

Mathematics

The aims and objectives of this qualification are to enable students to:

- understand mathematics and mathematical processes in a way that promotes confidence, fosters enjoyment and provides a strong foundation for progress to further study
- extend their range of mathematical skills and techniques
- understand coherence and progression in mathematics and how different areas of mathematics are connected
- apply mathematics in other fields of study and be aware of the relevance of mathematics to the world of work and to situations in society in general
- use their mathematical knowledge to make logical and reasoned decisions in solving problems both within pure mathematics and in a variety of contexts, and communicate the mathematical rationale for these decisions clearly
- reason logically and recognise incorrect reasoning
- generalise mathematically
- construct mathematical proofs
- use their mathematical skills and techniques to solve challenging problems that require them to decide on the solution strategy
- recognise when mathematics can be used to analyse and solve a problem in context
- represent situations mathematically and understand the relationship between problems in context and mathematical models that may be applied to solve them
- draw diagrams and sketch graphs to help explore mathematical situations and interpret solutions
- make deductions and inferences and draw conclusions by using mathematical reasoning
- interpret solutions and communicate their interpretation effectively in the context of the problem
- read and comprehend mathematical arguments, including justifications of methods and formulae, and communicate their understanding
- read and comprehend articles concerning applications of mathematics and communicate their understanding
- use technology such as calculators and computers effectively and recognise when their use may be inappropriate
- take increasing responsibility for their own learning and the evaluation of their own mathematical development.

Year 12 AS-Level Mathematics

Term One

Content of study	Pure: • Unit 1 - Algebra & Functions Applied - Statistics: • Unit 1 - Statistical Sampling • Unit 2a - Data Presentation and Interpretation
What are the aims and objectives of this term?	Pure – Algebra and Functions: • Algebraic expressions – basic algebraic manipulation, indices & surds • Quadratic functions – factorising, solving, graphs and the discriminant • Equations – quadratic/linear simultaneous • Inequalities – linear and quadratic (including graphical solutions) • Graphs – cubic, quartic and reciprocal • Transformations – transforming graphs – $f(x)$ notation

	Applied – Unit 1, Statistical Sampling: • Introduction to sampling terminology • Advantages and disadvantages of sampling • Understand and use sampling techniques • Compare sampling in context Applied - Unit 2 Data Presentation and Interpretation: • Calculation and interpretation of measures of location • Calculation and interpretation of measures of variation • Understand and use coding • Interpret diagrams for single variable data • Interpret scatter diagrams and regression lines • Recognise and interpret outliers • Draw simple conclusions from statistical problems •
What previous knowledge is required?	Previous learning from GCSE: Pure – Algebra and Functions: A4 • Collecting like terms and factorising N8 • Surds A19 • Solving linear simultaneous equations A18 • Solving quadratic equations (by factorising and completing the square) A22 • Working with inequalities • Solving quadratic inequalities A12 • Functional notation and shapes of standard graphs (e.g. parabola, cubic, reciprocal) N7 • Rules of indices Applied - Statistics and Sampling: S1 • Infer properties of populations or distributions from a sample, while knowing the limitations of sampling S5 • Apply statistics to describe a population Applied – Data Presentation and Interpretation: S2 • Interpret and construct tables, charts and diagrams, including frequency tables, bar charts, pie charts and pictograms for categorical data, vertical

	line charts for ungrouped discrete numerical data and know their appropriate use S3 - Construct and interpret diagrams for grouped discrete data and continuous data, i.e. histograms with equal and unequal class intervals and cumulative frequency graphs, and know their appropriate use S4 - Interpret, analyse and compare the distributions of data sets from univariate empirical distributions through appropriate measures of central tendency (median, mean, mode and modal class) and spread (range, including consideration of outliers), quartiles and inter-quartile range S6 - Use and interpret scatter graphs of bivariate data; recognise correlation and know that it does not indicate causation; draw estimated lines of best fit; make predictions; interpolate and extrapolate apparent trends while knowing the dangers of so doing
How will this term's content help with future learning?	Pure: - Year 1, Unit 2 – Coordinate geometry in the (x,y) plane - Year 1, Unit 3 – Further Algebra - Year 1, Unit 4 – Trigonometry - Year 1, Unit 5 – Vectors - Year 1, Unit 6 – Differentiation - Year 1, Unit 7 – Integration - Year 1, Unit 8 – Exponentials and Logarithms - Year 2, Unit 3 – Functions and Modelling - Year 2, Unit 8 – Differentiation - Year 2, Unit 9 - Numerical methods Statistics: - Year 2, Unit 1 – Regression and Correlation
Resources	- Tutorial videos for all topics and interactive questions available at www.hegartymaths.com. All students provided with an account - Tutorial videos and practice exam questions available at https://www.mathsgenie.co.uk/newalevel.html - Practice papers with accompanying mark schemes and video solutions available at https://www.mathsgenie.co.uk/alevelpapers.html - Electronic copies of the textbooks and additional resources available at https://www.pearsonactivelearn.com/app/home (login details provided upon purchase of textbook) - Tutorial videos, practice questions and practice exam questions available at https://www.drfrostmaths.com/course.php?coid=29 - Additional revision resources available at www.bbc.co.uk/bitesize
Links to the national curriculum/specification	https://qualifications.pearson.com/content/dam/pdf/A%20Level/Mathematics/2017/specification-and-sample-assesment/as-l3-mathematics-specification.pdf Pure - Algebra and Functions:

2.1

- Understand and use the laws of indices for all rational exponents

2.2

- Use and manipulate surds, including rationalising the denominator

2.3

- Work with quadratic functions and their graphs
- The discriminant of a quadratic function, including the conditions for real and repeated roots
- Completing the square
- Solution of quadratic equations, including solving quadratic equations in a function of the unknown

2.4

- Solve simultaneous equations in two variables by elimination and by substitution, including one linear and one quadratic equation

2.5

- Solve linear and quadratic inequalities in a single variable and interpret such inequalities graphically, including inequalities with brackets and fractions
- Express solutions through correct use of 'and' and 'or', or through set notation
- Represent linear and quadratic inequalities such as $y > x + 1$ and $y > ax^2 + bx + c$ graphically

2.6

- Manipulate polynomials algebraically, including expanding brackets, collecting like terms and factorisation and simple algebraic division; use of the factor theorem

2.7

- Understand and use graphs of functions; sketch curves defined by simple equations including polynomials, $y = \frac{a}{x}$ and $y = \frac{a}{x^2}$ (including their vertical and horizontal asymptotes)
- Interpret algebraic solution of equations graphically; use intersection points of graphs to solve equations

2.8

- Understand the effect of simple transformations on the graph of $y = f(x)$ including sketching associated graphs:

$$y = af(x), \quad y = f(x) + a, \quad y = f(x + a), \quad y = f(ax)$$

Applied - Statistical Sampling:

1.1

- Understand and use the terms 'population' and sample
- Use samples to make informal inferences about the population
- Understand and use sampling techniques, including simple random sampling and opportunity sampling
- Select or critique sampling techniques in the context of solving a statistical problem, including the understanding that different samples can lead to different conclusions about the population

	Applied – Data Presentation and Interpretation: 2.1 - Interpret diagrams for single-variable data, including understanding that area in a histogram represents frequency - Connect to probability distributions 2.2 - Interpret scatter diagrams and regression lines for bivariate data, including recognition of scatter diagrams which include distinct sections of the population (calculations involving regression lines are excluded) - Understand informal interpretation of correlation - Understand that correlation does not imply causation 2.3 - Interpret measures of central tendency and variation, extending to standard deviation - Be able to calculate standard deviation, including from summary statistics 2.4 - Recognise and interpret possible outliers in data sets and statistical diagrams - Select or critique data presentation techniques in the context of a statistical problem - Be able to clean data, including dealing with missing data, errors and outliers	
Assessments	- Pure Mathematics Year 1 (AS) Unit Test 1: Algebra and Functions - Statistics Year 1 (AS) Unit Test 1: Statistical Sampling - Statistics Year 1 (AS) Unit Test 2: Data presentation and interpretation	
Term Two		
Content of study (Title)	Pure <i>Unit 2: Coordinate geometry in the (x,y) plane</i> <i>Unit 3: Further Algebra</i>	Applied <i>Unit 3: Probability</i> <i>Unit 4: Statistical Distribution</i> <i>Unit 5: Hypothesis testing</i>
What are the aims and objectives of this term?	Pure Unit 2: Straight line graphs Circles Unit 3: Algebraic Methods The binomial expansion	Applied See above
What previous knowledge is required?	Pure: Algebraic manipulation covered so far - Simultaneous equations - Completing the square - Factorising quadratics - notation GCSE (9-1) in Mathematics at Higher Tier A9 Equation of a line - Parallel and perpendicular lines G20 Pythagoras	Applied: GCSE (9-1) in Mathematics at Higher Tier P1 Record, describe and analyse the frequency of outcomes of probability experiments using tables and frequency trees P2 Apply ideas of randomness, fairness and equally likely events to calculate expected outcomes of multiple future experiments

	• A14 Conversion graphs • R10 Calculating the proportionality constant k • G10 Circle theorems • A4 Expanding brackets • A2 Substitution • A6 Proof	• P3 Relate relative expected frequencies to theoretical probability, using appropriate language and the 0-1 probability scale • P4 Apply the property that the probabilities of an exhaustive set of outcomes sum to one; apply the property that the probabilities of an exhaustive set of mutually exclusive events sum to one • P6 Enumerate sets and combinations of sets systematically, using tables, grids • P7 Construct theoretical possibility spaces for single and combined experiments with equally likely outcomes and use these to calculate theoretical probabilities • P9 Tree diagrams and Venn diagrams An understanding of probability from the previous unit and the awareness that the area under a curve will be looked at again in this unit. GCSE (9-1) in Mathematics at Higher Tier • N1 Order positive and negative integers, decimals and fractions; use the symbols $=$, $\neq$, $<$, $>$, $\leq$, and $\geq$ An understanding of how to calculate binomial probabilities and using samples from populations from previous units.
How will this term's content help with future learning?	<i>Pure:</i> <i>Year 13:</i> <i>Unit 3 Functions and modelling</i> <i>Unit 5 The binomial theorem</i>	<i>Applied:</i> <i>Year 13:</i> <i>Unit 1: Hypothesis testing</i> <i>Unit 2 Conditional Probability</i>
Resources		
Links to the national curriculum/specification	<i>Pure:</i> 2.7 Understand and use proportional relationships and their graphs 3.1 Understand and use the equation of a straight line, including the forms $y-y_1=m(x-x_1)$ and $ax+by+c=0$ Gradient conditions for two straight lines to be parallel or perpendicular Be able to use straight line models in a variety of contexts 3.2 Understand and use the coordinate geometry of the circle including using the equation of a	<i>Applied</i> 3.1 Understand and use mutually exclusive and independent events when calculating probabilities Link to discrete and continuous distributions 4.1 Understand and use simple, discrete probability distributions (calculation of mean and variance of discrete random variables is excluded), including the binomial distribution, as a model; calculate probabilities using the binomial distribution

	circle in the form $(x-a)^2+(y-b)^2=r^2$ Completing the square to find the centre and radius of a circle Use of the following properties: - the angle in a semicircle is a right angle - the perpendicular from the centre to a chord bisects the chord - the radius of a circle at a given point on its circumference is perpendicular to the tangent to the circle at that point 2.6 Manipulate polynomials algebraically, including expanding brackets and collecting like terms, factorisation and simple algebraic division; use of the factor theorem 1.1 Understand and use the structure of mathematical proof, proceeding from given assumptions through a series of logical steps to a conclusion; use methods of proof, including: proof by deduction, proof by exhaustion, disproof by counter-example 4.1 Understand and use the binomial expansion of $(a+bx)^n$ for positive integer n; the notations $n!$ and nC_r; link to binomial probabilities	5.1 Understand and apply the language of statistical hypothesis testing, developed through a binomial model: null hypothesis, alternative hypothesis, significance level, test statistic, 1-tail test, 2-tail test, critical value, critical region, acceptance region, p-value 5.2 Conduct a statistical hypothesis test for the proportion in the binomial distribution and interpret the results in context Understand that a sample is being used to make an inference about the population and appreciate that the significance level is the probability of incorrectly rejecting the null hypothesis
Assessments	Pure: Coordinate geometry in the (x,y) plane assessment Further Algebra assessment	<i>Applied:</i> Probability assessment Statistical distribution assessment Statistical Hypothesis testing assessment
Term Three		
Content of study (Title)	Pure Unit 4: Trigonometry	Applied Unit 5: Vectors (2D) Unit 6: Quantities and units in mechanics Unit 7: Kinematics
What are the aims and objectives of this term?	Pure To understand and apply: Trigonometric ratios, Trigonometric identities and equations	Applied To understand and apply: Vectors in 2D, Modelling in mechanics, Constant acceleration
What previous knowledge is required?	Pure: Algebra covered so far - Basic algebraic manipulation - Quadratics - Graph transformations GCSE (9-1) in Mathematics at Higher Tier	Applied: An understanding of probability from the previous unit and the awareness that the area under a curve will be looked at again in this unit. GCSE (9-1) in Mathematics at Higher Tier

	G20 Pythagoras' Theorem Trigonometry in right-angled triangles G22 The sine rule The cosine rule G23 The area of a triangle G15 Bearings Covered so far - Surds - Trigonometry GCSE (9-1) in Mathematics at Higher Tier G24 Vectors	N1 Order positive and negative integers, decimals and fractions; use the symbols =, ≠, <, >, ≤, and ≥ An understanding of how to calculate binomial probabilities and using samples from populations from previous units.
How will this term's content help with future learning?	<i>Pure:</i> <i>Year 13</i> <i>Unit 6 Trigonometry</i> <i>Unit 11 Vectors 3D</i>	<i>Applied</i> <i>Year 13</i> <i>Unit 5: Forces and friction</i> <i>Unit 6: Projectiles</i>
Resources		
Links to the national curriculum/specification	<i>Pure</i> 5.1 Understand and use the definitions of sine, cosine and tangent for all arguments; the sine and cosine rules; the area of a triangle in the form $\frac{1}{2}ab\sin C$ 5.3 Understand and use the sine, cosine and tangent functions; their graphs, symmetries and periodicity 5.5 Understand and use $\tan\theta = \frac{\sin\theta}{\cos\theta}$ Understand and use $\sin^2\theta + \cos^2\theta = 1$ 5.7 Solve simple trigonometric equations in a given interval, including quadratic equations in sin, cos and tan and equations involving multiples of the unknown angle 10.1 Use vectors in two dimensions 10.2 Calculate the magnitude and direction of a vector and convert between component form and magnitude/direction form 10.3 Add vectors diagrammatically and perform the algebraic operations of vector addition and multiplication by scalars, and understand their geometrical interpretations 10.4 Understand and use position vectors; calculate the distance between two points represented by position vectors	<i>Applied</i> 6.1 Understand and use fundamental quantities and units in the S.I. system: length, time, mass. Understand and use derived quantities and units: velocity, acceleration, force, weight 7.1 Understand and use the language of kinematics: position; displacement; distance travelled; velocity; speed; acceleration. 7.2 Understand, use and interpret graphs in kinematics for motion in a straight line: displacement against time and interpretation of gradient; velocity against time and interpretation of gradient and area under the graph 7.3 Understand, use and derive the formulae for constant acceleration for motion in a straight line 8.3 Understand and use weight and motion in a straight line under gravity; gravitational acceleration, g, and its value in S.I. units to varying degrees of accuracy

	10.5 Use vectors to solve problems in pure mathematics and in context, (including forces)	
Assessments	<i>Pure:</i> <i>Unit 4: Trigonometry assessment</i>	<i>Applied:</i> <i>Unit 5: Vectors (2D) Assessment</i> <i>Unit 6: Quantities and units in mechanics assessment</i> <i>Unit 7: Kinematics assessment</i>
Term Four		
Content of study (Title)	Pure <i>Unit 6 Differentiation</i> <i>Unit 7: Integration</i>	Applied <i>Unit 8: Forces and Motion</i> <i>Unit 9: Kinematics 2</i>
What are the aims and objectives of this term?	Pure See above	Applied See above
What previous knowledge is required?	Covered so far - Indices - Solving quadratics - Coordinate geometry - Proof - Function notation - Indices GCSE (9-1) in Mathematics at Higher Tier N8 Fractions G16 Area of 2D shapes - Volume and surface area of 3D shapes A5 Rearranging equations R16 Compound interest	- Modelling and definitions/assumptions from the introduction in Unit 6 GCSE (9-1) in Mathematics at Higher Tier A19 Solve two simultaneous equations in two variables (linear/linear or linear/quadratic) algebraically; find approximate solutions using a graph GCSE (9-1) in Mathematics at Higher Tier R1 Change freely between related standard units (e.g. time, length, area, volume/capacity, mass) and compound units (e.g. speed, rates of pay, prices, density, pressure) in numerical and algebraic contexts R11 Use compound units such as speed, rates of pay, unit pricing, density and pressure A2 Substitute numerical values into formulae and expressions, including scientific formulae A5 Understand and use standard mathematical formulae; rearrange formulae to change the subject A14 Plot and interpret graphs (including reciprocal graphs and exponential graphs) and graphs of non-standard functions in real contexts to find approximate solutions to problems such as simple kinematic problems involving distance, speed and acceleration

		• A15 Calculate or estimate gradients of graphs and area under graphs (including quadratic and non-linear graphs), and interpret results in cases such as distance-time graphs, velocity-time graphs and graphs in financial contexts • A17 Solve linear equations in one unknown algebraically (including those with the unknown on both sides of the equation) • A18 Solve quadratic equations (including those that require rearrangement) algebraically by factorising, by completing the square and by using the quadratic formula AS Mathematics - Pure Mathematics content • 3.1 Gradient (See Unit 2a of the SoW)
How will this term's content help with future learning?	<i>Pure:</i> <i>Year 13 Unit 8 Differentiation</i> <i>Year 13 Unit 10 Integration</i>	<i>Applied</i> <i>Year 13 Unit 8 Further Kinematics</i> <i>Year 13 Unit 7 Application of forces</i>
Resources		
Links to the national curriculum/specification	<i>Pure:</i> 7.1 Understand and use the derivative of $f(x)$ as the gradient of the tangent to the graph of $y=f(x)$ at a general point (x,y); the gradient of the tangent as a limit; interpretation as a rate of change Sketching the gradient function for a given curve Second derivatives Differentiation from first principles for small positive integer powers of x 7.2 Differentiate x^n, for rational values of n, and related constant multiples, sums and differences 7.3 Apply differentiation to find gradients, tangents and normals, maxima and minima and stationary points Identify where functions are increasing or decreasing 8.1 Know and use the Fundamental Theorem of Calculus 8.2 Integrate x^n (excluding $n=-1$), and related sums, differences and constant multiples	<i>Applied</i> 7.1 Understand and use the language of kinematics: position; displacement; distance travelled; velocity; speed; acceleration. 7.2 Understand, use and interpret graphs in kinematics for motion in a straight line: displacement against time and interpretation of gradient; velocity against time and interpretation of gradient and area under the graph 7.3 Understand, use and derive the formulae for constant acceleration for motion in a straight line 8.3 Understand and use weight and motion in a straight line under gravity; gravitational acceleration, g, and its value in S.I. units to varying degrees of accuracy 8.1 Understand the concept of a force; understand and use Newton's first law. 8.2 Understand and use Newton's second law for motion in a straight line

	8.3 Evaluate definite integrals; use a definite integral to find the area under a curve	(restricted to forces in two perpendicular directions or simple cases of forces given as 2D (i, j) vectors). 8.4 Understand and use Newton's third law; equilibrium of forces on a particle and motion in a straight line; application to problems involving smooth pulleys and connected particles.
Assessments	Pure: <i>Differentiation assessment</i> <i>Integration assessment</i>	<i>Applied</i> <i>Kinematics 1 assessment</i> <i>Forces & Newtons Laws assessment</i>
Term Five		
Content of study (Title)	Pure <i>Unit 8: Exponentials and logarithms</i> <i>Revision and formal assessment</i>	Applied <i>Revision and formal assessment</i>
What are the aims and objectives of this term?	Pure See above	Applied See above
What previous knowledge is required?	Covered so far - Indices GCSE (91) in Mathematics at Higher Tier - R16 Compound interest	
How will this term's content help with future learning?	<i>Year 13 Unit 3 Functions and modelling</i>	
Resources		
Links to the national curriculum/specification	6.1 Know and use the function ax^a and its graph, where a is positive Know and use the function ex^x and its graph 6.2 Know that the gradient of ek^x is equal to kek^x and hence understand why the exponential model is suitable in many applications 6.3 Know and use the definition of $\log_a x$ as the inverse of ax^a as the inverse of ax^a is positive and $x \geq 0$ Know and use the function $\ln x$ and its graph Know and use $\ln x$ as the inverse function of ex^x 6.4 Understand and use the laws of logarithms: $\log_a x + \log_a y = \log_a(xy)$ $\log_a \frac{x}{y} = \log_a x - \log_a y$ $\log_a x^p = p \log_a x$	

	$k \log_a x = \log_a x^k$ $k \log_a \frac{x}{y} = \log_a \frac{x}{y^k}$ (including, for example, $k = -1$ $k = -1$ and $= -12 = -12$) 6.5 Solve equations of the form $ax = b$ $ax = b$ 6.6 Use logarithmic graphs to estimate parameters in relationships of the form $y = ax^n$ $y = ax^n$ and $y = kbx^y = kbx$, given data for xx and yy 6.7 Understand and use exponential growth and decay; use in modelling (examples may include the use of e in continuous compound interest, radioactive decay, drug concentration decay, exponential growth as a model for population growth); consideration of limitations and refinements of exponential models	
Assessments	Pure: <i>Exponentials and logarithms assessment</i>	
Term Six		
Content of study	Pure YR13 Unit 1: Proof Unit 2: Algebraic and partial fractions	Applied YR 13 Unit 4: Moments
What are the aims and objectives of this term?	Pure See above	Applied See above
What previous knowledge is required?	GCSE (91) in Mathematics at Higher Tier G20 Pythagoras Theorem Trigonometry A4 Algebraic fractions A18 Algebraic manipulation including completing the square N4, N8, N10 Surds, prime and irrational numbers AS Mathematics - Pure Mathematics content 1.1 Proof (See Unit 3a of the SoW) 2.6 Algebraic division, factor theorem (See Unit 3a of the SoW)	- Types of forces and force diagrams - Assumptions made throughout this course (e.g. particle, rigid, light, etc.) - Weight = mass $\times$ gravity ($W = mg$) - S.I. units GCSE (9-1) in Mathematics at Higher Tier A19 Solving linear and simultaneous equations AS Mathematics - Mechanics content 8.4 Basic equilibrium (See Unit 8a of the SoW)
How will this term's content help with future learning?	Pure: Year 13 Unit 8 Differentiation Year 13 Unit 10 Integration	Applied: Year 13 Unit 5 Forces and Friction
Resources		
Links to the national curriculum/specification	Pure: 1.1	Applied: 9.1

	Understand and use the structure of mathematical proof, proceeding from given assumptions through a series of logical steps to a conclusion; use methods of proof, including proof by deduction. Proof by contradiction (including proof of the irrationality of $2-\sqrt{2}$ and the infinity of primes, and application to unfamiliar proofs) 2.6 Simplify rational expressions including by factorising and cancelling, and algebraic division (by linear expressions only) 2.10 Decompose rational functions into partial fractions (denominators not more complicated than squared linear terms and with no more than 3 terms, numerators constant or linear)	Understand and use moments in simple static contexts.
Assessments	Pure: <i>Proof assessment</i> <i>Algebraic and partial fractions assessment</i>	<i>Applied:</i> <i>Moments assessments</i>