MATHEMATICS TERM BY TERM CURRICULUM

Specification link - Mathematics A level

January 2023

TERM	GCSE to A Level Transition work
August	Independent consolidation of GCSE content allowing students to master the pre-requisite knowledge required for early success in A Level study. The cyclical curriculum will continually check this knowledge and develop its fluency as students progress through the course.

YEAR 12

TERM	Lead Teacher (Pure Mathematics) delivered via 3 x 70-minute lesson per week	Teacher 2 (Statistics and Mechanics) delivered via 1 x 1 hour 45 minute per week
1	P1.1 Algebra and functions (part 1) • Perform essential algebraic manipulations, such as expanding brackets, collecting like terms, factorising etc. • Understand and be able to use the laws of indices for all rational exponents. • Be able to use and manipulate surds, including rationalising the denominator. • Solve a quadratic equation by factorising. • Work with quadratic functions and their graphs. • Know and be able to use the discriminant of a quadratic function, including the conditions for real and repeated roots. • Complete the square. e.g. $ax^2+bx+c=a(x+b/2a)^2+(c-b^2/4a)$. • Solve quadratic equations, including in a function of the unknown. • Solve linear simultaneous equations using elimination and substitution. • Substitution to solve simultaneous equations where one equation is linear and the other is a quadratic.	S1.1 Data presentation and interpretation (part 1) • Calculate measures of location, mean, median and mode. • Calculate measures of variation, standard deviation, variance, range and interpercentile range. • Interpret and draw inferences from summary statistics.

	P1.2 Further algebra • Understand and be able to use the binomial expansion of (a + bx)n for positive integer n. • Find an unknown coefficient of a binomial expansion. • Use algebraic division. • Know and be able to apply the factor theorem. • Be able to fully factorise a cubic expression. • Understand and be able to 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 and disproof by counter-example.	S1.3 Probability • Understand and be able to use mutually exclusive and independent events when calculating probabilities; • Make links to discrete and continuous distributions.
2	Assessment Point 1 (Content based on above areas)	
	P1.3 Differentiation • Understand and be able to 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). • Understand the gradient of the tangent as a limit and its interpretation as a rate of change. • Sketch the gradient function for a given curve. • Use the second derivative to establish the nature of a turning point • Understand differentiation from first principles for small positive integer powers of x. • Differentiate x^n, for rational values of n, and related constant multiples, sums and differences. • Apply differentiation to find gradients, tangents and normals, maxima and minima and stationary points. • Identify where functions are increasing or decreasing.	S1.6 Data presentation and interpretation (part 2) • Know how to interpret diagrams for single variable data. • Know how to interpret scatter diagrams and regression lines for bivariate data. • Recognise the explanatory and response variables. • Make predictions using the regression line and understand its limitations. • Understand informal interpretation of correlation. • Understand that correlation does not imply causation. • Recognise and interpret possible outliers in data sets and statistical diagrams. • Select or critique data presentation techniques in the context of a statistical problem. • Clean data, including dealing with missing data, errors and outliers.

	P1.4 Integration • Know and be able to use the Fundamental Theorem of Calculus. • Integrate x^n (excluding n = –1), and related sums, differences and constant multiples. • Evaluate definite integrals. • Use a definite integral to find the area under a curve.	S1.4 Statistical Sampling • Understand and be able to use the terms 'population' and 'sample'. • Know how to use samples to make informal inferences about the population. • Describe advantages and disadvantages of sampling compared to census. • Understand and be able to use sampling techniques. • Describe advantages and disadvantages of sampling techniques. • Select or critique sampling techniques in the context of solving a statistical problem. • Understand that different samples can lead to different conclusions about the population.
3	P1.6 Coordinate geometry in the (x, y) plane • Understand and use the equation of a straight line. • Know and be able to apply the gradient conditions for two straight lines to be parallel or perpendicular. • Find lengths and areas using equations of straight lines. • Be able to use straight-line graphs in modelling. • Find the midpoint of a line segment. • Understand and use the equation of a circle. • Find points of intersection between a circle and a line. • Know and be able to use the properties of chords and tangents.	S1.2 Statistical Distributions • Understand and be able to use simple, discrete probability distributions, including the binomial distribution. • Identify the discrete uniform distribution. • Calculate probabilities using the binomial distribution.
	P1.8 Algebra and functions (part 2) • Solve linear and quadratic inequalities. • Know how to express solutions through correct use of 'and' and 'or' or through set notation. • Interpret linear and quadratic inequalities graphically. • Represent linear and quadratic inequalities graphically. • Understand and use graphs of functions. • Sketch curves defined by simple equations including polynomials. • Use intersection points of graphs to solve equations. • Understand the effect of simple transformations on the graph of y = f(x). • Sketch the result of a simple transformation given the graph of any function y = f(x).	S1.5 Statistical Hypothesis Testing • Understand and be able to apply the language of statistical hypothesis testing, developed through a binomial model. • 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.

4	Assessment Point 2 (Content based on above areas)	
	P1.5 Vectors (2D) • Use vectors in two dimensions. • Calculate the magnitude and direction of a vector and convert between component form and magnitude/direction form. • Add vectors diagrammatically and perform the algebraic operations of vector addition and multiplication by scalars, and understand their geometrical interpretations. • Understand and be able to use position vectors. • Calculate the distance between two points represented by position vectors. • Use vectors to solve problems in pure mathematics and in context, (including forces).	M1.1 Quantities and units in mechanics • Understand the concept of a mathematical model, and be able to abstract from a real-world situation to a mathematical description (model). • Know the language used to describe simplifying assumptions. • Understand the particle model. • Be familiar with the basic terminology for mechanics. • Be familiar with commonly-made assumptions when using these models. • Analyse the model appropriately, and interpret and communicate the implications of the analysis in terms of the situation being modelled. • Understand and use fundamental quantities and units in the S.I. system: length, time and mass. • Understand that units behave in the same way as algebraic quantities, e.g. meters per second is m/s = m × 1/s = ms-1. • Understand and use derived quantities and units: velocity, acceleration, force, weight. • Know the difference between position, displacement and distance; • Know the difference between velocity and speed, and between acceleration and magnitude of acceleration. • Know the difference between mass and weight (including gravity). • Understand there are different types of forces.
		M1.2 Kinematics 1 • Draw and interpret kinematics graphs, knowing the significance (where appropriate) of their gradients and the areas underneath them. • Recognise when it is appropriate to use the suvat formulae for constant acceleration. • Solve kinematics problems using constant acceleration formulae. • The formulae that must be derived and learnt are: $s = \frac{(u+v)t}{2}$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$ $s = vt - \frac{1}{2}at^2$ • Be able to solve problems involving vertical motion under gravity.

5	P1.7 Trigonometry • Understand and be able to use the definitions of sine, cosine and tangent for all arguments. • Understand and be able to use the sine and cosine rules. • Understand and be able to use the area of a triangle in the form ½ ab sin C. • Understand and be able to use the sine, cosine and tangent functions; their graphs, symmetries and periodicity. • Be able to solve trigonometric equations within a given interval. • Understand and be able to use $\tan\theta = \frac{\cos\theta}{\sin\theta}$. • Understand and use $\sin^2\theta + \cos^2\theta = 1$.	M1.3 Forces and Newton's laws • Understand the concept of a force; understand and use Newton's first law. ('An object continues in state of rest or uniform motion unless acted on by an external force.') • Understand and be able to use Newton's second law (F = ma) for motion in a straight line (restricted to forces in two perpendicular directions or simple cases of forces given as 2D (i, j) vectors). • Understand and use Newton's third law. ('For every action there is an equal and opposite reaction'); equilibrium of forces on a particle and motion in a straight line; application to problems involving smooth pulleys and connected particles.
	P1.9 Exponentials and logarithms • Know and be able to use the function a^x and its graph, where a is positive. • Know and be able to use the function e^x and its graph. • Know that the gradient of e^{kx} is equal to ke^{kx} and hence understand why the exponential model is suitable in many applications. • Know and be able to use the definition of $\log_a x$ as the inverse of a^x, where a is positive and $x \geq 0$. • Know and be able to use the function $\ln x$ and its graph. • Know and be able to use ln x as the inverse function of e^x . • 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 $k = -\frac{1}{2}$). • Be able to solve equations of the form $a^x = b$. • Be able to use logarithmic graphs to estimate parameters in relationships of the form $y = ax^n$ and $y = kb^x$, given data for x and y. • Understand and be able to use exponential growth and decay in modelling, considering limitations and refinements of exponential models.	M1.4 Kinematics 2 • Use calculus (differentiation) in kinematics to model motion in a straight line for a particle moving with variable acceleration. • Understand that gradients of the relevant graphs link to rates of change. • Know how to find max and min velocities by considering zero gradients and understand how this links with the actual motion (i.e. acceleration = 0). • Use calculus (integration) in kinematics to model motion in a straight line for a particle moving under the action of a variable force. • Understand that the area under a graph is the integral, which leads to a physical quantity. • Know how to use initial conditions to calculate the constant of integration and refer back to the problem.
	Revision for mock exams Mock exams (Near full AS paper)	

6	P2.5 Functions and modelling • Understand what is meant by a modulus of a linear function. • Sketch graphs of functions involving modulus functions. • Solve equations and inequalities involving modulus functions. • Work out the domain and range of functions. • Know the definition of a one-one and a many-one mappings. • Work out the composition of two functions. • Work out the inverse of a function and sketch its graph. • Understand the condition for an inverse function to exist. • Understand the effect of simple transformations on the graph of $y = f(x)$ including sketching associated graphs and combinations of the transformations: $y = af(x)$, $y = f(x) + a$, $y = f(x + a)$, $y = f(ax)$. • Transform graphs to produce other graphs. • Understand the effect of composite transformations on equations of curves and be able to describe them geometrically. • Use functions in modelling, including consideration of limitations and refinements of the models.	P2.1 Algebraic and partial fractions • Be able to add, subtract, multiply and divide algebraic fractions. • Know how to use the factor theorem to shown a linear expression of the form (a+bx) is a factor of a polynomial. • Use the factor theorem for divisors of the form (a+bx). • Simplify algebraic fractions by fully factorising polynomials up to cubic. • Solve linear simultaneous equations using elimination and substitution. • Be able to use substitution to solve simultaneous equations where one equation is linear and the other quadratic. • Split a proper fraction into partial fractions. • Split an improper fraction into partial fractions, dividing the numerator by the denominator (by polynomial long division or by inspection).
	Independent Summer consolidation of year 12 work; aimed at keeping Year 12 learning in working memory.	

YEAR 13

TERM	Lead Teacher (Pure Mathematics) delivered via 3 x 70-minute lesson per week	Teacher 2 (Statistics and Mechanics) delivered via 1 x 1 hour 45 minute per week
1	P2.6 Series and sequences • Know what a sequence of numbers is and the meaning of finite and infinite sequences. • Know what a series is. • Know the difference between convergent and divergent sequences. • Know what is meant by arithmetic series and sequences. • Use the standard formulae associated with arithmetic series and sequences. • Know what is meant by geometric series and sequences. • Use the standard formulae associated with geometric series and sequences. • Know the condition for a geometric series to be convergent and be able to find its sum to infinity. • Solve problems involving arithmetic and geometric series and sequences. • Know the proofs and derivations of the sum formulae (for both AP and GP). • Be familiar with ∑ notation and how it can be used to generate a sequence and series. • Know how this notation will lead to an AP or GP and its sum. • Know that $\sum_{1}^{n} 1 = n$ • Know that a sequence can be generated using a formula for the nth term or a recurrence relation of the form xn + 1 = f(xn). • Know the difference between increasing, decreasing and periodic sequences. • Understand how a recurrence relation of the form Un = f(Un-1) can generate a sequence. • Describe increasing, decreasing and periodic sequences.	S2.1 The Normal distribution • Understand the properties of the Normal distribution. • Find probabilities using the Normal distribution. • Know the position of the points of inflection of a Normal distribution. • Find the mean and variance of a binomial distribution. • Understand and be able to apply a continuity correction. • Use the Normal distribution as an approximation to the binomial distribution. • Conduct a statistical hypothesis test for the mean of the Normal distribution. • Interpret the results in context.

	P2.8 Trigonometry • Understand the definition of a radian and be able to convert between radians and degrees. • Know and be able to use exact values of sin, cos and tan. • Derive and use the formulae for arc length and area of sector. • Understand and be able to use the standard small angle approximations for sine, cosine and tangent. • Understand the secant, cosecant and cotangent functions, and their relationships to sine, cosine and tangent. • Sketch the graphs of secant, cosecant and cotangent; • Simplify expressions and solve involving sec, cosec and cot; • Solve identities involving sec, cosec and cot. • Know and be able to use the identities $1 + \tan^2 x = \sec^2 x$ and $1 + \cot^2 x = \operatorname{cosec}^2 x$ to prove other identities and solve equations in degrees and/or radians. • Work with the inverse trig functions sin–1, cos–1 and tan–1. • Sketch the graphs of sin–1, cos–1 and tan–1. • Prove geometrically the following compound angle formulae for $\sin(A \pm B)$, $\cos(A \pm B)$ and $\tan(A \pm B)$. • Use compound angle identities to rearrange expressions or prove other identities. • Use compound angle identities to rearrange equations into a different form and then solve. • Recall or work out double angle identities. • Use double angle identities to rearrange expressions or prove other identities. • Use double angle identities to rearrange equations into a different form and then solve. • Express $a\cos\theta + b\sin\theta$ as a single sine or cosine function. • Solve equations of the form $a\cos\theta + b\sin\theta = c$ in a given interval. • Construct proofs involving trigonometric functions and previously learnt identities. • Use trigonometric functions to solve problems in context, including problems involving vectors, kinematics and forces.	
2	Assessment point 1 (Content based on above areas plus weaknesses identified in the Year 12 mock exams)	

2	P2.9 Parametric equations • Understand the difference between the Cartesian and parametric system of expressing coordinates. • Convert between parametric and Cartesian forms. • Plot and sketch curves given in parametric form. • Recognise some standard curves in parametric form and how they can be used for modelling.	S2.2 Probability • Understand and be able to use probability formulae using set notation. • Use tree diagrams, Venn diagrams and two-way tables. • Understand and be able to use the conditional probability formula $P(A \mid B) = \frac{P(A \cap B)}{P(B)}$ • Model with probability. • Critique assumptions made and the likely effect of more realistic assumptions.
	P2.2 Differentiation • Find the derivative of $\sin x$ and $\cos x$ from first principles. • Differentiate functions involving e^x, $\ln x$ and related functions such as $6e^{4x}$ and $5\ln 3x$ and sketch the graphs of these functions. • Differentiate to find equations of tangents and normals to the curve. • Differentiate composite functions using the chain rule. • Differentiate using the product rule. • Differentiate using the quotient rule. • Differentiate parametric equations. • Find the gradient at a given point from parametric equations. • Find the equation of a tangent or normal (parametric). • Use implicit differentiation to differentiate an equation involving two variables. • Find the gradient of a curve using implicit differentiation. • Verify a given point is stationary (implicit). • Find and identify the nature of stationary points and understand rates of change of gradient. • Use a model to find the value after a given time. • Set up and use logarithms to solve an equation for an exponential growth or decay problem. • Use logarithms to find the base of an exponential. • Know how to model the growth or decay of 2D and 3D objects using connected rates of change. • Set up a differential equation using given information which may include direct proportion.	S2.3 Regression and correlation • Understand and be able to apply the language of statistical hypothesis testing, developed through a binomial model. • 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.

3	P2.3 Integration • Integrate expressions by inspection using the reverse of differentiation. • Integrate xn for all values of n and understand that the integral of 1/x is ln|x|. • Integrate expressions by inspection using the reverse of the chain rule (or function of a function). • Integrate trigonometric expressions. • Integrate expressions involving ex. • Recognise integrals of the form $\int \frac{f'(x)}{f(x)} dx = \ln \|f(x)\| + c$. • Use trigonometric identities to manipulate and simplify expressions to a form which can be integrated directly. • Integrate expressions using an appropriate substitution. • Select the correct substitution and justify their choices. • Integrate an expression using integration by parts. • Select the correct method for integration and justify their choices. • Integrate rational expressions by using partial fractions that are linear in the denominator. • Simplify the expression using laws of logarithms. • Understand and be able to use integration as the limit of a sum. • Understand the difference between an indefinite and definite integral and why we do not need + c. • Integrate polynomials and other functions to find definite integrals, and use these to find the areas of regions bounded by curves and/or lines. • Use a definite integral to find the area under a curve and the area between two curves. • Use the trapezium rule to find an approximation to the area under a curve. • Appreciate the trapezium rule is an approximation and realise when it gives an overestimate or underestimate. • Write a differential equation from a worded problem. • Use a differential equation as a model to solve a problem. • Solve a differential equation. • Substitute the initial conditions or otherwise into the equation to find + c and the general solution.	M2.1 Forces at any angle (part 1) • Understand the language relating to forces. • Identify the forces acting on a particle and represent them in a force diagram. • Understand how to find the resultant force (magnitude and direction). • Find the resultant of several concurrent forces by vector addition. • Resolve a force into components and be able to select suitable directions for resolution.

3	P2.4 Proof • Understand that various types of proof can be used to give confirmation that previously learnt formulae are true, and have a sound mathematical basis. • Understand that there are different types of proof and disproof (e.g. deduction and contradiction), and know when it is appropriate to use which particular method. • Be able to use an appropriate proof within other areas of the specification later in the course.	M2.4 Forces at any angle (part 2) • Understand that a rough plane will have an associated frictional force, which opposes relative motion (i.e. the direction of the frictional force is always opposite to how the object is moving or 'wants' to move). • Understand that the 'roughness' of two surfaces is represented by a value called the coefficient of friction represented by μ. • Know that $0 \leq \mu$ but that there is no theoretical upper limit for μ although for most surfaces it tends to be less than 1 and that a 'smooth' surface has a value of $\mu = 0$. • Draw force diagrams involving rough surfaces which include the frictional force. • Understand and be able to use the formula $F \leq \mu R$.
		M2.2 Further kinematics (part 1) • Find the time of flight of a projectile. • Find the range and maximum height of a projectile. • Derive formulae to find the greatest height, the time of flight and the horizontal range (for a full trajectory). • Know how to modify projectile equations to take account of the height of release. • Derive and use the equation of the path.
	Mock exams (Near full A2 paper)	

4	P2.7 The binomial theorem (May be taught at the end of Year 12 time permitting) • Be able to find the binomial expansion of $(1-x)^{-1}$ for rational values of n and $\|x\| < 1$. • Be able to find the binomial expansion of $(1+x)^n$ for rational values of n and $\|x\| < 1$. • Be able to find the binomial expansion of $(1+bx)^n$ for rational values of n and $\|x\| < \frac{1}{\|b\|}$. • Be able to find the binomial expansion of $(a+x)^n$ for rational values of n and $\|x\| < a$. • Be able to find the binomial expansion of $(a+bx)^n$ for rational values of n and $\left\|\frac{bx}{a}\right\| < 1$. • Know how to use the binomial theorem to find approximations (including roots). • Be able to use partial fractions to write a rational function as a series expansion.	M2.5 Applications of forces (part 1) • Understand that a rough plane will have an associated frictional force, which opposes understand that a body is in equilibrium under a set of concurrent (acting through the same point) forces is if their resultant is zero. • Know that vectors representing forces in equilibrium form a closed polygon. • Understand how to solve problems involving equilibrium of a particle under coplanar forces, including particles on inclined planes and 2D vectors. • Know and understand the meaning of Newton's second law. • Formulate the equation of motion for a particle in 1-dimensional motion where the resultant force is mass × acceleration. • Formulate the equation of motion for a particle in 2-dimensional motion where the resultant force is mass × acceleration. • Formulate and solve separate equations of motion for connected particles, where one of the particles could be on an inclined and/or rough plane.
	P2.10 Numerical methods • Locate roots of f(x) = 0 by considering changes of sign of f(x). • Use numerical methods to find solutions of equations. • Understand the principle of iteration. • Appreciate the need for convergence in iteration. • Use iteration to find terms in a sequence. • Sketch cobweb and staircase diagrams. • Be able to use cobweb and staircase diagrams to demonstrate convergence or divergence for equations of the form x = g(x). • Solve equations approximately using the Newton-Raphson method. • Understand how the Newton-Raphson method works in geometrical terms. • Use numerical methods to solve problems in context.	M2.6 Further kinematics (part 2) • Extend techniques for motion in 1 dimension to 2 dimensions by using calculus and vector versions of equations for variable force/acceleration problems. • Understand the language and notation of kinematics appropriate to variable motion in 2 dimensions, i.e. knowing the notation r‘ and r” for variable acceleration in terms of time. • Recognise when the use of constant acceleration formulae is appropriate. • Write positions, velocities and accelerations in vector form. • Understand the language of kinematics appropriate to motion in 2 dimensions • Find the magnitude and direction of vectors. • Extend techniques for motion in 1 dimension to 2 dimensions by using vectors. • Know how to use velocity triangles to solve simple problems. • Understand and use suvat formulae for constant acceleration in 2D. • Know how to apply the equations of motion to i, j vector problems. • Use $v = u + at$, $r = ut + \frac{1}{2}at^2$ etc. with vectors given in i , j or column vector form.

4	P2.11 Vectors (3D) • Extend the work on vectors from AS Pure Mathematics to 3D with column vectors and with the use of i, j and k unit vectors. • Calculate the magnitude of a 3D vector. • Know the definition of a unit vector in 3D. • Add 3D vectors diagrammatically and perform the algebraic operations of vector addition and multiplication by scalars, and understand their geometrical interpretations. • Understand and use position vectors, and calculate the distance between two 3D points represented by position vectors. • Use vectors to solve problems in pure mathematics and in contexts (e.g. mechanics).	M2.7 Moments • Realise that a force can produce a turning effect. • Know that a moment of a force is given by the formula force × distance giving Nm and know what the sense of a moment is. • Understand that the force and distance must be perpendicular to one another. • Draw mathematical models to represent horizontal rod problems. • Realise what conditions are needed for a system to remain in equilibrium. • Solve problems when a bar is on the point of tilting.
		M2.8 Applications of forces (part 2) • Solve statics problems for a system of forces which are not concurrent (e.g. ladder problems), thus applying the principle of moments for forces at any angle.
5	Revision for final exams	
6	Paper 1: Pure Mathematics 33%, 2 hours, 100 marks	Any pure content can be assessed on either paper
	Paper 2: Pure Mathematics 33%, 2 hours, 100 marks	
	Paper 3: Statistics and Mechanics 33%, 2 hours, 100 marks	Section A: Statistics (50 marks) Section B: Mechanics (50 marks)