Topic	Rationale	Knowledge Acquisition	Key Vocabulary	Skills and Enrichment
Unit 1	Builders of telescopes us reciprocals to work out the shape of lenses they need. Carbon dating uses negative indices to describe the decay of carbon 14.	Find the reciprocal of simple numbers and fractions mentally	Reciprocal, standard form, index, indices	Will a sequence of reciprocals ever have a ‘0’ term? Does raising to a power always make a number bigger? What units are used to measure distance in the universe?
		Use the index laws to include negative power answers and understand that these answers are smaller than 1		
		Evaluate powers of fractions		
		Know that a number multiplied by its reciprocal is 1		
		Write numbers greater than 10 in standard index form		
		Understand the order in which to calculate expressions that contain powers and brackets in both the numerator and denominator of a fraction		
		Know that the reciprocal of a reciprocal is the original number		
		Write numbers less than 1 in standard index form		
		Order numbers written in standard index form		
		Complete calculations using numbers written in standard index form		
		Use negative indices		
		Simplify expressions which include surds		
		Use fractional indices and write a fractional power as a root		
		Work out negative fractional powers of numbers		
		Present a concise and reasoned argument using surds		
		Understand / use rational / irrational numbers		
		Distinguish between exact representations of roots and their decimal approximations		

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Unit 2	Sequences and patterns occur in nature and scientific experiments. They can be used to make predictions. Expanding brackets can help promoters work out what price to put concert tickets at for the greatest profit.	Generate any term of a sequence when the *n*th term is given	Quadratic sequence, term, expression	There are 100 rabbits on an island, how many will there be in 6 months' time? What is the area of a rectangle that is (x+2) by (x-2) metres? Does $x^2 + a^2$ factorise?
		Generate the next term in a quadratic sequence		
		Find a term of a quadratic sequence with $T(n) = an^2$ for a given value of *n*		
		Find the *n*th term of a quadratic sequence of the form $an^2 \pm b$		
		Find the *n*th term of a quadratic sequence of the form $an^2 \pm bn \pm c$		
		Multiply out brackets involving positive terms such as $(a + b)(c + d)$ and collect like terms		
		Multiply out brackets involving positive and negative terms such as $(a + b)(c – d)$ or $(a – b)(c – d)$ and collect like terms		
		Square a linear expression and collect like terms		
		Derive and use identities for the product of two linear expressions of the form $(a + b)(a – b) = a^2 – b^2$ and $(x + 2)(x – 2) = x^2 – 4$		
		Factorise a simple quadratic expression		
		Factorise more complex quadratic expressions		
		Derive and use the difference of two squares		
		Factorise a perfect square		
		Solve quadratic equations where the coefficient of x^2 is 1		
		Solve quadratic equations that are the difference of two squares		

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Unit 3	Businesses use inequalities to work out minimum and maximum profits based on different sales. Engineers designing roller coaster rides have to solve equations to make sure the ride is safe.	Know that $a^0 = 1$ Solve equations of the form (where *c* or *f* is 1) Solve simple linear inequalities in one variable and represent the solution on a number line e.g. $-6 < 2n$ or $-9 < 2n + 3$ Solve more complex linear inequalities in one variable and represent the solution on a number line e.g. $3n + 2 < 11$ and $2n - 1 > 1$ Use the index laws to include negative power answers and establish that these answers are smaller than 1 Construct and solve equations of the form $a(bx \pm c) = d(ex \pm f)$ where negative signs are anywhere in the equation (*a* or *d* are greater than 1), e.g. $3(-2x - 1) = -4x + 1$ Multiply both sides of an inequality by a negative number Change the subject of a simple formula Construct and solve equations of the form (where *c* and *f* are greater than 1) Change the subject of a two-step formula Use factorisation to make a given letter the subject of a formula Change algebraic fractions to equivalent fractions Change the subject of a complex formula that involves fractions, e.g. make *u* or *v* the subject of the formula Solve problems by finding a variable that is not the subject of a formula	Inequality, solution set.	How are inequalities used in optimisation problems? Do all equations have a solution

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Unit 4	Pharmaceutical companies can use frequency polygons to compare the effects of new medicines. Scientists use grouped data to analyse geographical features	Identify suitable sample size	Sample, frequency polygon, median, quartile	What type of career use frequency polygons? Is it better to have a high average with a large range or a low average with a small range?
		Select the range of possible methods that could be used to collect primary data		
		Select and discuss the range of possible sources that could be used to collect secondary data		
		Draw and interpret a stem and leaf diagram		
		Construct and use frequency polygons to compare sets of data		
		Calculate possible values of a set of data given summary statistics		
		Calculate an estimate of the mean of a large set of grouped data		
		Estimate the mean from a frequency polygon		
		Identify the class that contains the median of a set of grouped data from a table		
		Estimate the median of a set of grouped data using a cumulative frequency chart		
		Find the lower and upper quartiles of a set of grouped data using a cumulative frequency chart and box plot		
		Find quartiles from raw data and present data in a box plot		
		Find the lower and upper quartiles of a set of grouped data using a cumulative frequency chart and box plot		
		Find the interquartile range of a large set of grouped data using a cumulative frequency chart		
		Interpret and construct histograms		

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Unit 5	Knowing the relationship between quantities can help us to make predictions. Scientists use direct proportion to study the relationship between temperature, volume and pressure of gases	Given a relationship (as proportion) graphically or in words, extend beyond known values, e.g. off lines of chart, or above pairs of values given	Direct proportion, inverse proportion	Are a clothes store's profits in direct proportion to its sales? How much does a 10kg mass weigh on mars?
		Identify and describe practical examples of direct proportion		
		Check by drawing graphs whether two variables are in direct proportion		
		Set up equations to show direct proportion		
		Recognise sets of data that are proportional		
		Understand direct proportion as equality of ratios		
		Use algebraic methods to solve problems involving variables in direct proportion		
		Use expressions of the form y is proportional to x		
		Use expressions of the form y is proportional to x^2		
		Identify data that is proportional to the inverse of a variable		
		Recognise the formulae for length of arcs in a circle		
		Recognise the formulae for area of sectors in a circle		
		Use the formulae for length of arcs and area of sectors of circles to solve problems		
		Understand and use inverse proportion		

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Unit 6	The path of a basketball can be modelled using a quadratic function	Recognise the graph of a quadratic function	Function, quadratic	What is the best way to throw a basketball into the net?
		Construct a table of values, including negative values of x for a function such as $y = ax^2 + b$		
		Recognise the graphs of $y = x^2$, $y = 3x^2 + 4$, $y = x^3$		
		Solve simple quadratic equations graphically such as $ax^2 + b = c$, including where $c = 0$		
		Find the line of symmetry and write down the turning point of a quadratic graph		
		Recognise graphs of functions of the form $y = ax^2 + b$ and $y = ax^3$		
		Identify maxima, minima and lines of symmetry on quadratic and cubic graphs		
		Solve quadratic equations such as $ax^2 + bx = 0$ and $x^2 + bx + c = 0$ graphically and relate the solutions to quadratic factorisation		
		Recognise and use reciprocal graphs and graphs for inverse proportion		
		Sketch and interpret graphs of reciprocal functions		

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Unit 7	British speed limits are given in mph, but many countries use kmph. Converting between them is useful when travelling abroad. Meteorologists examine air pressure to help predict storms.	Solve problems using constant rates and related formulae Extend to simple conversions of compound measures Identify the upper and lower bounds of a measurement by calculating half of the unit used for rounding Identify upper and lower bounds for rounding of discrete and continuous data Calculate simple error intervals using inequality notation $a \leq x < b$ Solve problems using average rate of change and related formula Calculate the lower and upper bounds of area measurement Calculate the upper and lower bounds of compound measures Determine upper and lower bounds in complex problems Solve problems by understanding upper and lower bounds	Formulae, compound measures, bounds	What is the speed limit on French motorways in mph? How do snow shoes reduce your chance of sinking into snow?

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Unit 8	You can solve two equations together to work out the best phone deal. Marketing managers might analyse gradients of graphs of sales figures to predict trends.	Recognise that linear functions can be rearranged to give y explicitly in terms of x, e.g. rearrange $y + 3x – 2 = 0$ in the form $y = 2 – 3x$	Linear function, equation pair, elimination, substitution, gradient, intercept, variable	Is it better for a business to pay £55 per callout for a computer repair or pay £100 per year and £36 per callout?
		Solve a pair of simultaneous equations of the form $ax + y = b$, $y = ax$ by substitution		
		Solve a pair of simultaneous equations by elimination, when they are solved by addition. Equations are of the form $ax + y = b$, $x – y = c$		
		Identify the solutions of simultaneous equations on a graph		
		Solve a pair of simultaneous equations by elimination, when they are solved by subtraction. Equations are of the form $ax + y = b$, $x + y = c$		
		Rearrange equations of the form $ax + by = c$ to compare gradients and y- intercepts		
		Find the equation of the line between two points		
		Solve inequalities in two variables by using linear graphs		
		Solve a pair of simultaneous by elimination, when they are solved by multiplication. Equations are of the form $ax + by = c$, $dx + ey = f$		
		Solve more complex inequalities in two variables by using linear and quadratic graphs		
		Construct models of real-life situations by drawing graphs and constructing algebraic equations		
		Solve simultaneous equations in two variables where one is a linear equation and the other quadratic		

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Unit 9	Trigonometry is used by engineers to build bridges, by cartographers when drawing maps, by astronomers when calculating interplanetary distances and aeroplane pilots to calculate flightpaths and angles of descent.	Understand that the ratio of any two sides is constant in similar right-angles triangles	Sine, cosine, tangent, trigonometric ratio, Pythagoras	How does an architect use trigonometry to design the roof of a house? How can you measure the height of a kite from the ground?
		Use the sine, cosine and tangent ratios to find the lengths of unknown sides in a right-angled triangle, using straight-forward algebraic manipulation, e.g. calculate the adjacent (using cosine), or the opposite (using sine or tangent ratios)		
		Use the sine, cosine and tangent ratios to find the lengths of unknown sides in a right-angled triangle, using more complex algebraic manipulation, e.g. the hypotenuse (using cosine or sine), or adjacent (using the tangent ratio)		
		Begin to use the trigonometric ratios to find the size of an angle in a right-angled triangle		
		Use the appropriate ratio to find a length, or angle, and hence solve a two-dimensional problem		
		Sketch graphs of sine / cosine / tangent functions for any angle, generating / interpreting them		
		Use sine / cosine / tangent of any size of angle and Pythagoras' theorem when solving problems in 3D		

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Unit 10	A lot of the work mathematicians do involves justifying why something is true or false.	Justify solutions to problems set in an unfamiliar context	Justify, counter example, algebraic model, reasoned argument.	Are all square numbers positive? Can you prove your answer is always true? Pythagoras proved his theorem. How many right-angled triangles would you need to test to prove it always works?
		Identify exceptional cases or counter examples and explain them		
		Use counter examples to show why a statement is false		
		Construct models of real life situations by drawing graphs and constructing algebraic equations		
		Justify generalisation, arguments or solutions and investigate whether particular cases can be generalised further		
		Present a reasoned argument using algebra		
		Generate full solutions using reasoned argument		
		Explore the effect of varying values and make convincing arguments to justify generalisations		