text{ has roots } \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Laws of Indices

$$a^x a^y = a^{x+y}$$

$$a^x \div a^y = a^{x-y}$$

$$(a^x)^y = a^{xy}$$

Laws of Logarithms

$$x = a^n \Leftrightarrow n = \log_a x \text{ for } a > 0 \text{ and } x > 0$$

$$\log_a x + \log_a y = \log_a (xy)$$

$$\log_a x - \log_a y = \log_a \left(\frac{x}{y} \right)$$

$$k \log_a x = \log_a (x^k)$$

Coordinate Geometry

A straight line graph, gradient m passing through (x_1, y_1) has equation $y - y_1 = m(x - x_1)$

Straight lines with gradients m_1 and m_2 are perpendicular when $m_1 m_2 = -1$

Sequences

General term of an arithmetic progression:

$$u_n = a + (n-1)d$$

General term of a geometric progression:

$$u_n = ar^{n-1}$$



Key Formulae

Trigonometry

In the triangle ABC

$$\text{Sine rule: } \frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\text{Cosine rule: } a^2 = b^2 + c^2 - 2bc \cos A$$

$$\text{Area} = \frac{1}{2}ab \sin C$$

$$\cos^2 A + \sin^2 A = 1$$

$$\sec^2 A = 1 + \tan^2 A$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

$$\sin 2A = 2 \sin A \cos A$$

$$\cos 2A = \cos^2 A - \sin^2 A$$

$$\tan 2A = \frac{2 \tan A}{1 - \tan^2 A}$$

Mensuration

Circumference and area of circle, radius r and diameter d :

$$C = 2\pi r = \pi d \quad A = \pi r^2$$

Pythagoras' theorem:

In any right-angled triangle where a , b and c are the lengths of the sides and c is the hypotenuse, $c^2 = a^2 + b^2$

Area of a trapezium = $\frac{1}{2}(a + b)h$, where a and b are the lengths of the parallel sides and h is their perpendicular separation.

Volume of a prism = area of cross section $\times$ length

For a circle of radius r , where an angle at the centre of θ radians subtends an arc of length s and encloses an associated sector of area A :

$$s = r\theta \quad A = \frac{1}{2}r^2\theta$$



Key Formulae

Calculus and Differential Equations

Differentiation

Function Derivative

$$x^n \quad nx^{n-1}$$

$$\sin kx \quad k \cos kx$$

$$\cos kx \quad -k \sin kx$$

$$e^{kx} \quad ke^{kx}$$

$$\ln x \quad \frac{1}{x}$$

$$f(x) + g(x) \quad f'(x) + g'(x)$$

$$f(x)g(x) \quad f'(x)g(x) + f(x)g'(x)$$

$$f(g(x)) \quad f'(g(x))g'(x)$$

Integration

Function Integral

$$x^n \quad \frac{1}{n+1} x^{n+1} + c, \quad n \neq -1$$

$$\cos kx \quad \frac{1}{k} \sin kx + c$$

$$\sin kx \quad -\frac{1}{k} \cos kx + c$$

$$e^{kx} \quad \frac{1}{k} e^{kx} + c$$

$$\frac{1}{x} \quad \ln|x| + c, \quad x \neq 0$$

$$f'(x) + g'(x) \quad f(x) + g(x) + c$$

$$f'(g(x))g'(x) \quad f(g(x)) + c$$

$$\text{Area under a curve} = \int_a^b y \, dx \quad (y \geq 0)$$

Vectors

$$|xi + yj + zk| = \sqrt{x^2 + y^2 + z^2}$$

Statistics

$$\text{The mean of a set of data: } \bar{x} = \frac{\sum x}{n} = \frac{\sum fx}{\sum f}$$

$$\text{The standard Normal variable: } Z = \frac{X - \mu}{\sigma}$$

$$\text{where } X \sim N(\mu, \sigma^2)$$

Mechanics

Forces and Equilibrium

$$\text{Weight} = \text{mass} \times g$$

$$\text{Friction: } F \leq \mu R$$

$$\text{Newton's second law in the form: } F = ma$$

Kinematics

For motion in a straight line with variable acceleration:

$$v = \frac{dr}{dt} \quad a = \frac{dv}{dt} = \frac{d^2r}{dt^2}$$

$$r = \int v \, dt \quad v = \int a \, dt$$



Home-learning & Independent Work

Objectives of a Sixth Form Home-learning Policy

Objectives of a John Roan Sixth Form Homework policy are as follows:

- To enable our students to achieve the best grades that they are capable of at Post-16 through:
 - The consolidation and revision of learned material
 - The application of learned material
 - Preparation for lessons to enable access to challenging subject content
- To reinforce high expectations of our students as independent learners
- To equip our students with the study skills required for University and other destinations

Expectation of subject homework

At The John Roan Sixth Form we aim to teach students to become independent learners who use their private study time effectively. Students will be given guidance and support with creating revision schedules, effective note taking, essay writing and academic literacy, but will also be expected to practise and demonstrate these in their home learning.

As a benchmark, students should expect to receive an amount of homework per subject that is equivalent to twice the number of contact hours that they receive in school: six hours per subject which amounts to 18 hours per week.

Deadlines

Failure to meet deadlines for homework will result in a one-hour detention after school the following day, while repeated failures to meet homework deadline will escalate to an academic support plan or school-based exclusion. Students who are placed into detention will still be expected to complete missed homework. Students are encouraged to communicate with teachers about other deadlines in place so that they can be supportive of work set in other subjects.

Homework setting

All homework will be set for students using Show My Homework which is available as an app which can be accessed via a mobile phone, or as a website that can be accessed via a computer. In some instances, homework will be set on software including Microsoft Teams. However, instructions for any homework set on these platforms will be repeated on Show My Homework to ensure consistency.



Home-learning & Independent Work

Examples of home-learning set at KS5 in A-Level Maths will typically include 4 features to support your learning:

Fluency	Exam Practice
- Practicing the key skills we have developed in lessons. - This is usually practice from the textbook, supplemented with additional resources as required. 	- Familiarizing yourself with exam questions in key for building success and confidence. - Each week you will complete a small number of exam questions on recent and previous topics. 
Problem Solving	Revision Notes
- THE most important skill in A Level maths is problem solving. - These will vary a lot but include maths riddles, University Admissions Tests Questions, UKMT Maths Challenge questions, random problems we find! 	- Oftentimes people think revision notes aren't needed in maths, but this is not the case. - As such we model, structure and scaffold the production of revision notes on all units of work when completed. 

Independent practice in class

In addition to independent practice given as home-learning, students can expect to complete independent practice questions within lessons where appropriate. This may be in the form of textbook practice questions and/or exam-style questions. Students should expect to encounter a range of question styles and formats and should become familiar with the structure and conventions of Edexcel A-level Mathematics exam questions. Regular independent practice will help students develop confidence, accuracy and fluency in applying their mathematical knowledge.



How to get an A*

1. Attendance and punctuality

The best way to succeed in Maths is to be present, and on time, in lesson with your teacher and accessing the materials and teaching. If there is a reason for your absence, you must catch up with the work as soon as possible by using the links on SharePoint. Ensure you let your teacher know.

2. Home-learning

The homework that will be set each week is directly related to the content that you need to study but also the skills you need to master to access the exam. It is very important therefore that you complete this to a high level. If you use online solution banks to support you, ensure this is clear in your working (i.e. write in green pen) and that you are confident you can redo the question(s) independently following it. Blindly copying homework will not help!

3. High quality revision and retrieval

Learning requires a change in long-term memory. This means you must regularly review the content that you have studied in class at regular intervals. We support this through our setting of homework, but it is important you supplement this with your own independent learning and practice.

4. Test corrections & reflections (DIRT)

"You do not learn from experience; you learn from reflecting on experience" – John Dewey. This is true in all forms of life, including maths A Level. Just completing an exam is not enough, you must really engage in the subsequent DIRT lesson following this and hone your reflection skills.

5. Don't be afraid to be wrong

Often students think the best mathematician is the one who is never wrong. But this is not the case. It's the one who always tries and never gives up. If you're given difficult problems, have a go! It's only through practice, exposure and reflection that you will improve.



Essential Resources

Websites

amsp.org.uk

This website has LOTS of maths practice including a useful section on 'Essential Skills' when preparing for the jump from GCSE to A Level

physicsandmathstutor.com

This website gives you access to lots of different past papers and mark schemes for your own revision

[Sharepoint: Maths Folder](#)

In the Maths folder on SharePoint we have resources for all lessons, including links to videos for support

Videos

[Mr Bicen Maths \(YouTube\)](#)

This YouTube channel (made by a teacher Ms Dryden used to work with!) is a fantastic resource. It talks through every topic across the A Level course with clear explanations and examples.

[Numberphile \(YouTube\)](#)

This YouTube channel has hundreds of videos about quirky maths and mathematicians. It's a great place to find fascinating maths stories to make you really think!

Social Media

There are loads of interesting maths accounts on social media.

Some that are great for revision and learning support.

Some that share cool maths problems and interesting conundrums.

Whenever you come across one, 'like' it so the algorithm knows to give you more!
(And show it to your maths teacher...you know they'll appreciate it!)



University Courses & Career Paths



Transferrable skills

**Analytical Thinking
Critical Reasoning
Problem Solving**

**Numerical Proficiency
Logical Reasoning
Attention to Detail**

**Data Analysis
Pattern Analysis
More Problem Solving!**



University Courses – Have a go at researching...

Mathematics

Computer Science

Engineering

Economics / Finance

Mathematics and Philosophy



Career Paths

Mathematician / Maths Teacher

Statistician

Operations Research

Actuary / Accounting

Economist / Financial Analyst

Data Scientist

Civil / Mechanical / Aerospace Engineer

Cryptographer

Software Engineer

Inspired

Confident

Ambitious



Key Contacts and FAQ's

Key Contacts

Head of Maths: Ben Farren

A-level Maths contacts: Ben Farren and Callum Sawdy

Email addresses:

Ben.Farren@thejohnroanschool.org.uk

Callum.Sawdy@thejohnroanschool.org.uk

Frequently asked questions

1. What are the biggest challenges in A-level Maths? A-level Maths is a big step-up from GCSE. The topics are more complex and require a greater depth of understanding. The volume of content requires students to be committed and demonstrate consistent effort.
2. How do I revise for A-level Maths? Firstly, it is imperative that you attend *a//* lessons and complete all home-learning. The principles of retrieval and memory apply to Maths too, so you should review content taught in class at regular intervals. Create high-quality revision materials and use them to learn and recall key information, such as formulae. Regularly practising exam-style questions will help you identify what you do and don't understand, while exposing you to the range of question types you may encounter in exams. You should also make full use of the tools provided and become familiar with your calculator, formula booklet and the Large Data Set.
3. What is the large data set? The Large Data Set (LDS) is a spreadsheet containing real-world weather data from the Met Office, which you will use in Statistics lessons to practise applied statistical techniques. You do not need to memorise the entire LDS, but you should be familiar with the locations of the weather stations, the time periods covered, the main variables and their corresponding units. In the Applied paper, exam questions may refer to these features, or data from the LDS may be provided as part of a question.
4. How can my parents support me with A-level Maths? Parents can support by encouraging good attendance, punctuality and the completion of home learning to a high standard. They can also help you establish a regular revision routine and communicate with teachers about your progress or any concerns.