



# St George's School

## Mathematics

### KS5 Curriculum

<b>PREREQUISITE KNOWLEDGE &amp; SKILLS</b> <i>The foundations needed to thrive in this subject.</i>	<p><b>Who should study this subject?</b> To succeed at A Level Mathematics you must love the subject, have an analytical mind, an eye for detail and thrive on the challenge of algebra, looking for patterns, applying theory to abstract problems and the determination to find the solution. Characteristics of the most successful mathematicians include: Persistence, Communication, Resilience, Critical thinking, Logic, Curiosity, Creativity, Organisation.</p> <p><b>Key Skills developed during KS4:</b> A love of manipulating numbers and algebra along with an enquiring mind and ability to think logically with an eye for detail.</p> <p><b>St George's course entry requirements:</b> In addition to the entry requirement for sixth form, a <b>grade 7</b> or above in Mathematics</p>
<b>QUALIFICATION</b> <i>Exam Board, aims and objectives.</i>	<p><b>A Level Mathematics, Edexcel</b> <a href="https://qualifications.pearson.com/en/qualifications/edexcel-a-levels/mathematics-2017.html">https://qualifications.pearson.com/en/qualifications/edexcel-a-levels/mathematics-2017.html</a></p> <p>The new A Level Mathematics qualification has been developed to provide students with a coherent course of study to develop mathematical understanding. Students are encouraged to think, act and communicate mathematically, providing them with the skills to analyse situations in mathematics and elsewhere</p>
<b>ASSESSMENT</b> <i>Internal monitoring and final assessment.</i>	<p><b>Internal Assessment:</b> Students will have prep allocated at the end of each lesson and there will be a more formally assessed homework and topic test at the end of each major section of work (approx. two per half term). In addition there will be:</p> <ul style="list-style-type: none"><li>Start of Year 12: Review of Algebra Test (RAT) (Two 45 minute examinations)</li><li>Easter Year 12: End of year Examination (One 2 hour 30 minute examination)</li><li>September Year 13: AS Test (Two 1 hour examinations)</li><li>Christmas Year 13: Mock A2 Examination (Two 2 hour examinations)</li></ul> <p><b>Final assessment:</b> Assessment for A Level is by three 2 hour written papers.</p> <ul style="list-style-type: none"><li>Paper 1 assesses content from Pure Mathematics</li><li>Paper 2 assesses content from Pure Mathematics</li><li>Paper 3 assesses content from Statistics and Mechanics.</li></ul> <p>All papers will be sat during the June sessions at the end of Year 13.</p>
<b>ENRICHMENT</b> <i>Trips &amp; Visits, wider reading, etc.</i>	<p><b>Visits and Events:</b></p> <ul style="list-style-type: none"><li>Senior Maths Challenge</li><li>Maths Team Challenge</li><li>University of Hertfordshire Problem Solving Workshops</li><li>Mathsfest</li></ul> <p><b>Wider reading:</b></p> <ul style="list-style-type: none"><li>Books by Marcus du Sautoy, Rob Eastaway, Hannah Fry, Simon Singh and Ian Stewart</li><li>Podcasts including More or Less, Infinite Monkey Cage, Curious Cases of Rutherford and Fry</li></ul>

	<p>There are websites which are useful for wider reading:</p> <ul style="list-style-type: none"> <li>• <a href="http://www.cut-the-rope.org/">http://www.cut-the-rope.org/</a></li> <li>• <a href="https://plus.maths.org/content/">https://plus.maths.org/content/</a></li> </ul>
<p><b>NEXT STEPS</b> <i>Where this subject can take you.</i></p>	<p>We want 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.</p> <p><b>Related University Courses:</b> A Level Mathematics is one of the most widely accepted and respected subject choices by universities and is likely to enhance your options. Mathematics is offered as a single subject, part of a joint degree or is a vital part of 422 degree level courses in Great Britain. A Level Mathematics is a mandatory requirement for degree courses, such as Engineering, Physics, Statistics, and often Economics. Although not a requirement, A Level Mathematics is a typical subject taken by students on courses as wide ranging as Architecture, Law, Medicine, Psychology, Geography, Finance, Oceanography, Astronomy and Ecology.</p> <p><b>Career Paths:</b> Mathematics is contained and used within a wide variety of careers, it opens doorways to careers within Accounting, Engineering, Technology and Zoology, to name a few. As a consequence, it can be considered as one of the most useful, diverse and powerful subjects that can be taken at this level.</p>

Year 12	
<p><b>Autumn Term</b></p>	<p><b>Topics:</b> <b>AS Pure</b> Algebraic Expressions, Quadratics, Equations and Inequalities, Graphs and Transformations, Straight Line Graphs, Circles, Algebraic methods, Binomial Expansion, Vectors. <b>AS Statistics</b> Data collection, Measures of Location and Spread, Representations of Data, Correlation.</p> <p><b>Skills</b></p> <p><b>AS Pure</b> Expand a single term over brackets, collect like terms and expand the product of two or three expressions Factorise linear, quadratic and simple cubic expressions Know and use the laws of indices and surds including rationalising denominators Solve quadratic equations Read and use <math>f(x)</math> notation Sketch graphs and find turning points of quadratics Find and interpreting the discriminant Use and apply models that involve quadratic functions Solve linear simultaneous equations and linear and quadratic inequalities Represent and interpret algebraic solutions of equations, linear and quadratic inequalities graphically Sketch cubic, quartic, reciprocal graphs Use intersection points of graphs to solve equations Find the gradient, intercept and equation of a line Understand the link between the equation of a line, and its gradient and intercept. Find the point of interception for a pair of straight lines Know and use the rules for parallel and perpendicular gradients Solve length and area problems. Use straight lines to construct mathematical models Find midpoints of a line segment Find the equation of perpendicular bisectors. Solve geometric problems involving straight lines and circles. Find the angle in a semi circle and solve other problems involving circles and triangles. Cancel factors in algebraic fractions Divide a polynomial by a linear expression Use the factor theorem to factorise a cubic expression Construct mathematical proofs using algebra</p>

Use proof by exhaustion and disproof by counter -example.  
Understand the Binomial theorem, calculation of binomial coefficient and applying the binomial theorem.  
Developing 2D geometry skills with a detailed study of vectors, understanding position and displacement vectors and using vectors to solve geometrical problems in context

### **AS Statistics**

Understand 'population', 'sample', 'census and the advantages and disadvantages of different sampling techniques.  
Define qualitative, quantitative, discrete and continuous data and understand grouped data.  
Calculate measures of central tendency, measures of location, measures of spread, variance and standard deviation.  
Understand and use coding.  
Identify outliers in data sets  
Draw and interpret box plots, cumulative frequency diagrams and histograms  
Compare two data sets.  
Draw and interpret scatter diagrams for bivariate data  
Interpret correlation, coefficients of a regression line and when you can use a regression line to make predictions.

### **Assessment:**

Work will be continually monitored with regular formal homework assessments and in class topic check points

## **Spring Term**

### **Topics:**

#### **AS Pure**

Trigonometric Ratios, Trigonometric Identities and equations, Differentiation and Integration.

#### **AS Statistics**

Probability, Statistical Distributions, Hypothesis testing and Large Data Set analysis

#### **AS Mechanics**

Introduction to modelling, motion with constant acceleration, forces and motion

### **Skills:**

#### **AS Pure**

Applying the sine rule and cosine rules to find sides and angles of any triangle

Find the area of a triangle using an appropriate formula.

Solve problems using triangles

Sketch the graphs of sine, cosine and tangent functions and simple transformations of these graphs.

Understanding and using trigonometric functions and their graphs and exact trigonometric values

Understanding and using trigonometric identities, solving trigonometric equations

Find first and second order derivatives of simple functions and use them to solve problems involving gradients, tangents and normals

Identify increasing and decreasing functions

Find stationary points of functions and determine their nature

Sketch the gradient function of a given function

Model real-life situations with differentiation

Integrate polynomials

Evaluate definite integrals

Find areas bounded by curves and straight lines.

#### **AS Statistics**

Calculate probabilities for single events

Draw and interpret Venn diagrams

Understand mutually exclusive and independent events, and determine whether two events are independent.

Use and understand tree diagrams

Understand simple discrete probability and binomial distributions

Calculate individual and cumulative probabilities for binomial distributions

Understand the language and concept of hypothesis testing

Find critical values of a binomial distribution

Carry out one-tail and two-tail tests for the proportion of the binomial distribution and interpret the results.

Use ICT resources (excel) to investigate a large data set.

#### **AS Mechanics**

Use mechanics to model real-life scenarios understanding SI units and common assumptions.  
 Know the difference between scalar and vector quantities.  
 Using travel graphs and solving problems in kinematics.  
 Deriving equations for motion with constant acceleration, using and applying constant acceleration formula including to vertical motion under gravity culminating in solving multi-stage problems.  
 Draw force diagrams and calculate resultant forces  
 Understand and use Newton's first law  
 Calculate resultant forces by adding vectors  
 Understand and use Newton's second law,  $F = ma$   
 Apply Newton's second law to vector forces and acceleration  
 Understand and use Newton's third law  
 Solve problems involving connected particles

**Assessment:**

Work will be continually monitored with regular formal homework assessments and in class topic check points.

A formal year 12 examination is taken at Easter (One 2 hour 30 minute examination)

**Summer Term**

**Topics**

**AS Pure** – Exponential and logarithms

**AS Mechanics** – Variable acceleration.

**A2 Pure** – Algebraic methods, functions and graphs, sequences and series, binomial expansion, radians.

**A2 Mechanics** - Moments

**Skills:**

During the summer term students complete all AS topics and then build on these to develop the skills required for A2 examinations.

**AS Pure**

Sketch graphs of the form  $y = a^x$ ,  $y = e^x$ , and transformations of these graphs

Differentiate  $e^{kx}$  and understand why this result is important

Use and interpret models that use exponential functions

Recognise the relationship between exponents and logarithms

Recall and apply the laws of logarithms

Solve equations of the form  $a^x = b$

Describe and use the natural logarithm function

Use logarithms to estimate the values of constants in non-linear models

**AS Mechanics**

Understand that displacement, velocity and acceleration may be given as functions of time

Use differentiation to solve kinematics problems

Use calculus to solve problems involving maxima and minima

Use integration to solve kinematics problems

Use calculus to derive constant acceleration formulae

**A2 Pure**

Use proof by contradiction to prove true statements

Multiply and divide two or more algebraic fractions

Add or subtract two or more algebraic fractions

Convert an expression with linear factors in the denominator into partial fractions

Convert an expression with repeated linear factors in the denominator into partial fractions

Divide algebraic expressions

Convert an improper fraction into partial fraction form

Understand and use the modulus function

Understand mappings and functions, and use domain and range

Combine two or more functions to make a composite function

Know how to find the inverse of a function graphically and algebraically

Sketch the graphs of the modulus functions

$y = |f(x)|$  and  $y = f(|x|)$

Apply a combination of two (or more) transformations to the same curve

Transform the modulus function

Find the nth term of an arithmetic sequence

Prove and use the formula for the sum of the first n terms of an arithmetic sequence

Find the nth term of a geometric sequence  
Prove and use the formula for the sum of a finite geometric series  
Prove and use the formula for the sum to infinity of a convergent geometric series  
Use sigma notation to describe series  
Generate sequences from recurrence relations  
Model real-life situations with sequences and series  
Expand  $(1 + x)^n$  for any rational constant n and determine the range of values of x for which the expansion is valid  
Expand  $(1 + bx)^n$  for any rational constant n and determine the range of values of x for which the expansion is valid  
Use partial fractions to expand fractional expressions  
Convert between degrees and radians and apply this to trigonometric graphs and their transformations  
Know exact values of angles measured in radians  
Find an arc length using radians  
Find areas of sectors and segments using radians  
Use approximate trigonometric values when  $\theta$  is small

### **A2 Mechanics**

Calculate the turning effect of a force applied to a rigid body  
Calculate the resultant moment of a set of forces acting on a rigid body  
Solve problems involving uniform rods in equilibrium  
Solve problems involving non-uniform rods  
Solve problems involving rods on the point of tilting

### **Assessment:**

Work will be continually monitored with regular formal homework assessments and in class topic check points

## Year 13

### Autumn Term

#### **Topics:**

**A2 Pure** – Trigonometric functions, trigonometry and modelling, Differentiation, Integration  
**A2 Statistics** – Regression, correlation and hypothesis testing, conditional probability, the normal distribution.  
**A2 Mechanics** – Forces and friction, projectiles.

#### **Skills:**

##### **A2 Pure**

Understand the definitions of secant, cosecant and cotangent and their relationship to cosine, sine and tangent  
Understand the graphs of secant, cosecant and cotangent and their domain and range  
Simplify expressions, prove simple identities and solve equations involving secant, cosecant and cotangent  
Prove and use  $\sec^2 x \equiv 1 + \tan^2 x$  and  $\operatorname{cosec}^2 x \equiv 1 + \cot^2 x$   
Understand and use inverse trigonometric functions and their domain and ranges  
Prove and use the addition formulae  
Understand and use the double-angle formulae  
Solve trigonometric equations using the double-angle and addition formulae  
Write expressions of the form  $a\cos\theta \pm b\sin\theta$  in the forms  $R\cos(\theta \pm \alpha)$  or  $R\sin(\theta \pm \alpha)$   
Prove trigonometric identities using a variety of identities  
Use trigonometric functions to model real-life situations  
Differentiate trigonometric functions  
Differentiate exponentials and logarithms  
Differentiate functions using the chain, product and quotient rules  
Differentiate parametric equations  
Differentiate functions which are defined implicitly  
Use the second derivative to describe the behaviour of a function  
Solve problems involving connected rates of change and construct simple differential equations

Integrate standard mathematical functions including trigonometric and exponential functions and use the reverse of the chain rule to integrate functions of the form  $f(ax + b)$   
Use trigonometric identities in integration  
Use the reverse of the chain rule to integrate more complex functions  
Integrate functions by making a substitution, using integration by parts and using partial fractions

### **A2 Statistics**

Understand exponential models in bivariate data  
Use a change of variable to estimate coefficients in an exponential model  
Understand and calculate the product moment correlation coefficient  
Carry out hypothesis test for zero correlation  
Understand set notation in probability  
Understand conditional probability  
Solve conditional probability problems using two -way tables and Venn diagrams  
Use probability formulae to solve problems  
Solve conditional probability using tree diagrams  
Understand the normal distribution and the characteristics of a normal distribution curve  
Find percentage points on a standard normal curve  
Calculate values on a standard normal curve  
Find unknown means and/or standard deviations for a normal distribution  
Approximate a binomial distribution using a normal distribution  
Select appropriate distributions and solve real -life problems in context  
Carry out hypothesis test for the mean of a normal distribution

### **A2 Mechanics**

Resolve forces into components  
Use the triangle law to find a resultant force  
Solve problems involving smooth or rough inclined planes  
Understand friction and the coefficient of friction  
Use  $F \leq \mu R$   
Model motion under gravity for an object projected horizontally  
Resolve velocity into components  
Solve problems involving particles projected at an angle  
Derive the formulae for time of flight, range and greatest height, and the equation of the path of a projectile

### **Assessment:**

#### **AS Examination during September**

Subsequent work will be continually monitored with regular formal homework assessments and in class topic check points.

### **Spring Term**

**Topics:**  
**A2 Pure** – Parametric equations, Numerical methods, Integration, Vectors  
**A2 Mechanics** – Application of forces, Further kinematics

### **Skills:**

#### **A2 Pure**

Convert parametric equations into Cartesian form by substitution  
Convert parametric equations into Cartesian form using trigonometric identities  
Understand and use parametric equations of curves and sketch parametric curves  
Solve coordinate geometry problems involving parametric equations  
Use parametric equations in modelling in a variety of contexts  
Locate roots of  $f(x) = 0$  by considering change of sign  
Use iteration to find an approximation to the root of the equation  $f(x) = 0$   
Use the Newton-Raphson procedure to find approximations to the solutions of equations of the form  $f(x) = 0$   
Use numerical methods to solve problems in context  
Use integration to find the area under a curve  
Use the trapezium rule to approximate the area under a curve  
Solve simple differential equations and model real-life situations with differential equations  
Understand 3D Cartesian coordinates  
Use vectors in three dimensions  
Use vectors to solve geometric problems  
Model 3D motion in mechanics with vectors

**A2 Mechanics**

Find an unknown force when a system is in equilibrium  
Solve statics problems involving weight, tension and pulleys  
Understand and solve problems involving limiting equilibrium  
Solve problems involving motion on rough or smooth inclined planes  
Solve problems involving connected particles that require the resolution of forces  
Work with vectors for displacement, velocity and acceleration when using the vector equations of motion  
Using calculus with harder functions of time involving variable acceleration  
Differentiate and integrate vectors with respect to time

**Assessment:****A2 Mock examination in January**

Subsequent work will be continually monitored with regular formal homework assessments and in class checkpoints

**Summer Term****Topics:**

The general aim is that all formal teaching of new topics is complete by the Spring term. This term is used for revision.

**Skills:**

Analysing multi- step problems  
Deciding on logical solution paths  
Communicating logically and with mathematical rationale.  
Developing independent revision skills and self-help groups  
Refining examination techniques of resilience, timekeeping and answering questions accurately by use of Mark Schemes.

**Assessment:**

'In class' revision topics check points and low grade quizzes may be given to support students' independent revision at the discretion of the teacher.

Final Assessment as detailed above