



The John Roan School Sixth Form

The best in everyone™

Part of United Learning

A-Level Further Maths

Student Handbook

Exam board: Edexcel

Course code: 9FM0

Contents

Curriculum	Page 3
Work Organisation	Page 6
Specification	
Core Pure	Page 7
Applied	Page 18
Assessment	Page 23
Mark schemes	Page 27
Key Formulae	Page 30
Homework & Independent Learning	Page 35
How to get an A*	Page 37
Essential resources	Page 38
University courses and careers	Page 39
Key contacts and FAQ's	Page 40

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 Further 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:

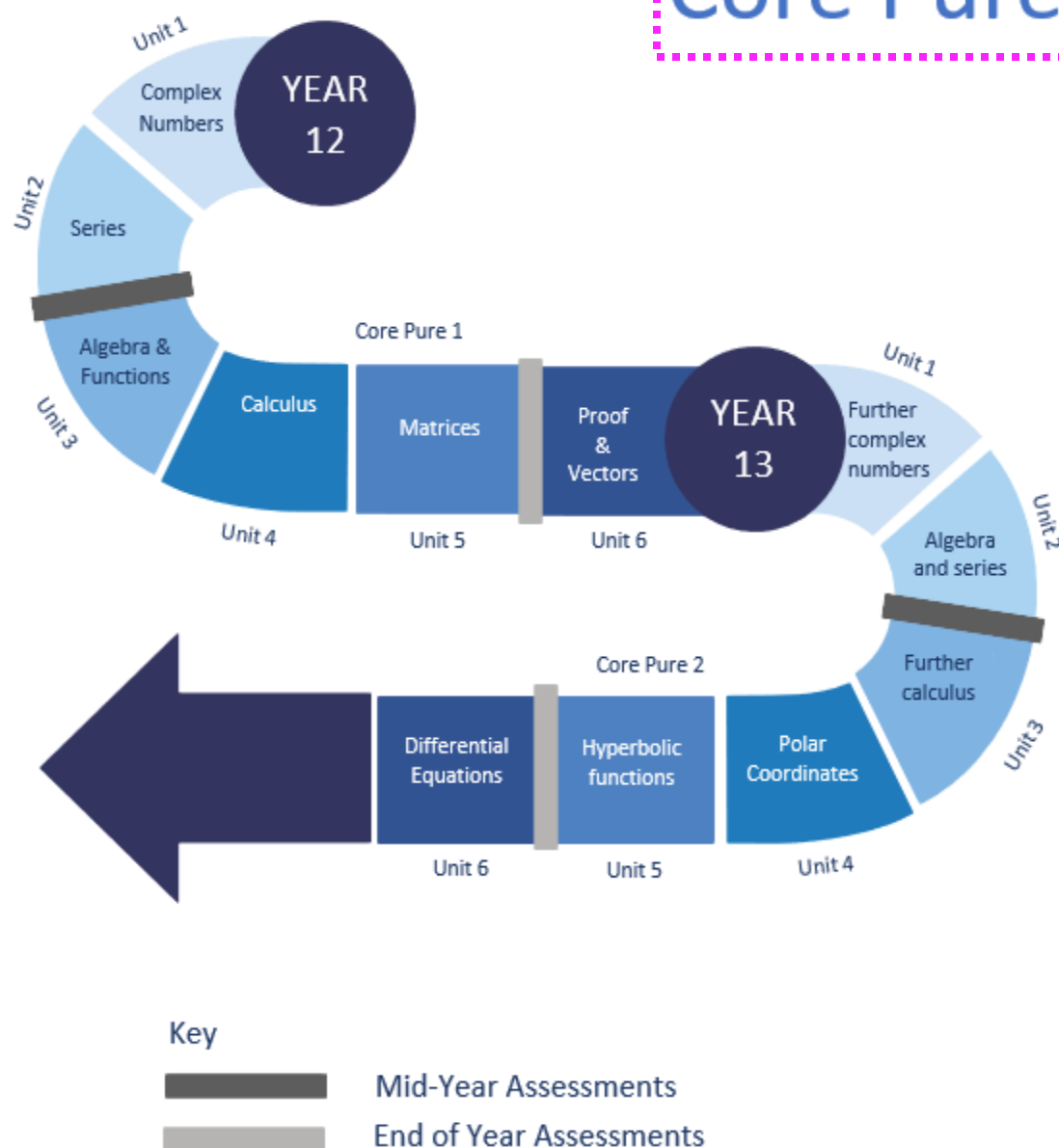
- **Entitlement:** All pupils in maths are exposed to problem solving and rich problems from the very first maths lesson until the last. We teach in the hope that all students will continue with maths in some form at university or career. This ensures that all pupils can access all areas of maths and 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.



Further Maths

Key Stage 5

Core Pure



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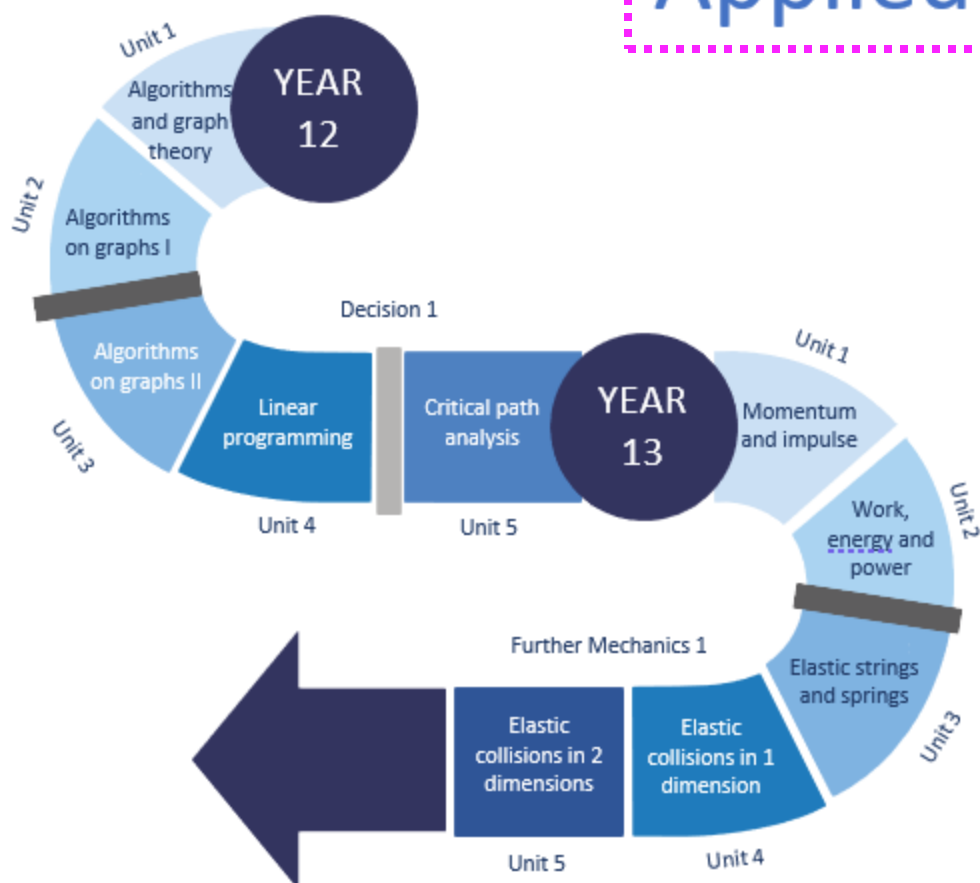


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Further Maths

Key Stage 5

Applied



Key



Mid-Year Assessments

End of Year Assessments

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How we organise our work in A-Level Further 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: Core Pure

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

Topic	What students need to learn:		
	Content		Guidance
1 Proof	1.1	Construct proofs using mathematical induction. Contexts include sums of series, divisibility and powers of matrices.	To include induction proofs for (i) summation of series e.g. show $\sum_{r=1}^n r^3 = \frac{1}{4}n^2(n+1)^2$ or show $\sum_{r=1}^n r(r+1) = \frac{n(n+1)(n+2)}{3}$ (ii) divisibility e.g. show $3^{2n} + 11$ is divisible by 4 (iii) matrix products e.g. show $\begin{pmatrix} 3 & -4 \\ 1 & -1 \end{pmatrix}^n = \begin{pmatrix} 2n+1 & -4n \\ n & 1-2n \end{pmatrix}$
2 Complex numbers	2.1	Solve any quadratic equation with real coefficients. Solve cubic or quartic equations with real coefficients.	Given sufficient information to deduce at least one root for cubics or at least one complex root or quadratic factor for quartics, for example: (i) $f(z) = 2z^3 + 5z^2 + 7z + 10$ Given that $z + 2$ is a factor of $f(z)$, use algebra to solve $f(z) = 0$ completely. (ii) $g(x) = x^4 - x^3 + 6x^2 + 14x - 20$ Given $g(1) = 0$ and $g(-2) = 0$, use algebra to solve $g(x) = 0$ completely.
	2.2	Add, subtract, multiply and divide complex numbers in the form $x + iy$ with x and y real. Understand and use the terms 'real part' and 'imaginary part'.	Students should know the meaning of the terms, 'modulus' and 'argument'.



Exam Specification: Core Pure

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

Topic	What students need to learn:		
	Content	Guidance	
2 Complex numbers <i>continued</i>	2.3	Understand and use the complex conjugate. Know that non-real roots of polynomial equations with real coefficients occur in conjugate pairs.	Knowledge that if z_1 is a root of $f(z) = 0$ then z_1^* is also a root.
	2.4	Use and interpret Argand diagrams.	Students should be able to represent the sum or difference of two complex numbers on an Argand diagram.
	2.5	Convert between the Cartesian form and the modulus-argument form of a complex number.	Knowledge of radians is assumed.
	2.6	Multiply and divide complex numbers in modulus argument form.	Knowledge of the results $ z_1 z_2 = z_1 z_2 , \quad \left \frac{z_1}{z_2} \right = \frac{ z_1 }{ z_2 }$ $\arg(z_1 z_2) = \arg z_1 + \arg z_2$ $\arg\left(\frac{z_1}{z_2}\right) = \arg z_1 - \arg z_2$ Knowledge of radians and compound angle formulae is assumed.
	2.7	Construct and interpret simple loci in the argand diagram such as $z - a > r$ and $\arg(z - a) = \theta$.	To include loci such as $z - a = b$, $z - a = z - b$, $\arg(z - a) = \beta$, and regions such as $z - a \leq z - b$, $z - a \leq b$, $\alpha < \arg(z - a) < \beta$ Knowledge of radians is assumed.



Exam Specification: Core Pure

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

Topic	What students need to learn:		
	Content	Guidance	
2 Complex numbers <i>continued</i>	2.8	Understand de Moivre's theorem and use it to find multiple angle formulae and sums of series.	To include using the results, $z + \frac{1}{z} = 2 \cos \theta$ and $z - \frac{1}{z} = 2i \sin \theta$ to find $\cos p\theta, \sin q\theta$ and $\tan r\theta$ in terms of powers of $\sin \theta, \cos \theta$ and $\tan \theta$ and powers of $\sin \theta, \cos \theta$ and $\tan \theta$ in terms of multiple angles. For sums of series, students should be able to show that, for example, $1 + z + z^2 + \dots + z^{n-1} = 1 + i \cot \left(\frac{\pi}{2n} \right)$ where $z = \cos \left(\frac{\pi}{n} \right) + i \sin \left(\frac{\pi}{n} \right)$ and n is a positive integer.
	2.9	Know and use the definition $e^{i\theta} = \cos \theta + i \sin \theta$ and the form $z = re^{i\theta}$	Students should be familiar with $\cos \theta = \frac{1}{2}(e^{i\theta} + e^{-i\theta}) \text{ and}$ $\sin \theta = \frac{1}{2i}(e^{i\theta} - e^{-i\theta})$
	2.10	Find the n distinct n th roots of $re^{i\theta}$ for $r \neq 0$ and know that they form the vertices of a regular n -gon in the Argand diagram.	
	2.11	Use complex roots of unity to solve geometric problems.	
3 Matrices	3.1	Add, subtract and multiply conformable matrices. Multiply a matrix by a scalar.	
	3.2	Understand and use zero and identity matrices.	



Exam Specification: Core Pure

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

Topic	What students need to learn:		
	Content	Guidance	
3 Matrices <i>continued</i>	3.3	Use matrices to represent linear transformations in 2-D. Successive transformations. Single transformations in 3-D.	For 2-D, identification and use of the matrix representation of single and combined transformations from: reflection in coordinate axes and lines $y = \pm x$, rotation through any angle about $(0, 0)$, stretches parallel to the x-axis and y-axis, and enlargement about centre $(0, 0)$, with scale factor k, ($k \neq 0$), where $k \in \mathbb{R}$. Knowledge that the transformation represented by AB is the transformation represented by B followed by the transformation represented by A. 3-D transformations confined to reflection in one of $x = 0$, $y = 0$, $z = 0$ or rotation about one of the coordinate axes. Knowledge of 3-D vectors is assumed.
	3.4	Find invariant points and lines for a linear transformation.	For a given transformation, students should be able to find the coordinates of invariant points and the equations of invariant lines.
	3.5	Calculate determinants of 2×2 and 3×3 matrices and interpret as scale factors, including the effect on orientation.	Idea of the determinant as an area scale factor in transformations.
	3.6	Understand and use singular and non-singular matrices. Properties of inverse matrices. Calculate and use the inverse of non-singular 2×2 matrices and 3×3 matrices.	Understanding the process of finding the inverse of a matrix is required. Students should be able to use a calculator to calculate the inverse of a matrix.



Exam Specification: Core Pure

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

Topic	What students need to learn:		
	Content	Guidance	
3 Matrices <i>continued</i>	3.7	Solve three linear simultaneous equations in three variables by use of the inverse matrix.	
	3.8	Interpret geometrically the solution and failure of solution of three simultaneous linear equations.	Students should be aware of the different possible geometrical configurations of three planes, including cases where the planes, (i) meet in a point (ii) form a sheaf (iii) form a prism or are otherwise inconsistent
4 Further algebra and functions	4.1	Understand and use the relationship between roots and coefficients of polynomial equations up to quartic equations.	For example, given a cubic polynomial equation with roots α, β and γ students should be able to evaluate expressions such as, (i) $\alpha^2 + \beta^2 + \gamma^2$ (ii) $\frac{1}{\alpha} + \frac{1}{\beta} + \frac{1}{\gamma}$ (iii) $(3 + \alpha)(3 + \beta)(3 + \gamma)$ (iv) $\alpha^3 + \beta^3 + \gamma^3$
	4.2	Form a polynomial equation whose roots are a linear transformation of the roots of a given polynomial equation (of at least cubic degree).	
	4.3	Understand and use formulae for the sums of integers, squares and cubes and use these to sum other series.	For example, students should be able to sum series such as $\sum_{r=1}^n r^2(r+2)$



Exam Specification: Core Pure

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

Topic	What students need to learn:		
	Content	Guidance	
4 Further algebra and functions <i>continued</i>	4.4	Understand and use the method of differences for summation of series including use of partial fractions.	Students should be able to sum series such as $\sum_{r=1}^n \frac{1}{r(r+1)}$ by using partial fractions such as $\frac{1}{r(r+1)} = \frac{1}{r} - \frac{1}{r+1}$
	4.5	Find the Maclaurin series of a function including the general term.	
	4.6	Recognise and use the Maclaurin series for e^x , $\ln(1+x)$, $\sin x$, $\cos x$ and $(1+x)^n$, and be aware of the range of values of x for which they are valid (proof not required).	To include the derivation of the series expansions of compound functions.
5 Further calculus	5.1	Derive formulae for and calculate volumes of revolution.	Both $\pi \int y^2 dx$ and $\pi \int x^2 dy$ are required . Students should be able to find a volume of revolution given either Cartesian equations or parametric equations.
	5.2	Evaluate improper integrals where either the integrand is undefined at a value in the range of integration or the range of integration extends to infinity.	For example, $\int_0^\infty e^{-x} dx$, $\int_0^2 \frac{1}{\sqrt{x}} dx$
	5.3	Understand and evaluate the mean value of a function.	Students should be familiar with the mean value of a function $f(x)$ as, $\frac{1}{b-a} \int_a^b f(x) dx$
	5.4	Integrate using partial fractions.	Extend to quadratic factors $ax^2 + c$ in the denominator

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Exam Specification: Core Pure

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

Topic	What students need to learn:		
	Content	Guidance	
5 Further calculus <i>continued</i>	5.5	Differentiate inverse trigonometric functions.	For example, students should be able to differentiate expressions such as, $\arcsin x + x\sqrt{1-x^2}$ and $\frac{1}{2}\arctan x^2$
	5.6	Integrate functions of the form $(a^2 - x^2)^{-\frac{1}{2}}$ and $(a^2 - x^2)^{-1}$ and be able to choose trigonometric substitutions to integrate associated functions.	
6 Further vectors	6.1	Understand and use the vector and Cartesian forms of an equation of a straight line in 3-D.	The forms, $\mathbf{r} = \mathbf{a} + \lambda\mathbf{b}$ and $\frac{x-a_1}{b_1} = \frac{x-a_2}{b_2} = \frac{x-a_3}{b_3}$ Find the point of intersection of two straight lines given in vector form. Students should be familiar with the concept of skew lines and parallel lines.
	6.2	Understand and use the vector and Cartesian forms of the equation of a plane.	The forms $\mathbf{r} = \mathbf{a} + \lambda\mathbf{b} + \mu\mathbf{c}$ and $ax + by + cz = d$
	6.3	Calculate the scalar product and use it to express the equation of a plane, and to calculate the angle between two lines, the angle between two planes and the angle between a line and a plane.	$\mathbf{a} \cdot \mathbf{b} = \mathbf{a} \mathbf{b} \cos \theta$ The form $\mathbf{r} \cdot \mathbf{n} = k$ for a plane.
	6.4	Check whether vectors are perpendicular by using the scalar product.	Knowledge of the property that $\mathbf{a} \cdot \mathbf{b} = 0$ if the vectors $\mathbf{a}$ and $\mathbf{b}$ are perpendicular.



Exam Specification: Core Pure

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Topic	What students need to learn:		
	Content	Guidance	
6 Further vectors <i>continued</i>	6.5	Find the intersection of a line and a plane. Calculate the perpendicular distance between two lines, from a point to a line and from a point to a plane.	The perpendicular distance from (α, β, γ) to $n_1x + n_2y + n_3z + d = 0$ is $\frac{ n_1\alpha + n_2\beta + n_3\gamma + d }{\sqrt{n_1^2 + n_2^2 + n_3^2}}$
	7.1	Understand and use polar coordinates and be able to convert between polar and Cartesian coordinates.	
7 Polar coordinates	7.2	Sketch curves with r given as a function of θ , including use of trigonometric functions.	The sketching of curves such as $r = p \sec(\alpha - \theta)$, $r = a$, $r = 2a \cos\theta$, $r = k\theta$, $r = a(1 \pm \cos\theta)$, $r = a(3 + 2 \cos\theta)$, $r = a \cos 2\theta$ and $r^2 = a^2 \cos 2\theta$ may be set.
	7.3	Find the area enclosed by a polar curve.	Use of the formula $\frac{1}{2} \int_{\alpha}^{\beta} r^2 d\theta$ for area. The ability to find tangents parallel to, or at right angles to, the initial line is expected.
8 Hyperbolic functions	8.1	Understand the definitions of hyperbolic functions $\sinh x$, $\cosh x$ and $\tanh x$, including their domains and ranges, and be able to sketch their graphs.	For example, $\cosh x = \frac{1}{2}(e^x + e^{-x})$
	8.2	Differentiate and integrate hyperbolic functions.	For example, differentiate $\tanh 3x$, $x \sinh^2 x$, $\frac{\cosh 2x}{\sqrt{x+1}}$



Exam Specification: Core Pure

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

Topic	What students need to learn:		
	Content	Guidance	
8 Hyperbolic functions <i>continued</i>	8.3	Understand and be able to use the definitions of the inverse hyperbolic functions and their domains and ranges.	$\operatorname{arsinh} x = \ln \left[x + \sqrt{x^2 + 1} \right]$ $\operatorname{arcosh} x = \ln \left[x + \sqrt{x^2 - 1} \right], \quad x \geq 1$ $\operatorname{artanh} x = \frac{1}{2} \ln \left[\frac{1+x}{1-x} \right], \quad -1 < x < 1$
	8.4	Derive and use the logarithmic forms of the inverse hyperbolic functions.	
	8.5	Integrate functions of the form $(x^2 + a^2)^{-\frac{1}{2}}$ and $(x^2 - a^2)^{-\frac{1}{2}}$ and be able to choose substitutions to integrate associated functions.	
9 Differential equations	9.1	Find and use an integrating factor to solve differential equations of form $\frac{dy}{dx} + P(x)y = Q(x)$ and recognise when it is appropriate to do so.	The integrating factor $e^{\int P(x)dx}$ may be quoted without proof.
	9.2	Find both general and particular solutions to differential equations.	Students will be expected to sketch members of the family of solution curves.
	9.3	Use differential equations in modelling in kinematics and in other contexts.	
	9.4	Solve differential equations of form $y'' + ay' + by = 0$ where a and b are constants by using the auxiliary equation.	



Exam Specification: Core Pure

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Topic	What students need to learn:		
	Content	Guidance	
9 Differential equations continued	9.5	Solve differential equations of form $y'' + ay' + by = f(x)$ where a and b are constants by solving the homogeneous case and adding a particular integral to the complementary function (in cases where $f(x)$ is a polynomial, exponential or trigonometric function).	$f(x)$ will have one of the forms ke^{px} , $A + Bx$, $p + qx + cx^2$ or $m \cos \omega x + n \sin \omega x$
	9.6	Understand and use the relationship between the cases when the discriminant of the auxiliary equation is positive, zero and negative and the form of solution of the differential equation.	
	9.7	Solve the equation for simple harmonic motion $\ddot{x} = -\omega^2 x$ and relate the solution to the motion.	
	9.8	Model damped oscillations using second order differential equations and interpret their solutions.	Damped harmonic motion, with resistance varying as the derivative of the displacement, is expected. Problems may be set on forced vibration.

Exam Specification: Core Pure

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

Topic	What students need to learn:		
	Content		Guidance
9 Differential equations <i>continued</i>	9.9	Analyse and interpret models of situations with one independent variable and two dependent variables as a pair of coupled first order simultaneous equations and be able to solve them, for example predator-prey models.	Restricted to coupled first order linear equations of the form, $\frac{dx}{dt} = ax + by + f(t)$ $\frac{dy}{dt} = cx + dy + g(t)$



Exam Specification: Further Pure 1

In bold are topics covered in AS. FP1 is 1 of 2 applied modules you will study.

Paper 3A: Further Pure Mathematics 1

Topics	What students need to learn:		
	Content		Guidance
1 Further Trigonometry	1.1	The t-formulae	The derivation and use of $\sin \theta = \frac{2t}{1+t^2}, \cos \theta = \frac{1-t^2}{1+t^2},$ $\tan \theta = \frac{2t}{1-t^2}, \text{ where } t = \tan \frac{\theta}{2}$
	1.2	Applications of t-formulae to trigonometric identities	E.g. show that $\frac{1 + \operatorname{cosec} \theta}{\cot \theta} = \frac{1 + \tan \frac{\theta}{2}}{1 - \tan \frac{\theta}{2}}$
	1.3	Applications of t-formulae to solve trigonometric equations	E.g. the solution of equations of the form $a \cos x + b \sin x = c$
2 Further calculus	2.1	Derivation and use of Taylor series.	The derivation, for example, of the expansion of $\sin x$ in ascending powers of $(x - \pi)$ up to and including the term in $(x - \pi)^3$.
	2.2	Use of series expansions to find limits.	E.g. $\lim_{x \rightarrow 0} \frac{x - \arctan x}{x^3}, \lim_{x \rightarrow 0} \frac{e^{2x^2} - 1}{x^2}$
	2.3	Leibnitz's theorem.	Leibnitz's theorem for differentiating products.
	2.4	L'Hospital's Rule.	The use of derivatives to evaluate limits of indeterminate forms. Repeated applications and/or substitutions may be required. E.g. $\lim_{x \rightarrow 0} \frac{2 \sin x - \sin 2x}{x - \sin x}, \lim_{x \rightarrow \infty} \left(1 + \frac{a}{x}\right)^x$



Exam Specification: Further Pure 1

In bold are topics covered in AS. FP1 is 1 of 2 applied modules you will study.

Topics	What students need to learn:		
	Content	Guidance	
2 Further calculus <i>continued</i>	2.5	The Weierstrass substitution for integration.	The use of tangent half angle substitutions to find definite and indefinite integrals. E.g. $\int \operatorname{cosec} x \, dx$, $\int_{\frac{\pi}{3}}^{\frac{\pi}{2}} \frac{1}{1 + \sin x - \cos x} \, dx$ using $t = \tan \frac{x}{2}$.
3 Further differential equations	3.1	Use of Taylor series method for series solution of differential equations.	For example, derivation of the series solution in powers of x , as far as the term in x^4 , of the differential equation $\frac{d^2 y}{dx^2} + x \frac{dy}{dx} + y = 0,$ where $y = 1, \frac{dy}{dx} = 0$ at $x = 0$
	3.2	Differential equations reducible by means of a given substitution.	Differential equations reducible to the types as specified in section 9 of the A level Further Pure Mathematics content for papers 1 and 2.
4 Coordinate systems	4.1	Cartesian and parametric equations for the parabola and rectangular hyperbola , ellipse and hyperbola.	Students should be familiar with the equations: $y^2 = 4ax$; $x = at^2$, $y = 2at$ $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$; $x = a \cos t$, $y = b \sin t$. $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$; $x = a \sec t$, $y = b \tan t$, $x = a \cosh t$, $y = b \sinh t$
	4.2	The focus-directrix properties of the parabola , ellipse and hyperbola, including the eccentricity.	For example, students should know that, for the ellipse $b^2 = a^2(1 - e^2)$, the foci are $(ae, 0)$ and $(-ae, 0)$ and the equations of the directrices are $x = +\frac{a}{e}$ and $x = -\frac{a}{e}$
	4.3	Tangents and normals to these curves.	The condition for $y = mx + c$ to be a tangent to these curves is expected to be known. Students are expected to be able to use algebraic differentiation to find $\frac{dy}{dx}$ for these curves.
	4.4	Loci problems.	

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Exam Specification: Further Pure 1

In bold are topics covered in AS. FP1 is 1 of 2 applied modules you will study.

Topics	What students need to learn:		
	Content		Guidance
5 Further vectors	5.1	The vector product $\mathbf{a} \times \mathbf{b}$ of two vectors.	To include the interpretation of $ \mathbf{a} \times \mathbf{b} $ as an area.
	5.2	The scalar triple product $\mathbf{a} \cdot \mathbf{b} \times \mathbf{c}$	Students should be able to use the scalar triple product to find the volume of a tetrahedron and a parallelepiped.
	5.3	Applications of vectors to three dimensional geometry involving points, lines and planes.	To include the equation of a line in the form $(\mathbf{r} - \mathbf{a}) \times \mathbf{b} = \mathbf{0}$. Direction ratios and direction cosines of a line.
6 Further numerical methods	6.1	Numerical solution of first order and second order differential equations.	The approximations $\left(\frac{dy}{dx}\right)_n \approx \frac{(y_{n+1} - y_n)}{h}$ $\left(\frac{dy}{dx}\right)_n \approx \frac{(y_{n+1} - y_{n-1})}{2h}$ $\left(\frac{d^2y}{dx^2}\right)_n \approx \frac{(y_{n+1} - 2y_n + y_{n-1}))}{h^2}$
	6.2	Simpson's rule.	
7 Inequalities	7.1	The manipulation and solution of algebraic inequalities and inequations , including those involving the modulus sign.	The solution of inequalities such as $\frac{1}{x-a} > \frac{x}{x-b}, \quad x^2 - 1 > 2(x+1)$



Exam Specification: Further Mechanics 1

In bold are topics covered in AS. FM1 is 1 of 2 applied modules you will study.

Paper 3C: Further Mechanics 1*

Topics	What students need to learn:		
	Content	Guidance	
1 Momentum and impulse	1.1	Momentum and impulse. The impulse-momentum principle. The principle of conservation of momentum applied to two spheres colliding directly.	The spheres may be modelled as particles.
	1.2	Momentum as a vector. The impulse-momentum principle in vector form.	
2 Work, energy and power	2.1	Kinetic and potential energy, work and power. The work-energy principle. The principle of conservation of mechanical energy.	Problems involving motion under a variable resistance and/or up and down an inclined plane may be set.
3 Elastic strings and springs and elastic energy	3.1	Elastic strings and springs. Hooke's law.	
	3.2	Energy stored in an elastic string or spring.	Problems using the work-energy principle involving kinetic energy, potential energy and elastic energy may be set.
4 Elastic collisions in one dimension	4.1	Direct impact of elastic spheres. Newton's law of restitution. Loss of kinetic energy due to impact.	Students will be expected to know and use the inequalities $0 \leq e \leq 1$ (where e is the coefficient of restitution). The spheres may be modelled as particles.
	4.2	Successive direct impacts of spheres and/or a sphere with a smooth plane surface.	The spheres may be modelled as particles.



Exam Specification: Further Mechanics 1

In bold are topics covered in AS. FM1 is 1 of 2 applied modules you will study.

Topics	What students need to learn:		
	Content		Guidance
5 Elastic collisions in two dimensions	5.1	Oblique impact of smooth elastic spheres and a smooth sphere with a fixed surface. Loss of kinetic energy due to impact.	Problems will only involve spheres with the same radius. Problems may be set in vector form. The spheres may be modelled as particles.
	5.2	Successive oblique impacts of a sphere with smooth plane surfaces.	The sphere may be modelled as particle.



Assessment

Content and assessment overview

This Pearson Edexcel Level 3 Advanced GCE in Further Mathematics builds on the skills, knowledge and understanding set out in the whole GCSE subject content for mathematics and the subject content for the Pearson Edexcel Level 3 Advanced Subsidiary and Advanced GCE Mathematics qualifications. Assessments will be designed to reward students for demonstrating the ability to provide responses that draw together different areas of their knowledge, skills and understanding from across the full course of study for the AS further mathematics qualification and also from across the AS Mathematics qualification. Problem solving, proof and mathematical modelling will be assessed in further mathematics in the context of the wider knowledge which students taking A level further mathematics will have studied.

The Pearson Edexcel Level 3 Advanced GCE in Further Mathematics consists of four externally-examined papers. Students must take Paper 1 and Paper 2, the two mandatory Core Pure papers, and two optional papers. Students are permitted to take more than the two optional papers if they want to extend their course of study. See page 56 for details of how their grade will be awarded.

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

Paper 1: Core Pure Mathematics 1 (*Paper code: 9FM0/01)

Paper 2: Core Pure Mathematics 2 (*Paper code: 9FM0/02)

Each paper is:

1 hour and 30 minutes written examination

25% of the qualification

75 marks

Content overview

Proof, Complex numbers, Matrices, Further algebra and functions, Further calculus, Further vectors, Polar coordinates, Hyperbolic functions, Differential equations

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

Further Mathematics Optional Papers (*Paper codes: 9FM0/3A-3D, 9FM0/4A-4D)

Each paper is:

Written examination: 1 hour and 30 minutes

25% of the qualification

75 marks

Content overview

Students take **two** options from the following eight:

Option 1 Papers

3A: Further Pure Mathematics 1

3B: Further Statistics 1

3C: Further Mechanics 1

3D: Decision Mathematics 1

Option 2 Papers

4A: Further Pure Mathematics 2

4B: Further Statistics 2

4C: Further Mechanics 2

4D: Decision Mathematics 2

There are restrictions on which papers can be taken together.

Students choose a pair of options, either:

- any two Option 1 papers, or
- a matching pair of Option 1 and Option 2 papers

This makes a total of ten different option pairs.

Assessment overview

- Students must answer all questions.
- Calculators can be used in the assessment.



Breakdown of assessment objectives

Students must:		% in GCE A Level
AO1	Use and apply standard techniques Learners should be able to: - select and correctly carry out routine procedures; and - accurately recall facts, terminology and definitions	48-52%
AO2	Reason, interpret and communicate mathematically Learners should be able to: - construct rigorous mathematical arguments (including proofs); - make deductions and inferences; - assess the validity of mathematical arguments; - explain their reasoning; and - use mathematical language and notation correctly. <i>Where questions/tasks targeting this assessment objective will also credit Learners for the ability to 'use and apply standard techniques' (AO1) and/or to 'solve problems within mathematics and in other contexts'</i> <i>(AO3) an appropriate proportion of the marks for the question/task must be attributed to the corresponding assessment objective(s).</i>	At least 15%
AO3	Solve problems within mathematics and in other contexts Learners should be able to: - translate problems in mathematical and non-mathematical contexts into mathematical processes; - interpret solutions to problems in their original context, and, where appropriate, evaluate their accuracy and limitations; - translate situations in context into mathematical models; - Use mathematical models; and - evaluate the outcomes of modelling in context, recognise the limitations of models and, where appropriate, explain how to refine them. <i>Where questions/tasks targeting this assessment objective will also credit Learners for the ability to 'use and apply standard techniques' (AO1) and/or to 'reason, interpret and communicate mathematically' (AO2) an appropriate proportion of the marks for the question/task must be attributed to the corresponding assessment objective(s).</i>	At least 15%
Total		100%

Inspired

Confident

Ambitious

Breakdown of assessment objectives

Route C	Paper	Assessment Objectives			Total for all Assessment Objectives
		AO1 %	AO2 %	AO3 %	
	Paper 1 Core Pure Mathematics 1	11.67-13.00	4.67-6.00	6.67-8.00	23-27%
	Paper 2 Core Pure Mathematics 2	11.67-13.00	5.67-7.00	5.33-6.67	23-27%
	Paper 3 Further Pure Mathematics 1	11.67-13.00	6.00-7.33	5.33-6.67	23-27%
	Paper 4 Further Mechanics 1	11.67-13.00	3.00-4.33	8.67-10.00	23-27%
	Total for GCE A Level	48-52%	At least 15%	At least 15%	100%



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:

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

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



Key Formulae

Complex Numbers

For two complex numbers $z_1 = r_1 e^{i\theta_1}$ and $z_2 = r_2 e^{i\theta_2}$

$$z_1 z_2 = r_1 r_2 e^{i(\theta_1 + \theta_2)}$$

$$\frac{z_1}{z_2} = \frac{r_1}{r_2} e^{i(\theta_1 - \theta_2)}$$

Loci in the Argand diagram:

$|z - a| = r$ is a circle radius r centred at a

$\arg(z - a) = \theta$ is a half line drawn from a at angle θ to a line parallel to the positive real axis.

Exponential Form: $e^{i\theta} = \cos \theta + i \sin \theta$

Matrices

For a 2 by 2 matrix $\begin{pmatrix} a & b \\ c & d \end{pmatrix}$ the determinant $\Delta = \begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$

the inverse is $\frac{1}{\Delta} \begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$

The transformation represented by matrix **AB** is the transformation represented by matrix **B** followed by the transformation represented by matrix **A**.

For matrices **A**, **B**:

$$(\mathbf{AB})^{-1} = \mathbf{B}^{-1} \mathbf{A}^{-1}$$

Algebra

$$\sum_{r=1}^n r = \frac{1}{2} n(n+1)$$

For $ax^2 + bx + c = 0$ with roots α and β :

$$\alpha + \beta = -\frac{b}{a} \quad \alpha\beta = \frac{c}{a}$$

For $ax^3 + bx^2 + cx + d = 0$ with roots α , β and γ :

$$\sum \alpha = -\frac{b}{a} \quad \sum \alpha\beta = \frac{c}{a} \quad \alpha\beta\gamma = -\frac{d}{a}$$



Key Formulae

Hyperbolic Functions

$$\cosh x \equiv \frac{1}{2}(e^x + e^{-x})$$

$$\sinh x \equiv \frac{1}{2}(e^x - e^{-x})$$

$$\tanh x \equiv \frac{\sinh x}{\cosh x}$$

Calculus and Differential Equations

Differentiation

Function	Derivative
x^n	nx^{n-1}
$\sin kx$	$k \cos kx$
$\cos kx$	$-k \sin kx$
$\sinh kx$	$k \cosh kx$
$\cosh kx$	$k \sinh kx$
e^{kx}	ke^{kx}
$\ln x$	$\frac{1}{x}$
$f(x) + g(x)$	$f'(x) + g'(x)$
$f(x)g(x)$	$f'(x)g(x) + f(x)g'(x)$
$f(g(x))$	$f'(g(x))g'(x)$



Key Formulae

Vectors

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

Scalar product of two vectors $\mathbf{a} = \begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix}$ and $\mathbf{b} = \begin{pmatrix} b_1 \\ b_2 \\ b_3 \end{pmatrix}$ is

$$\begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix} \cdot \begin{pmatrix} b_1 \\ b_2 \\ b_3 \end{pmatrix} = a_1b_1 + a_2b_2 + a_3b_3 = |\mathbf{a}||\mathbf{b}|\cos\theta$$

where θ is the acute angle between the vectors $\mathbf{a}$ and $\mathbf{b}$

The equation of the line through the point with position vector $\mathbf{a}$ parallel to vector $\mathbf{b}$ is:

$$\mathbf{r} = \mathbf{a} + t\mathbf{b}$$

The equation of the plane containing the point with position vector $\mathbf{a}$ and perpendicular to vector $\mathbf{n}$ is:

$$(\mathbf{r} - \mathbf{a}) \cdot \mathbf{n} = 0$$



Homework & Independent Work

Objectives of a Sixth Form Homework 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. Homework

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!)

Inspired

Confident

Ambitious



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 Further Maths contact: 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 Further Maths?** A-level Further Maths is a significant step up from A-level Maths. The topics are more complex and require greater depth of understanding, as well as strong reasoning and problem-solving skills. Studying both A-level Maths and Further Maths also involves a significant amount of home learning and independent practice. A solid foundation in A-level Maths is essential for understanding many Further Maths concepts.
2. **How do I revise for A-level Further Maths?** Firstly, it is imperative that you attend *all* 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. **Can I choose my optional modules?** We can only offer one pathway for Further Maths. Each year the Maths team decide what would work best for a particular cohort. If you have any questions or concerns, please reach out to the contacts above who can explain our rationale for this academic year.
4. **How can my parents support me with A-level Further 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.