KS5 Curriculum Overview: Core Maths

Core aims of the subject at Key Stage 5

"Mathematics expresses values that reflect the cosmos, including orderliness, balance, harmony, logic, and abstract beauty." **Deepak Chopra**

Mathematics is a creative and highly inter-connected discipline that has been developed over centuries, providing the solution to some of history's most intriguing problems. It is essential to everyday life, critical to science, technology and engineering, and necessary for financial literacy and most forms of employment. A high-quality mathematics education therefore provides a foundation for understanding the world, the ability to reason mathematically, an appreciation of the beauty and power of mathematics, and a sense of enjoyment and curiosity about the subject.

Our curriculum in mathematics aims to develop fluency in the fundamentals of mathematics, including through varied and frequent practice with increasingly complex problems over time, so that students develop conceptual understanding and the ability to recall and apply knowledge rapidly and accurately. We are also striving to allow students to reason mathematically by following a line of enquiry, conjecturing relationships and generalisations, develop mathematical arguments and proofs and make conclusions based on logical inferences. Our intention is also for students to solve problems by applying their mathematics to a variety of routine and non-routine problems with increasing sophistication, including breaking down problems into a series of simpler steps and persevering in seeking solutions; as such resilience is a crucial skill that we will be cultivating in students. Students also need to be able to utilise technology effectively, such as scientific calculators, to perform increasingly complex problems (as well having strong written and mental mathematical skills, not instead of). As the repertoire of mathematical skills that a student possesses grows increasingly more complex, so should the ability of students to use their mathematics to model real life situations.

At key stage 3, we promote equality by working through the breadth of the curriculum at the same pace for all students so that all students can achieve regardless of their starting point. All students at key stage 3 have the option of attending a number of lunchtime clubs in mathematics (Countdown club, 24 club, TT Rockstars club). We extend our highest attaining students through depth and more challenging problem solving, rather than an acceleration of content. At key stage 4, all students continue their mathematical studies on an appropriate GCSE pathway determined by their prior attainment and performance across key stages 2 and 3 to give them the best chance of achieving well in the subject. The GCSE curriculum is also supplemented for the most able students by offering Additional Maths to inspire, motivate and support students in their transition to key stage 5; in all key stages we also enter our most able students into the annual UKMT maths challenge competition. We intend for a high proportion of our students to go on and study or use mathematics in some form post-16; this

means that our key stage 4 curriculum needs to be broad enough to cater for students who will go on to study maths at the highest level in our Further Mathematics and STEP preparation classes to those who will study Core Mathematics to complement their A Level choices.

In addition to the obvious intention of preparing students for more advanced mathematical studies, mathematics also prepares students for future learning in other disciplines and improves the cognitive ability in general of students and, as such, is essential for their personal development. The study of mathematics conditions the brain to see connections and builds neural pathways that make the brain stronger for all other things. Mathematical study enhances students' general intelligence and supports the life-long learning of students by: creating a framework in the brain for systematic thinking, developing the ability to solve and analyse problems, stretching the mind to work on unfamiliar tasks with confidence, developing the sequencing skills critical to arriving at accurate results or logical conclusions, promoting caution and care in thinking and deciphering complex mathematical problems to arrive at an accurate answer and learning through trial and error to integrate different principles to arrive at a logical conclusion.

In addition to these disciplinary aspects of the mathematics curriculum, the actual mathematical knowledge and skills that students learn are also vitally important in allowing students to achieve elsewhere in school. Topics studied in mathematics are prerequisite for several disciplines across key stages 3, 4 and 5 such as geography, psychology and economics (to name only a few). Mathematics also provides a theoretical springboard for the ever-evolving STEM sector. Nationally, there are huge shortfalls in job applicants with strong STEM skills and reports estimate that the cost of this shortfall is £1.5 billion each year. Furthermore, occupations in the STEM sector are growing at a rate that nearly is nearly double other sectors which could see this shortfall exacerbated. Our intention is to develop students' abilities sufficiently so that they are able to rise to the challenging opportunities this sector has to offer. In the 21st century science, technology and engineering are constantly changing and have become increasingly important for society. The mathematical principles that govern these areas, however, have not changed and consequently the breadth and depth of our curriculum aims to future-proof our students in this field. This is all in addition to the inspirational and motivating research that claims that candidates with strong maths skills earn on average 11% more in their lifetime.

Mathematics is a discipline which is universal; transcending language and cultural differences. Throughout its rich history, mathematics has adopted elements from around the world and gives students the opportunity to appreciate fundamental truths and create water-tight arguments based on logic and reasoning; as such it helps contribute to the student's spiritual, moral, spiritual and cultural development.

Ultimately, the intention of the maths curriculum is to provide students with the necessary thinking skills and content to be successful in their next stage of life or education.

Assessment

Each chapter will be assessed by an end of unit test. More formal assessment happens at the end of year 12 and the end of the Autumn term in year 13 where students will sit a full mock exam. Informal assessment happens in lesson through questioning and circulating the classroom. A lot of work at Key Stage 5 is self-assessed as teachers will go through the answers to exercises during each lesson.

Homework

No homework is set for Core Maths as the content is intended to be delivered solely in lesson time. Preparation for assessments, however, is still expected from students in their study periods.

Clubs and/or intervention

Drop-in sessions run each week

Parental/Carer support

Parents can check homework online to keep up to date with student work.
Encourage students to attend drop-in sessions

Connections to Learning

Mathematics is a highly inter-connected discipline. Core Mathematics comprises four strands: applications of statistics, probability, linear programming and sequences and growth. These strands can be thought of as symbiotic; advances in one strand allow for further development of the others. Consequently, the connections between the various strands of the mathematics curriculum are myriad and one of the most enjoyable aspects of mathematics is studying seemingly separate areas of study and then making links between them and seeing how these areas interact. In addition, the majority of the curriculum for core mathematics is taken from GCSE mathematics. The focus for this qualification is applying the mathematics to various contexts. In mathematics lessons, depth of understanding is prioritised. This involves taking the time to see how a particular topic links to the other topics that have already been studied. As a consequence of the need to understand all of these various connections within mathematics, students should expect to be given regular opportunity to review prior learning as students will struggle with new concepts if they have not developed fluency with previous concepts.

Below shows the progression of the different strands of the curriculum from years 7 to 11 (Geometry has been omitted as Core Maths does not develop these ideas any further). The core maths content has been added to identify where this links to prior learning. As mentioned above, a lot of the content in this qualification will be familiar to students but there is an increased emphasis on application.

Number:

Number 1: Place Value for integers and decimals, ordering, rounding, upper and lower bounds, use estimation to replace values in calculation, powers of ten, multiplying and dividing by powers of ten

Number 2: Special Numbers: Squares, cubes, roots primes, multiples, factors, prime factor decomposition, LCM, HCF, Venn diagrams, standard form, higher powers, index rules,

Number 3: Calculations,(3a) addition, subtraction (including time differences, perimeter) (3b) multiplication and division, problem solving, product rule for counting(3c) calculating with negatives, order of operations

Number 4: Fractions and Decimals, (use bar diagrams) equivalencies (fractions to decimals), equivalent fractions and cancelling, adding and subtraction, mixed numbers and improper fractions. Multiplication and fractions of amounts.

Number 5: Revise fractions, addition, subtraction, multiplication and revision, percentages (equivalence and percentage change) and decimals including x and ÷ by 0.1, 0.01, multiplicative reasoning.

Number 6: Ratio and Proportion know and use notation, simplify, share in given ratio, include bar model and problem solving including combining ratios.

Number 7: Consolidate powers and roots if required. Indices including fractional indices

Algebra:

Algebra 1: Notation, expressions, simplifying, substituting, expanding and factorising

Algebra 2: Solving equations linear, brackets, unknowns both sides

Algebra 3: Sequences: continuing, term to term, nth term, recognition of arithmetic, geometric, Fibonacci

Algebra 4: Algebraic manipulation including index laws, expanding and factorising quadratics, solving quadratics by factorisation.

Algebra 5: Coordinate geometry, linear graphs, real life graphs including rates of change and compound measures. Quadratic graphs.

Algebra 6: Consolidate solving linear and quadratic equations if required; simultaneous equations and inequalities including inequations, number lines and graphical representations, rearranging formulae

GCSE Unit 9: Equations and inequalities
GCSE Unit 15: Equations and Graphs
GCSE Unit 6: Further Graphs
GCSE Unit 17: Further Algebra
GCSE Unit 19: Proportions and Graphs

Core Mathematics: Sequences and Growth
Core Mathematics: Linear Programming

Statistics:

Statistics 1: Types of data, averages and range: Mean, median, mode and range, mean from frequency tables, estimated mean, extend into geometric mean

Statistics 2: Probability including and/or laws, sample spaces, frequency trees, probability trees, two way tables and Venn diagrams, conditional probability, probability using algebraic terms.

Statistics 3: Recap averages and range, Collecting and representing data, sampling, pie charts, line graphs, stem and leaf, dual and composite bar charts extending into reverse mean, cumulative frequency, box plots, quartiles and IQR

GCSE Unit 10: Probability
GCSE Unit 14: Further Statistics

Core Mathematics: Applications of Statistics
Core Mathematics: Probability

and simple surds. Estimating powers and roots of any given number.
Number 8: Consolidate percentages, ratio and proportion compound measures. Direct and indirect proportion, percentage change, reverse percentages and growth and decay.

GCSE Unit 4: Fractions, Decimals and Percentages
GCSE Unit 11: Multiplicative Reasoning

Core Mathematics: Sequences and Growth

Personal Development – throughout the course students are developed by increasing their ability for abstract thought as well as forming coherent, logial arguments and chains of reasoning. This course also supports students' personal development by maintaining and extending their ability to be numerate and apply mathematics to a variety of contexts. There is also a strong focus on being data literate in the statistics strand of the course.
Social Development – content from sequences and growth allows students to understand how disease is spread and the rates at which they spread giving them a good insight into the coronavirus pandemic
Cultural Development – throughout the course students are exposed to mathematics which was developed across the globe and the diverse history of the subject represents modern Britain. Students also learn to use a universal language which transcends cultures and countries.

Connections to Future Pathways

Studying maths helps to develop skills in logical thinking, analysis, problem-solving, decision-making and communication, which are valued by employers across many job sectors. Furthermore, mathematical careers are in every business and industry throughout every sector of the economy. Mathematics may not be the central focus of all professions, but it can serve as critical building blocks of a larger and more meaningful whole. Mechanical engineers, for example, work with numbers for the design and production of all types of simple and complex machines. Actuaries use numbers to calculate and assess the consequences of financial risk. And economists analyse and interpret

quantitative data to discern macro- and micro-economic patterns. Banking is a world of numbers and mathematics is used in the way accounts are handled, for calculating interest rates and for determining credit scores.

Data - Again, big data plays a major role in the increased demand for skilled data scientists. It is the job of data scientists to immerse themselves in the ocean of big data, bringing structure to it that, in turn, allows for effective analysis of that data. Many employers rate the ability to handle data very highly.
Number – Banking, Accountancy and Finance. For example, Accountants examine financial records and prepare financial documents for businesses, nonprofits, firms and individuals. They are responsible for the accuracy of the documents they create and for making sure that taxes are paid on time.
Algebra – Air Traffic Controllers, Video Game Designers and Economists. Air traffic controller uses math in order to be able to understand distances and measurements at a moment's notice. They also must be able to do mental math quickly and accurately. Part of their job is directing aircraft at what altitude and speed to fly. For example, air traffic controllers frequently need to calculate the minimum safe level for planes to fly at. To do this they use the equation:

Minimum safe level (measured in feet) = 30 × (1013 - pa)
(*pa* is the atmospheric pressure. This value can change daily, depending on weather systems.)

Other Careers:
• Logistics specialist • Control statistician • Systems operation analyst • Robotics analyst • Actuary • Insurance underwriter • Operations research analyst • Technical mathematical modeller • Financial analyst • Business metrics analyst • Big data analyst • Marketing consultant • Claims adjuster • Database administrator • Cryptographer

The most common destinations for our further mathematicians are: maths degree, physics degree, engineering degree or computer science degree.

Helpful sources of information

https://www.drfrostmaths.com/ provides a lot of the Powerpoint slides and resources that are used in lessons, this is also the platform where students complete their homework.
https://www.examsolutions.net/ and https://www.physicsandmathstutor.com/ are very helpful websites to help students prepare for exams
https://www.pearsonactivelearn.com/ has electronic access to the course textbooks (students will be need a login from their class teacher to access these)

https://integralmaths.org/ has a lot of support for students and contains assessments (as well as revision notes) for each unit across years 12 and 13
https://sparxmaths.com/ has video tutorials and quizzes on all of the prerequisite skills from key stages 3 and 4
https://www.desmos.com/ is a free graphing tool which students will find helpful to aid coordinate geometry problems; there is also an app for this that they can install on their phone
https://maths.org/step/ provides resources to help students to prepare for STEP

Year 12 Overview

Knowledge	Assessment
Applications of statistics Statistics is the study of the collection, organisation, analysis, interpretation and presentation of data. It plays an increasingly important role in life, study and employment in a wide variety of contexts. It is important to be comfortable and confident in dealing with real data. It is used in areas of study such as actuarial science, biology, business and economics, IT and psychology. These skills are deliberately at the start of the course as they are the ones that are most likely to be required by other A Levels.	

➢ Infer properties of populations or distributions from a sample, while knowing the limitations of sampling ➢ Interpret and construct tables and line graphs for time series data; calculate, interpret and use moving average ➢ Interpret, analyse and compare the distributions of data sets from univariate empirical distributions through appropriate measures of central tendency and range ➢ Interpret, analyse and compare the distributions of data sets from univariate empirical distributions through appropriate measures of central tendency, including quartiles, inter-quartile range, calculate and use variance and standard deviation ➢ Interpret, analyse and compare the distributions of data sets from univariate empirical distributions through appropriate graphical representation, including box plots ➢ 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 use them appropriately ➢ Recognise correlation and know that it does not indicate causation ➢ Use, apply and interpret Spearman's rank; calculate Spearman's rank correlation coefficient and use it as a measure of agreement or for comparisons of the degree of correlation (tied ranks may be tested in the examination papers). ➢ Use, apply and interpret linear regression; calculate the equation of a linear regression line using the method of least squares (candidates may be asked to draw this regression line on a scatter diagram) ➢ Apply and interpret explanatory (independent) and response (dependent) variables, interpolate and extrapolate apparent trends while knowing the dangers of doing so ➢ Draw estimated lines of best fit and make predictions; use and interpret the product moment correlation coefficient, recognising its limitations ➢ Use, apply and interpret linear regression; calculate the equation of a linear regression line using the method of least squares (candidates may be asked to draw this regression line on a scatter diagram)	➢ Students will be tested on each unit of work around two weeks after the unit has been completed. ➢ No other homework is expected of students outside of lessons. ➢ Students will be tested on each unit of work around two weeks after the unit has been completed. ➢ No other homework is expected of students outside of lessons. ➢ Students will be tested on each unit of work around two weeks after the unit has been completed. ➢ No other homework is expected of students outside of lessons. ➢ Students will be tested on each unit of work around two weeks after the unit has been completed. ➢ No other homework is expected of students outside of lessons.

➢ Set up, solve and interpret the answers to growth and decay problems, including compound interest ➢ Calculate simple interest and compound interest; use and interpret graphical representation of simple and compound interest	

<table>
<tr><td colspan="2">Sequences and growth
A mathematical understanding of sequences, growth and decay can be applied to a variety of real-life contexts and problem-solving tasks, including financial mathematics, population growth, epidemics, earthquakes and radioactive decay.</td></tr>
<tr><td>Recognise, sketch and interpret graphs of quadratic functions, reciprocal functions, polynomial functions of the form $y = x^n$ and exponential functions $y = k^x$ for positive values of k
Interpret the gradient at a point on a curve as the instantaneous rate of change and apply the concepts of average and instantaneous rates of change (gradients of chords and tangents) in numerical and graphical contexts
Calculate with roots, and with integer and fractional indices
Recognise and interpret linear and quadratic sequences; deduce expressions to calculate the nth term of linear and quadratic sequences
Recognise, use and interpret sequences, including those given by a formula for the nth term, those generated by a simple relation of the $x_{n+1}=f(x_n)$, Fibonacci sequences and the golden ratio
Understand and use sigma notation Recognise, use and interpret arithmetic series, including the general term of an arithmetic series and the sum to n terms of an arithmetic series
Recognise, use and interpret geometric series, including the general term of a geometric series, the sum to n terms of a geometric series and the sum to infinity of a convergent geometric series including the use of $|r| < 1$.</td><td>➢ Students will be tested on each unit of work around two weeks after the unit has been completed.
➢ No other homework is expected of students outside of lessons.</td></tr>
<tr><td colspan="2">Linear programming
This is a problem-solving approach to achieve the best outcome (such as maximum profit or lowest cost) through consideration of conditions that can be modelled by linear relationships. Linear programming can be applied to a variety of contexts in business and industry. It is used most extensively in business and economics but is also utilised for some engineering problems. Linear programming models are used in industries such as transportation, energy, telecommunications and manufacturing. Linear programming has proved useful in modelling diverse types of problems in planning, routing, scheduling, task assignment and design.</td></tr>
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Translate simple situations or procedures into algebraic expressions or formulae; derive an equation (or two simultaneous equations), solve the equation(s) and interpret the solution Plot graphs of equations that correspond to straight line graphs in the coordinate plane; use the form y = mx + c to identify parallel lines; find the equation of the line through two given points, or through one point with a given gradient Recognise, sketch and interpret graphs of linear functions Solve algebraically linear equations in one unknown with the unknown on both sides of the equation Solve two simultaneous equations in two variables (linear/linear) algebraically; find approximate solutions using a graph Solve linear inequalities in one variable, representing the solution on a number line using set notation Solve linear inequalities in two variables, representing the solution on a graph Use algebra to support and construct arguments Formulate problems as linear programs with up to three variables Solve and interpret two-variable problems graphically, using ruler and vertex methods Consider problems where solutions must have integer values.	➢ Students will be tested on each unit of work around two weeks after the unit has been completed. ➢ No other homework is expected of students outside of lessons.
Probability Probability is used to determine a numerical value for the chance or risk of events happening. Probability theory has made significant contributions to almost all branches of science and engineering over the last 100 years. Probability is used in areas of study such as finance, science, artificial intelligence, business, computer science and philosophy.	
Understand and demonstrate that empirical unbiased samples tend towards theoretical probability distributions, as sample size increases Enumerate sets and combinations of sets systematically using tree diagrams Calculate the probability of independent and dependent combined events, including sampling with and without replacement, using tree diagrams and other representations, Venn diagrams, sum and product laws Calculate and interpret conditional probabilities through representation using expected frequencies with two-way tables, tree diagrams and Venn diagrams	➢ Students will be tested on each unit of work around two weeks after the unit has been completed. ➢ No other homework is expected of students outside of lessons.

Understand, use and interpret probability notation, its application to Venn diagrams, exclusive and complementary events, independence of two events and conditional probability Understand, interpret and use appropriately the following formulae: $P(A') = 1 - P(A)$; $P(A \cup B) = P(A) + P(B) - P(A \cap B)$; $P(A \cap B) = P(A)P(B\|A)$; $P(B\|A) = P(B)$ and $P(A\|B) = P(A)$; $P(A \cap B) = P(A)P(B)$ Understand and interpret risk as the probability of something happening multiplied by the resulting cost or benefit if it does; comparison of levels of risk; application of risk to real-life contexts such as finance, insurance and trading.	