

Year: 12
Subject:
Further Maths
A level

Curriculum Intent:

Some pure topics from A Level mathematics are studied in greater depth, while some new topics are introduced. Algebraic work with series is extended. The powerful technique of proof by induction is used in various contexts. Complex numbers are introduced and lead to solutions of problems in algebra, geometry and trigonometry. Matrices are used to solve systems of equations and to explore transformations. Vector methods are applied to problems involving lines and planes.

In statistics situations are modelled by discrete random variables; the suitability of models is tested using Chi Squared tests. Bivariate data are investigated, with tests for correlation and association and modelling using regression.

In mechanics dimensional analysis is used to test the viability of models. The work energy principle and equations relating to power are used to solve problems involving motion. Momentum, impulse and the coefficient of restitution are used to model collisions. Horizontal and vertical circular motion are described using velocity, acceleration and Newton's second law.



	Term 1		Term 2		Term 3	
Topic Titles (in order of delivery)	<ol style="list-style-type: none"> Pure: Complex Numbers Pure: Matrices Pure: Application of Matrices Statistics: Counting Principles and Probability 	<ol style="list-style-type: none"> Pure: Further Vectors Pure: Roots of Polynomials Pure: Proof by Induction Mechanics: Dimensional Analysis Mechanics: Work, Energy and Power 	<ol style="list-style-type: none"> Statistics: Discrete Random Variables Statistics: The Poisson Distribution Statistics: Correlation and Regression Statistics: Chi squared Tests 	<ol style="list-style-type: none"> Mechanics: Momentum and Collisions 1 Mechanics: Circular Motion 1 Mechanics: Centre of Mass 1 Pure: Series and Induction 	<ol style="list-style-type: none"> Statistics: Non-parametric Hypothesis Tests Statistics: Combining Random Variables Statistics: Continuous Distributions 	<ol style="list-style-type: none"> Pure: Lines and Planes in Space Simultaneous Equations and Planes Mechanics: Momentum and Collisions 2 Mechanics: Circular Motion 2
Key knowledge / Retrieval topics	<p>1. Pure: Complex Numbers</p> <ul style="list-style-type: none"> Learn about a new set of numbers called the complex numbers. Perform arithmetic with complex numbers. Understand why complex numbers 	<p>1. Pure: Further Vectors</p> <ul style="list-style-type: none"> Write an equation of a straight line in three dimensions, both using vectors and using coordinates. 	<p>1. Statistics: Discrete Random Variables</p> <ul style="list-style-type: none"> Predict the mean and variance of a discrete random variable. Understand that a linear transformatio 	<p>1. Mechanics: Momentum and Collisions 1</p> <ul style="list-style-type: none"> Understand momentum and impulse in mathematical terms with units. 	<p>1. Statistics: Non-parametric Hypothesis Tests</p> <ul style="list-style-type: none"> Understand what is meant by a non-parametric hypothesis test and how to select an 	<p>1. Pure: Lines and Planes in Space</p> <ul style="list-style-type: none"> Find the equation of a plane in several different forms. Find intersections between

	<p>occur in conjugate pairs.</p> <ul style="list-style-type: none"> Learn about a geometric representation of complex numbers. Understand how arithmetic with complex numbers can be interpreted as geometric transformations. Represent equations and inequalities with complex numbers graphically. <p>2. Pure: Matrices</p> <ul style="list-style-type: none"> Add, subtract and perform scalar multiplication with conformable matrices. Learn about zero and identity matrices and their significance. Calculate the determinant of a 2 x 2 and 3 x 3 matrix. Find and interpret the inverse of a 2x2 and 3x3 matrix, where one exists. <p>3. Pure: Application of Matrices</p> <ul style="list-style-type: none"> Use matrices to solve sets of 	<ul style="list-style-type: none"> Find the intersection point of two lines. Calculate an angle between two vectors or two straight lines (using a scalar product). Decide whether two lines are parallel or perpendicular. Find a line that is perpendicular to two given lines (using a vector product). Solve problems involving distanced between points and lines. <p>2. Pure: Roots of Polynomials</p> <ul style="list-style-type: none"> Factorise polynomials and solve equations that many have complex roots. Learn a useful link between the roots of a polynomial and its coefficients. Use substitution to solve more complicated equations. 	<p>n of the variable changes the mean and variance.</p> <ul style="list-style-type: none"> Use the formulae for expectation and variance of a special distribution called the uniform distribution. Recognise when it is appropriate to use a uniform distribution. Use the formula for expectation and variance of the binomial distribution. Find probabilities, expectation and variance for a new distribution called the geometric distribution. Recognise when it is appropriate to use a geometric distribution. 	<ul style="list-style-type: none"> Understand that linear momentum is conserved in a collision between objects that are free to move. Understand that impulse on a body is equal to the change in momentum. Understand Newton's experimental law for collisions. Analyse and solve problems involving simple collisions in a straight line. Analyse and solve problems involving simple cases of connected particles. <p>2. Mechanics: Circular Motion 1</p> <ul style="list-style-type: none"> Model motion of a particle moving in a horizontal circular path 	<p>appropriate test.</p> <ul style="list-style-type: none"> Perform a single-sample sign test and a single-sample Wilcoxon signed-rank test. Perform a paired-sample sign test, a Wilcoxon matched-pairs signed-rank test and a Wilcoxon rank-sum test. Perform the Wilcoxon signed-rank test and the rank-sum test using a normal approximation. <p>2. Statistics: Combining Random Variables</p> <ul style="list-style-type: none"> Add together two independent random variables and how that changes the mean and the variance. 	<p>lines and planes.</p> <ul style="list-style-type: none"> Calculate angles between lines and planes. Calculate the distances between objects in three-dimensional space. <p>2. Simultaneous Equations and Planes</p> <ul style="list-style-type: none"> Identify different geometrical configurations of two or three planes. Determine whether a set of simultaneous equations has a unique solution, no solutions or infinitely many solutions. Use simultaneous equations to determine the geometrical configuration of the three planes.
--	---	--	--	--	--	--

	<p>simultaneous equations.</p> <ul style="list-style-type: none"> • Interpret matrices as linear transformations in two and three dimensions. • Find a matrix representing a combined transformation. • Find invariant points and invariants lines of a linear transformation. <p>4. Statistics: Counting Principles and Probability</p> <ul style="list-style-type: none"> • Break down complicated questions into parts which are easier to count, and then combine them together. • Count the number of ways to permute a set of objects. • Count the number of ways you can choose objects from a group. • Apply these tools to problems involving probabilities. 	<p>3. Pure: Proof by Induction</p> <ul style="list-style-type: none"> • Use the principle of induction to prove that patterns continue forever. • Apply this to matrices. • Apply this to number theory. • Apply this to inequalities. • Adapt the method to solve problems in a range of other contexts. <p>5. Mechanics: Dimensional Analysis</p> <ul style="list-style-type: none"> • Understand the concept of dimensions. • Use the language and symbols of dimensional analysis. • Understand the connections between units and dimensions. • Check the validity of a formula by using dimensional considerations. • Predict formulae by 	<p>2. Statistics: The Poisson Distribution</p> <ul style="list-style-type: none"> • Know the conditions required for a Poisson distribution to model a situation. • Understand the Poisson formula and how to calculate Poisson probabilities. • Calculate the mean, variance and standard deviation of a Poisson variable. • Use the distribution of the sum of independent Poisson distributions. <p>3. Statistics: Correlation and Regression</p> <ul style="list-style-type: none"> • Calculate the value of Pearson's product moment correlation coefficient. • Calculate the value of Spearman's rank correlation 	<p>under a constant speed.</p> <ul style="list-style-type: none"> • Link linear speed and angular speed of a particle moving in a horizontal circular path. • Use velocity as a vector quantity. • Find the acceleration and forces acting on a particle moving in a horizontal circular path. • Solve problems relating to motion in a horizontal circular path in 3D. <p>3. Mechanics: Centre of Mass 1</p> <ul style="list-style-type: none"> • Find the centre of mass of arrangements of particles, uniform rods and symmetrical uniform laminas. • Find centres of mass of 	<ul style="list-style-type: none"> • Apply these ideas to making predictions about the average or the sum of a sample. • Know about the distribution of linear combinations of normal variables. • Know about the distribution of the sum or average of many observations from any distribution. <p>3. Statistics: Continuous Distributions</p> <ul style="list-style-type: none"> • Describe probabilities of continuous variables. • Calculate expected statistics of continuous variables. • Calculate expected statistics of functions of continuous variables. 	<p>3. Mechanics: Momentum and Collisions 2</p> <ul style="list-style-type: none"> • Find the impulse of a variable force. • Apply the principle of impulse, conservation of momentum and Newton's experimental law in two dimensions using vector notation. • Calculate the result of oblique impacts. <p>4. Mechanics: Circular Motion 2</p> <ul style="list-style-type: none"> • Work with a particle moving in a circle with variable speed. • Model the motion of a particle moving in a circle in a vertical plane. • Use the principle of conservation of
--	--	--	---	--	---	---

		<p>using dimensional analysis.</p> <p>6. Mechanics: Work, Energy and Power</p> <ul style="list-style-type: none"> • Calculate the work done by a force. • Calculate kinetic energy. • Use the work-energy principle. • Equate gravitational potential energy to work done against gravity. • Perform calculations using power. 	<p>coefficient and identify when it is appropriate to use it.</p> <ul style="list-style-type: none"> • Conduct hypothesis tests on correlation coefficients. • Use linear regression to find the equations of lines of best fit. <p>4. Statistics: Chi squared Tests</p> <ul style="list-style-type: none"> • Check if two factors are independent. • Use Yates' correction to for check if two factors are independent. • Check if data comes from a distribution or for given proportions. • Check if data fits with other known distributions. 	<p>two- and three-dimensional objects of standard shape.</p> <ul style="list-style-type: none"> • Find centres of mass of composite bodies, including bent wires. <p>4. Pure: Series and Induction</p> <ul style="list-style-type: none"> • Use the principle of mathematical induction to prove results about sequences, series and differentiation. • Use given results for the sums of integers, squares and cubes to find expressions for sums of other series. • Use a technique called the method of differences to find expressions for the sum of n terms of a series. 	<ul style="list-style-type: none"> • Convert between the probability density function $f(x)$ and the cumulative probability $F(x) = P(X \leq x)$. • Find the median and quartiles. • Use two new probability distributions – the continuous uniform and the exponential. • Use the cumulative distribution function to find the distribution of the function of a random variable. 	<p>mechanical energy to solve problems involving a particle moving in a vertical circle.</p> <ul style="list-style-type: none"> • Work with the radial and tangential components of the acceleration. • Solve problems involving moving particles where part of their path is a vertical circle.
--	--	---	---	---	--	--

				<ul style="list-style-type: none"> Use the expression for the sum of the first n terms to determine whether an infinite series converges and find its limit. 		
Understanding / Sequence of delivery	1. Building on prior knowledge and making connections between topics.					
Assessment	End of Topic Assessments Integral Tests and Exam Style Questions		End of Topic Assessments Integral Tests and Exam Style Questions		End of Topic Assessments Integral Tests and Exam Style Questions	
	POP Test Past Exam Questions Grade Boundaries based on A Level 2019/2022		Topic Tests Past Exam Questions Grade Boundaries based on A Level 2019/2022		PPE Past Exam Questions Grade Boundaries based on A Level 2019/2022	