

Secondary Stage 9 Mathematics for Year 9

Number

Integers, powers and roots

- Add, subtract, multiply and divide directed numbers.
- Estimate square roots and cube roots.
- Use positive, negative and zero indices and the index laws for multiplication and division of positive integer powers.

Place value, ordering and rounding

- Recognise the equivalence of 0.1, $1/10$ and 10^{-1} ; multiply and divide whole numbers and decimals by 10 to the power of any positive or negative integer.
- Round numbers to a given number of decimal places or significant figures; use to give solutions to problems with an appropriate degree of accuracy.
- Use the order of operations, including brackets and powers.

Fractions, decimals, percentages, ratio and proportion

- Consolidate writing a fraction in its simplest form by cancelling common factors.
- Add, subtract, multiply and divide fractions, interpreting division as a multiplicative inverse, and cancelling common factors before multiplying or dividing.
- Solve problems involving percentage changes, choosing the correct numbers to take as 100% or as a whole, including simple problems involving personal or household finance, e.g. simple interest, discount, profit, loss and tax.
- Recognise when fractions or percentages are needed to compare different quantities.
- Compare two ratios; interpret and use ratio in a range of contexts.
- Recognise when two quantities are directly proportional; solve problems involving proportionality, e.g. converting between different currencies.

Calculation

Mental strategies

- Extend mental methods of calculation, working with decimals, fractions, percentages and factors, using jottings where appropriate.
- Solve word problems mentally.
- Consolidate use of the rules of arithmetic and inverse operations to simplify calculations.

Multiplication and division

- Multiply by decimals, understanding where to position the decimal point by considering equivalent calculations; divide by decimals by transforming to division by an integer.
- Recognise the effects of multiplying and dividing by numbers between 0 and 1.

Algebra

Expressions, equations and formulae

- Know the origins of the word algebra and its links to the work of the Arab mathematician Al'Khwarizmi.
- Use index notation for positive integer powers; apply the index laws for multiplication and division to simple algebraic expressions.
- Construct algebraic expressions.
- Simplify or transform algebraic expressions by taking out single-term common factors.
- Add and subtract simple algebraic fractions.
- Derive formulae and, in simple cases, change the subject; use formulae from mathematics and other subjects.
- Substitute positive and negative numbers into expressions and formulae.

- Construct and solve linear equations with integer coefficients (with and without brackets, negative signs anywhere in the equation, positive or negative solution); solve a number problem by constructing and solving a linear equation.
- Solve a simple pair of simultaneous linear equations by eliminating one variable.
- Expand the product of two linear expressions of the form $x \pm n$ and simplify the corresponding quadratic expression.
- Understand and use inequality signs ($<$, $>$, \leq , \geq); construct and solve linear inequalities in one variable; represent the solution set on a number line.

Sequences, functions and graphs

- Generate terms of a sequence using term-to-term and position-to-term rules.
- Derive an expression to describe the n th term of an arithmetic sequence.
- Find the inverse of a linear function.
- Construct tables of values and plot the graphs of linear functions, where y is given implicitly in terms of x , rearranging the equation into the form $y = mx + c$; know the significance of m and find the gradient of a straight line graph.
- Find the approximate solutions of a simple pair of simultaneous linear equations by finding the point of intersection of their graphs.
- Use systematic trial and improvement methods to find approximate solutions of equations such as $x^2 + 2x = 20$ (1, 2 and 7).
- Construct functions arising from real-life problems; draw and interpret their graphs.
- Use algebraic methods to solve problems involving direct proportion, relating solutions to graphs of the equations.

Geometry

Shapes and geometric reasoning

- Calculate the interior or exterior angle of any regular polygon; prove and use the formula for the sum of the interior angles of any polygon; prove that the sum of the exterior angles of any polygon is 360° .
- Solve problems using properties of angles, of parallel and intersecting lines, and of triangles, other polygons and circles, justifying inferences and explaining reasoning with diagrams and text.
- Draw 3D shapes on isometric paper.
- Analyse 3D shapes through plans and elevations.
- Identify reflection symmetry in 3D shapes.
- Use a straight edge and compasses to:
 - construct the perpendicular from a point to a line and the perpendicular from a point on a line
 - inscribe squares, equilateral triangles, and regular hexagons and octagons by constructing equal divisions of a circle.
- Know and use Pythagoras' theorem to solve two-dimensional problems involving right-angled triangles.

Position and movement

- Tessellate triangles and quadrilaterals and relate to angle sums and half-turn rotations; know which regular polygons tessellate, and explain why others will not.
- Use the coordinate grid to solve problems involving translations, rotations, reflections and enlargements.
- Transform 2D shapes by combinations of rotations, reflections and translations; describe the transformation that maps an object onto its image.
- Enlarge 2D shapes, given a centre and positive integer scale factor; identify the scale factor of an enlargement as the ratio of the lengths of any two corresponding line segments.

- Recognise that translations, rotations and reflections preserve length and angle, and map objects on to congruent images, and that enlargements preserve angle but not length.
- Know what is needed to give a precise description of a reflection, rotation, translation or enlargement.
- Use bearings (angles measured clockwise from the north) to solve problems involving distance and direction.
- Make and use scale drawings and interpret maps.
- Find by reasoning the locus of a point that moves at a given distance from a fixed point, or at a given distance from a fixed straight line.

Measure

Length, mass and capacity

- Solve problems involving measurements in a variety of contexts.

Time and rates of change

- Solve problems involving average speed.
- Use compound measures to make comparisons in real-life contexts, e.g. travel graphs and value for money.

Area, perimeter and volume

- Convert between metric units of area, e.g. mm^2 and cm^2 , cm^2 and m^2 and volume, e.g. mm^3 and cm^3 , cm^3 and m^3 ; know and use the relationship $1 \text{ cm}^3 = 1 \text{ ml}$.
- Know that land area is measured in hectares (ha), and that $1 \text{ hectare} = 10\,000 \text{ m}^2$; convert between hectares and square metres.
- Solve problems involving the circumference and area of circles, including by using the π key of a calculator.
- Calculate lengths, surface areas and volumes in right-angled prisms and cylinders.

Handling data

Planning and collecting data

- Suggest a question to explore using statistical methods; identify the sets of data needed, how to collect them, sample sizes and degree of accuracy.
- Identify primary or secondary sources of suitable data.
- Design, trial and refine data collection sheets.
- Collect and tabulate discrete and continuous data, choosing suitable equal class intervals where appropriate.

Processing and presenting data

- Calculate statistics and select those most appropriate to the problem.
- Select, draw, and interpret diagrams and graphs, including:
 - frequency diagrams for discrete and continuous data
 - line graphs for time series
 - scatter graphs to develop understanding of correlation
 - back to back stem-and-leaf diagrams.

Interpreting and discussing results

- Interpret tables, graphs and diagrams and make inferences to support or cast doubt on initial conjectures; have a basic understanding of correlation.
- Compare two or more distributions; make inferences, using the shape of the distributions and appropriate statistics.
- Relate results and conclusions to the original question.

Probability

- Know that the sum of probabilities of all mutually exclusive outcomes is 1 and use this when solving probability problems.

- Find and record all outcomes for two successive events in a sample space diagram.
- Understand relative frequency as an estimate of probability and use this to compare outcomes of experiments in a range of contexts.

Problem solving

Using techniques and skills in solving mathematical problems

- Calculate accurately, choosing operations and mental or written methods appropriate to the numbers and context.
- Manipulate numbers, algebraic expressions and equations, and apply routine algorithms.
- Understand everyday systems of measurement and use them to estimate, measure and calculate.
- Recognise and use spatial relationships in two dimensions and three dimensions.
- Draw accurate mathematical diagrams, graphs and constructions.
- Decide how to check results, by:
 - using rounding to estimate numbers to one significant figure and
 - calculating mentally then comparing with the estimate
 - considering whether an answer is reasonable in the context of the problem
 - using inverse operations.
- Estimate, approximate and check their working.
- Solve a range of word problems involving single or multi-step calculations.

Using understanding and strategies in solving problems

- Identify, organise, represent and interpret information accurately in written, tabular, graphical and diagrammatic forms.
- Explore the effect of varying values in order to generalise.
- Find a counter-example to show that a conjecture is not true.
- Present concise, reasoned arguments to justify solutions or generalisations using symbols, diagrams or graphs and related explanations.
- Recognise the impact of constraints or assumptions.
- Recognise connections with similar situations and outcomes.
- Consider and evaluate the efficiency of alternative strategies and approaches and refine solutions in the light of these.