

# Key Stage 4 Mathematics Programme of Study



Strands	Elements	Year 10	Year 11	Extension
		Learners are able to:	Learners are able to:	Learners are able to:
Developing numerical reasoning	Identify processes and connections	<ul style="list-style-type: none"> <li>transfer mathematical skills across the curriculum in a variety of contexts and everyday situations</li> <li>select, trial and evaluate a variety of possible approaches and break complex problems into a series of tasks</li> <li>prioritise and organise the relevant steps needed to complete the task or reach a solution</li> <li>choose an appropriate mental or written strategy and know when it is appropriate to use a calculator</li> <li>use a scientific calculator to carry out calculations effectively and efficiently using the available range of function keys</li> <li>identify, measure or obtain required information to complete the task</li> <li>identify what further information might be required and select what information is most appropriate</li> <li>select appropriate mathematics and techniques to use</li> <li>estimate and visualise size when measuring and use the correct units</li> <li><b>develop and evaluate mathematical strategies and ideas creatively</b> ❖</li> <li><b>consider connections between mathematical skills and contextualise these</b> ❖</li> </ul>		
	Represent and communicate	<ul style="list-style-type: none"> <li>explain results and procedures precisely using appropriate mathematical language</li> <li>refine methods of recording calculations</li> <li>use appropriate notation, symbols and units of measurement, including compound measures</li> <li>select and construct appropriate charts, diagrams and graphs with suitable scales</li> <li>interpret graphs that describe real-life situations, including those used in the media, recognising that some graphs may be misleading</li> <li><b>evaluate different forms of recording and presenting information, taking account of the context and audience</b> ❖</li> <li><b>generalise in words, and use algebra, to describe patterns that arise in numerical, spatial or practical situations</b> ❖</li> </ul>		
	Review	<ul style="list-style-type: none"> <li>select and apply appropriate checking strategies</li> <li>interpret answers within the context of the problem and consider whether answers, including calculator, analogue and digital displays, are sensible</li> <li>verify and justify results or solutions, including discussion on risk and chance where relevant</li> <li>interpret mathematical information; draw inferences from graphs, diagrams and data, including discussion on limitations of data</li> <li>draw conclusions from data and recognise that some conclusions may be misleading or uncertain</li> <li><b>recognise that inferences drawn from data may suggest the need for further investigation</b> ❖</li> <li><b>justify numerical and algebraic results, making appropriate connections</b> ❖</li> <li><b>explain and justify strategies, methods, reasoning and conclusions in a variety of different ways, including orally, graphically, writing (both in mathematical notation and without), using appropriate digital literacy equipment</b> ❖</li> <li><b>appreciate the difference between mathematical explanation and experimental evidence; recognise inconsistencies and bias</b> ❖</li> </ul>		

## Key

Within the table, text taken from the LNF will appear as non-bold. Text that has been extended from the LNF or that is a specific Mathematics Programme of Study skill will appear as bold. These skills are further identified by the following icons.

**Extended skill** ▲ **Programme of study skill** ❖ When combined with the LNF statements, these skills form the Key Stage 4 Mathematics Programme of Study.

## N.B.

In order to comply with accessibility and legibility, these tables have been designed to be printed at their optimum size of A3.

# Key Stage 4 Mathematics Programme of Study



Strands	Elements	Year 10	Year 11	Extension
		Learners are able to:	Learners are able to:	Learners are able to:
Using number skills	Use number facts and relationships	<ul style="list-style-type: none"> <li>use and interpret numbers in standard form within calculations</li> <li><b>convert to and from standard form</b> ❖</li> <li><b>find the lowest common multiples and highest common factor using prime factors</b> ❖</li> </ul>	<ul style="list-style-type: none"> <li><b>identify when to use standard form</b> ❖</li> </ul>	<ul style="list-style-type: none"> <li><b>manipulate surds</b> ❖</li> <li><b>distinguish between rational and irrational numbers</b> ❖</li> </ul>
	Fractions, decimals, percentages and ratio	<ul style="list-style-type: none"> <li>use multipliers as an efficient method when working with percentages, e.g. <i>multiply by 1.2 to increase an amount by 20%</i></li> <li><b>calculate the outcome of a given repeated proportional change</b> ❖</li> <li><b>calculate with direct and inverse proportion</b> ❖</li> <li><b>use calculations with different representations of fractions</b> ❖</li> </ul>	<ul style="list-style-type: none"> <li>use and understand the idea of reverse percentage to find an original quantity</li> <li><b>use powers to calculate the outcome of a given repeated proportional change</b> ❖</li> <li><b>use direct and inverse proportion</b> ❖</li> </ul>	<ul style="list-style-type: none"> <li>use and understand ratio and proportion in 2 <b>and 3</b> dimensions ▲</li> <li><b>change between recurring decimals and fractions</b> ❖</li> </ul>
	Calculate using mental and written methods	<ul style="list-style-type: none"> <li><b>select, choose and justify selection of method, including when to use a calculator</b> ❖</li> <li><b>use negative numbers</b> ❖</li> </ul>	<ul style="list-style-type: none"> <li><b>select, choose and justify selection of method, including when to use a calculator</b> ❖</li> </ul>	
	Estimate and check	<ul style="list-style-type: none"> <li><b>define upper and lower bounds of a number that has been given to a specified degree of accuracy</b> ❖</li> </ul>	<ul style="list-style-type: none"> <li>recognise and define limitations on accuracy of measurements <b>in calculations involving addition and subtraction</b> ▲</li> <li><b>explore the impact of premature rounding</b> ❖</li> </ul>	<ul style="list-style-type: none"> <li>recognise and define limitations on accuracy of measurements <b>in calculations involving the four operations</b> ▲</li> </ul>

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Strands	Elements	Year 10	Year 11	Extension
		Learners are able to:	Learners are able to:	Learners are able to:
Using number skills	Manage money	<ul style="list-style-type: none"> <li>understand and demonstrate the real-life process of foreign exchange</li> <li>consider best value of an item priced in two or more different currencies ❖</li> <li>calculate compound interest ❖</li> <li>make comparisons between financial products that involve short-term borrowing and investments ❖</li> <li>calculate with money, including household bills ❖</li> <li>make informed decisions relating to household budgeting ❖</li> <li>understand and calculate income tax</li> </ul>	<ul style="list-style-type: none"> <li>use and understand efficient methods of calculating compound interest</li> <li>make comparisons between financial products that involve long-term borrowing and investments ❖</li> </ul>	
Using measuring skills	Length, weight/mass, capacity	<ul style="list-style-type: none"> <li>find the perimeter of semicircles and quadrants, including compound shapes and cases that require a solution in terms of pi ❖</li> <li>find a radius or diameter given a circumference ❖</li> <li>use trigonometry and Pythagoras' theorem to calculate the length of a side in a right angled triangle ❖</li> <li>understand and use a variety of compound measures, including speed, density and population density ▲</li> <li>define upper and lower bounds of a measurement that has been given to a specified degree of accuracy ❖</li> <li>construct and interpolate from conversion graphs ❖</li> </ul>	<ul style="list-style-type: none"> <li>find the perimeter of a sector ❖</li> <li>find the arc length ❖</li> <li>use trigonometry to find the length of a side in a right angled triangle, e.g. finding the height of an isosceles triangle ❖</li> <li>understand and use a variety of compound measures that involve converting between units ▲</li> <li>recognise and define limitations on accuracy of measurements in calculations involving addition and subtraction ❖</li> <li>construct and extrapolate from conversion graphs ❖</li> </ul>	<ul style="list-style-type: none"> <li>find the perimeter of a segment ❖</li> <li>use trigonometry in non-right angled triangles ❖</li> <li>use Pythagoras' theorem and trigonometry in 3 dimensions ❖</li> <li>use the sine and cosine rule ❖</li> <li>recognise and define limitations on accuracy of measurements in calculations involving the four operations ❖</li> </ul>



Strands	Elements	Year 10	Year 11	Extension
		Learners are able to:	Learners are able to:	Learners are able to:
Using measuring skills	Time	<ul style="list-style-type: none"> <li>• use timetables and time zones to plan a multi-stage journey ❖</li> <li>• plan the optimum route from a selection of timetables ❖</li> </ul>		
	Temperature			
	Area and volume Angle and position	<ul style="list-style-type: none"> <li>• apply proportional change to 2-dimensional designs</li> <li>• find areas of semicircles and quadrants, including cases that require a solution expressed in terms of pi ❖</li> <li>• find a radius or diameter given an area ❖</li> <li>• convert between metric units of area ❖</li> <li>• convert between metric units of volume ❖</li> <li>• calculate an angle in a right angled triangle using trigonometry ❖</li> <li>• find the distance between two points from their coordinates ❖</li> <li>• find the midpoint of a line ❖</li> <li>• find locations given sets of bearings and/or distances ❖</li> </ul>	<ul style="list-style-type: none"> <li>• find surface areas of prisms, cylinders and spheres ❖</li> <li>• calculate sector area ❖</li> <li>• distinguish between formulae for length, area and volume, and check that a formula is dimensionally correct ❖</li> <li>• calculate volumes of spheres, hemispheres, cones and pyramids ❖</li> <li>• use circle theorems to calculate angles in circles ❖</li> <li>• use trigonometry in situations including those involving bearings, and angles of elevation and depression ❖</li> <li>• use coordinates in 3 dimensions ❖</li> </ul>	<ul style="list-style-type: none"> <li>• calculate segment area ❖</li> <li>• calculate the surface area of cones ❖</li> <li>• calculate volumes of compound solids ❖</li> <li>• use the alternate segment theorem ❖</li> <li>• understand and construct geometrical proofs using circle theorems ❖</li> <li>• sketch and use trigonometric graphs ❖</li> <li>• use trigonometry in non-right angled triangles ❖</li> <li>• use the sine and cosine rule ❖</li> <li>• use trigonometry to find an angle in 3 dimensions ❖</li> </ul>



Strands	Elements	Year 10	Year 11	Extension
		Learners are able to:	Learners are able to:	Learners are able to:
Using geometry skills	Shape	<ul style="list-style-type: none"> <li>recognise similar shapes and calculate the size of missing sides ❖</li> <li>use the terms arc, sector, segment, chord, tangent ❖</li> </ul>	<ul style="list-style-type: none"> <li>find the area of a 2D shape given the area of a similar shape and a pair of corresponding sides ❖</li> <li>find the volume of a similar shape given the volume of a similar shape and a pair of corresponding edges ❖</li> </ul>	<ul style="list-style-type: none"> <li>prove that two triangles are congruent ❖</li> <li>use the conditions for congruent triangles in formal proofs ❖</li> </ul>
	Construction	<ul style="list-style-type: none"> <li>draw plans and elevations of any 3D solid ❖</li> <li>construct perpendicular bisectors, the perpendicular from a point to a line, angles of 60° and 90°, and the bisector of an angle ❖</li> <li>shade a region defined by up to two conditions ❖</li> </ul>	<ul style="list-style-type: none"> <li>draw accurate plans and elevations of any 3D solid to an appropriate scale ❖</li> <li>select and apply loci to solve problems given more than two conditions ❖</li> </ul>	
	Movement	<ul style="list-style-type: none"> <li>reflect shapes in horizontal and vertical lines ❖</li> <li>describe reflection in horizontal or vertical lines ❖</li> <li>rotate shapes about a point ❖</li> <li>describe rotations and find the centre of rotation ❖</li> <li>translate a shape by a vector ❖</li> <li>describe a translation using vectors ❖</li> <li>enlarge a shape from a centre where the scale factor is 0.5 ❖</li> </ul>	<ul style="list-style-type: none"> <li>reflect shapes in the lines <math>y = x</math> and <math>y = -x</math> ❖</li> <li>enlarge a shape from a centre where the scale factor is a fraction ❖</li> <li>find the centre of enlargement ❖</li> <li>recognise and describe transformations ❖</li> </ul>	<ul style="list-style-type: none"> <li>enlarge a shape from a centre with a negative scale factor ❖</li> <li>recognise and describe combinations of transformations ❖</li> </ul>



Strands	Elements	Year 10	Year 11	Extension
		Learners are able to:	Learners are able to:	Learners are able to:
Using algebra skills	Number sequences	<ul style="list-style-type: none"> <li>generate non-linear sequences given the nth term rule ❖</li> </ul>	<ul style="list-style-type: none"> <li>express the nth term rules algebraically, e.g. <math>n^2</math>, <math>n^2 + 1</math>, <math>n^2 + 3</math>, <math>n^2 - 3</math>, <math>n^3</math> ❖</li> </ul>	<ul style="list-style-type: none"> <li>generate complex non-linear sequences given the nth term rule ❖</li> <li>express nth term rules algebraically, e.g. <math>2n^2 + 6</math>, <math>(n + a)^2</math>, <math>an^2 + bn + c</math> where <math>a</math> is not equal to 0 ❖</li> </ul>
	Expressions and formulae	<ul style="list-style-type: none"> <li>manipulate indices, e.g. <math>(2a^2)^3</math> ❖</li> <li>show and use rules of indices where the power is 0 or a fraction with numerator 1 ❖</li> <li>substitute into a variety of expressions, including those involving powers and brackets ❖</li> <li>multiply out double brackets ❖</li> <li>factorise algebraic expressions of two or more terms into a single bracket, including those where there is more than one common factor ❖</li> <li>rearrange formulae including whole number powers and brackets ❖</li> <li>distinguish between equations, formulae and expressions ❖</li> </ul>	<ul style="list-style-type: none"> <li>show and use indices rules where the power is a negative whole number or a proper fraction ❖</li> <li>recognise situations that require substitution, e.g. <i>drawing graphs</i> ❖</li> <li>factorise quadratic expressions where the coefficient of <math>x^2</math> is 1, including the difference of two squares ❖</li> <li>rearrange formulae involving brackets and powers ❖</li> </ul>	<ul style="list-style-type: none"> <li>rearrange formulae, including cases that require factorisation ❖</li> <li>simplify algebraic fractions ❖</li> <li>show and use indices rules where the power is a negative fraction or the base is a positive fraction ❖</li> <li>factorise quadratic expressions ❖</li> <li>distinguish between equations, formulae, expressions and identities ❖</li> </ul>
	Functions and graphs	<ul style="list-style-type: none"> <li>generate and plot points for simple quadratic and cubic functions ❖</li> <li>solve simple linear simultaneous equations graphically ❖</li> <li>construct graphs and define regions to show one inequality <math>&lt;</math> <math>&gt;</math> <math>\leq</math> <math>\geq</math> ❖</li> </ul>	<ul style="list-style-type: none"> <li>state the equation of parallel lines given facts or a graph ❖</li> <li>generate and plot points for quadratic and cubic functions ❖</li> <li>generate and plot points for simple reciprocal graphs ❖</li> <li>generate, plot points and use exponential graphs of the function <math>y = k^x</math> ❖</li> <li>solve linear simultaneous equations graphically ❖</li> <li>identify key features of, and distinguish between, graphs of linear, quadratic, cubic and reciprocal functions ❖</li> <li>construct graphs and define regions to show 2 or more inequalities ❖</li> </ul>	<ul style="list-style-type: none"> <li>find the equation of a line from a graph ❖</li> <li>state the equation of a perpendicular line given facts or a graph ❖</li> <li>construct or define regions given by 3 or more inequalities ❖</li> <li>transform graphs of functions ❖</li> </ul>

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		Learners are able to:	Learners are able to:	Learners are able to:
Using algebra skills	Equations and inequalities	<ul style="list-style-type: none"> <li>• solve equations by trial and improvement, and justify the solution ❖</li> <li>• solve linear simultaneous equations with matching coefficients ❖</li> <li>• draw inferences from distance–time graphs ❖</li> </ul>	<ul style="list-style-type: none"> <li>• solve linear simultaneous equations ❖</li> <li>• solve a quadratic equation where the coefficient of <math>x^2</math> is 1 by factorising ❖</li> <li>• examine rates of change, e.g. <i>vases and water</i> ❖</li> </ul>	<ul style="list-style-type: none"> <li>• construct and solve equations involving direct and inverse proportion, algebraically or otherwise ❖</li> <li>• solve quadratic equations by selection of an appropriate method ❖</li> <li>• find the distance travelled from speed–time graphs ❖</li> <li>• construct tangents to curves and interpret their gradients ❖</li> <li>• interpret the meaning of the area under a graph ❖</li> </ul>
Using data skills	Collect and record data Present and analyse data Interpret results	<ul style="list-style-type: none"> <li>• specify and test hypotheses, taking account of sampling ❖</li> <li>• identify possible sources of bias in the design of collection sheets and questionnaires ❖</li> <li>• evaluate questionnaires and write suitable questions, including response boxes ❖</li> <li>• construct and interpret graphs and diagrams (including pie charts) to represent discrete or continuous data, with the learner choosing the most appropriate representation, including frequency polygons and lines of best fit on scatter diagrams ❖</li> <li>• calculate the upper quartile, lower quartile and interquartile range of a set of discrete data and use them to describe a data set ❖</li> <li>• use a scatter diagram to make predictions about the data from a line of best fit drawn by eye ❖</li> <li>• understand the effects of extrapolation and interpolation on reliability ❖</li> <li>• use the mean, median, mode and range from grouped frequency tables to compare distributions ❖</li> </ul>	<ul style="list-style-type: none"> <li>• specify and test hypotheses, taking account of the limitations of the data ❖</li> <li>• consider the effect of sample size and other factors that affect the reliability of conclusions drawn ❖</li> <li>• sample systematically ❖</li> <li>• construct and interpret graphs and diagrams (including pie charts) to represent discrete or continuous data, with the learner choosing the most appropriate representation, including cumulative frequency curves and boxplots ❖</li> <li>• use a scatter diagram to make predictions about the data from a line of best fit that passes through the mean ❖</li> <li>• use a cumulative frequency curve to estimate the median, quartiles and interquartile range ❖</li> <li>• use the interquartile range to compare distributions ❖</li> <li>• compare sets of data and their distributions, using appropriate methods, including those that involve describing central tendency, dispersion, correlation ❖</li> <li>• recognise and use the most appropriate data to compare distributions ❖</li> </ul>	<ul style="list-style-type: none"> <li>• work with stratified sampling techniques ❖</li> <li>• define a random sample ❖</li> <li>• construct and interpret graphs and diagrams (including pie charts) to represent discrete or continuous data, with the learner choosing the most appropriate representation including histograms with unequal class widths ❖</li> <li>• compare sets of data and their distributions, using appropriate methods, including those that involve describing central tendency, dispersion, correlation ❖</li> <li>• recognise and use the most appropriate data to compare distributions ❖</li> </ul>



Strands	Elements	Year 10	Year 11	Extension
		Learners are able to:	Learners are able to:	Learners are able to:
Using data skills	Probability	<ul style="list-style-type: none"> <li>• know that the sum of probabilities is 1 and use this to find missing probabilities in fraction or decimal form, including where there are two equal probabilities missing ❖</li> <li>• compare an estimated probability from experimental results with a theoretical probability ❖</li> <li>• identify when to construct sample space diagrams or two way tables to solve a problem ❖</li> <li>• use a two way table and sample space diagram to calculate the probability of simple compound events ❖</li> <li>• use a two way table to calculate simple cases of <math>x</math> given <math>y</math>, e.g. <i>find the probability that a girl travels by bus</i> ❖</li> <li>• estimate the number of successes where probability is expressed as a fraction or decimal. ❖</li> </ul>	<ul style="list-style-type: none"> <li>• understand dependent and independent outcomes ❖</li> <li>• use relative frequency to test a given probability ❖</li> <li>• complete a tree diagram for two or more independent events ❖</li> <li>• use tree diagrams to calculate the probability of combined events. ❖</li> </ul>	<ul style="list-style-type: none"> <li>• construct and use a tree diagram for two or more dependent events. ❖</li> </ul>