



01

Maths - UK

YEARS 10 - 12

Experience Level: **KEY-STAGE 4**Number of Classes: **VARIABLE**Age Range: **16 - 18 YEARS**

01

Working mathematically

- consolidate their numerical and mathematical capability from key stage 3 and extend their understanding of the number system to include powers, roots (and fractional indices).
- select and use appropriate calculation strategies to solve increasingly complex problems, including exact calculations involving multiples of π (and surds), use of standard form and application and interpretation of limits of accuracy.
- consolidate their algebraic capability from key stage 3 and extend their understanding of algebraic simplification and manipulation to include quadratic expressions, (and expressions involving surds and algebraic fractions)



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02

01

Working mathematically (Contd.)

- extend fluency with expressions and equations from key stage 3, to include quadratic equations, simultaneous equations and inequalities.
- move freely between different numerical, algebraic, graphical and diagrammatic representations, including of linear, quadratic, reciprocal, (exponential and trigonometric) functions.
- use mathematical language and properties precisely.

02

Reason mathematically

- extend and formalise their knowledge of ratio and proportion, including trigonometric ratios, in working with measures and geometry, and in working with proportional relations algebraically and graphically.
- extend their ability to identify variables and express relations between variables algebraically and graphically.
- make and test conjectures about the generalisations that underlie patterns and relationships; look for proofs or counter-examples; begin to use algebra to support and construct arguments (and proofs).
- reason deductively in geometry, number and algebra, including using geometrical constructions.
- interpret when the structure of a numerical problem requires additive, multiplicative or proportional reasoning.
- explore what can and cannot be inferred in statistical and probabilistic settings, and express their arguments formally.
- assess the validity of an argument and the accuracy of a given way of presenting information.



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03

03

Solve problems

- develop their mathematical knowledge, in part through solving problems and evaluating the outcomes, including multi-step problems.
- develop their use of formal mathematical knowledge to interpret and solve problems, including in financial contexts.
- make and use connections between different parts of mathematics to solve problems.
- model situations mathematically and express the results using a range of formal mathematical representations, reflecting on how their solutions may have been affected by any modelling assumptions.
- select appropriate concepts, methods and techniques to apply to unfamiliar and non-routine problems; interpret their solution in the context of the given problem.

04

Number

- apply systematic listing strategies, (including use of the product rule for counting).
- (estimate powers and roots of any given positive number).
- calculate with roots, and with integer (and fractional) indices.
- calculate exactly with fractions, (surds) and multiples of π ; (simplify surd expressions involving squares (for example $\sqrt{12} = \sqrt{4 \times 3} = \sqrt{4} \times \sqrt{3} = 2\sqrt{3}$) and rationalise denominators).
- calculate with numbers in standard form $A \times 10^n$, where $1 \leq A < 10$ and n is an integer



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Number (Contd.)

- (change recurring decimals into their corresponding fractions and vice versa).
- identify and work with fractions in ratio problems.
- apply and interpret limits of accuracy when rounding or truncating, (including upper and lower bounds).

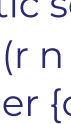
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Algebra

- simplify and manipulate algebraic expressions (including those involving surds (and algebraic fractions)) by:
 - factorising quadratic expressions of the form $x^2 + bx + c$, including the difference of two squares; (factorising quadratic expressions of the form $ax^2 + bx + c$).
 - simplifying expressions involving sums, products and powers, including the laws of indices.
- know the difference between an equation and an identity; argue mathematically to show algebraic expressions are equivalent, and use algebra to support and construct arguments (and proofs).
- where appropriate, interpret simple expressions as functions with inputs and outputs; (interpret the reverse process as the 'inverse function'); interpret the succession of two functions as a 'composite function'.
- use the form $y = mx + c$ to identify parallel (and perpendicular) lines; find the equation of the line through two given points, or through one point with a given gradient.
- identify and interpret roots, intercepts and turning points of quadratic functions graphically; deduce roots algebraically (and turning points by completing the square).



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05

05

Algebra (contd.)

- recognise, sketch and interpret graphs of linear functions, quadratic functions, simple cubic functions, the reciprocal function $y = 1/x$ with $x \neq 0$, (the exponential function $y = k$ to the x power for positive values of k , and the trigonometric functions (with arguments in degrees) $y = \sin x$, $y = \cos x$ and $y = \tan x$ for angles of any size).
- (sketch translations and reflections of the graph of a given function).
- 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.
- (calculate or estimate gradients of graphs and areas under graphs (including quadratic and other non-linear graphs), and interpret results in cases such as distance-time graphs, velocity-time graphs and graphs in financial contexts).
- (recognise and use the equation of a circle with centre at the origin; find the equation of a tangent to a circle at a given point).
- solve quadratic equations (including those that require rearrangement) algebraically by factorising, (by completing the square and by using the quadratic formula); find approximate solutions using a graph.
- solve two simultaneous equations in two variables (linear/linear (or linear/quadratic)) algebraically; find approximate solutions using a graph.



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06

05

Algebra (contd.)

- (find approximate solutions to equations numerically using iteration).
- 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.
- solve linear inequalities in one (or two) variable(s), (and quadratic inequalities in one variable); represent the solution set on a number line, (using set notation and on a graph).
- recognise and use sequences of triangular, square and cube numbers, simple arithmetic progressions, Fibonacci type sequences, quadratic sequences, and simple geometric progressions ($r \neq 0$ where n is an integer, and r is a positive rational number (or a surd)) (and other sequences).
- deduce expressions to calculate the n th term of linear (and quadratic) sequences.

06

Ratio, proportion and rates of change

- compare lengths, areas and volumes using ratio notation and/or scale factors; make links to similarity (including trigonometric ratios).
- convert between related compound units (speed, rates of pay, prices, density, pressure) in numerical and algebraic contexts.



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07

06

Ratio, proportion and rates of change (Contd.)

- understand that X is inversely proportional to Y is equivalent to X is proportional to $1/Y$; (construct and) interpret equations that describe direct and inverse proportion.
- interpret the gradient of a straight line graph as a rate of change; recognise and interpret graphs that illustrate direct and inverse proportion.
- (interpret the gradient at a point on a curve as the instantaneous rate of change; apply the concepts of instantaneous and average rate of change (gradients of tangents and chords) in numerical, algebraic and graphical contexts).
- set up, solve and interpret the answers in growth and decay problems, including compound interest (and work with general iterative processes).

07

Geometry and measures

- interpret and use fractional (and negative) scale factors for enlargements.
- (describe the changes and invariance achieved by combinations of rotations, reflections and translations).
- identify and apply circle definitions and properties, including: centre, radius, chord, diameter, circumference, tangent, arc, sector and segment.
- (apply and prove the standard circle theorems concerning angles, radii, tangents and chords, and use them to prove related results).
- construct and interpret plans and elevations of 3D shapes
- interpret and use bearings.

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08

07

Geometry and measures (Contd.)

- calculate arc lengths, angles and areas of sectors of circles.
- calculate surface areas and volumes of spheres, pyramids, cones and composite solids.
- apply the concepts of congruence and similarity, including the relationships between lengths, (areas and volumes) in similar figures.
- apply Pythagoras' Theorem and trigonometric ratios to find angles and lengths in right-angled triangles (and, where possible, general triangles) in two (and three) dimensional figures.
- know the exact values of $\sin \theta$ and $\cos \theta$ for $\theta = 0^\circ, 30^\circ, 45^\circ, 60^\circ$ and 90° ; know the exact value of $\tan \theta$ for $\theta = 0^\circ, 30^\circ, 45^\circ$ and 60° .
- (know and apply the sine rule, $a/\sin A = b/\sin B = c/\sin C$, and cosine rule, $a^2 = b^2 + c^2 - 2bc \cos A$, to find unknown lengths and angles).
- (know and apply $\text{Area} = 1/2 ab \sin C$ to calculate the area, sides or angles of any triangle).
- describe translations as 2D vectors.
- apply addition and subtraction of vectors, multiplication of vectors by a scalar, and diagrammatic and column representations of vectors; (use vectors to construct geometric arguments and proofs).

08

Probability

- apply the property that the probabilities of an exhaustive set of mutually exclusive events sum to one.
- use a probability model to predict the outcomes of future experiments; understand that empirical unbiased samples tend towards theoretical probability distributions, with increasing sample size.

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09

08

Probability (Contd.)

- calculate the probability of independent and dependent combined events, including using tree diagrams and other representations, and know the underlying assumptions.
- (calculate and interpret conditional probabilities through representation using expected frequencies with two-way tables, tree diagrams and Venn diagrams).

09

Statistics

- infer properties of populations or distributions from a sample, whilst knowing the limitations of sampling.
- interpret and construct tables and line graphs for time series data.
- (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).
- interpret, analyse and compare the distributions of data sets from univariate empirical distributions through:
 - appropriate graphical representation involving discrete, continuous and grouped data, (including box plots).
 - appropriate measures of central tendency (including modal class) and spread (including quartiles and inter-quartile range).
- apply statistics to describe a population.
- 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 whilst knowing the dangers of so doing.

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