Mathematics

Core Threads and Topics:

Number	**Ratio & Proportion**	**Algebra**
Geometry	**Statistics**	**Probability**

Sequencing and progression

The 6 core threads and sub-topics for each section identify learning outcomes for each area in **progressive milestone** stages, starting with the first stage, 'Foundation' milestone 1, through to the final stage, 'Advanced Expert' milestone * (higher GCSE content). Each phase uses and builds on the previous stage/milestone, and learning is sequenced throughout, and where appropriate, introduces a new topic within the thread being studied or allows for more consolidation learning through additional practice, before moving on, depending on what best meet the needs of learners.

Foundation (Pre-Fundamental) Milestone 1	Fundamental Milestone 2	Intermediate Milestone 3	Expert Milestone 4/5 (preparation for foundation level GCSE)	Advanced Expert Milestone * (preparation for higher level GCSE)
Effective engagement in the learning process and underpinning the cornerstones of all mathematical threads	*Fundamental learning elements, building the next layer of learning to tackle more problem-solving style mathematics*	*Increasing understanding of learning, tackling more abstract topics within the mathematical threads*	*Deepening understanding of more advanced topics as well as the application of learning within problem-solving style areas of mathematical enquiry.*	*Deepening understanding of the most advanced topics within the mathematic curriculum. Application of learning to make mathematical arguments and proofs within problem-solving style areas of mathematical enquiry.*

Opportunities are presented for pupils (where appropriate/possible) to:

• Experience taking responsibility for their own learning; Feel positive about themselves and their mathematical abilities; Reflect on their perceptions and experiences within the mathematical curriculum; Develop the understanding, language, communication skills and strategies required to be mathematically competent in life and academia; Make real decisions (with support where necessary so that they can act upon them) when dealing with mathematical enquiries; Take part in group activities and make contributions; Develop and maintain positive relationships and interactions with others within the classroom and Recognise and celebrate their achievements, successes whilst developing a passion for mathematical concepts.

Subject Theme Mapping						
Theme mapping and topics.	**Number** N1 - Operations with number N2 - Place value and standard form N3 - Rounding & estimation N4 - Primes, factors & multiples N5 - Fractions, decimals and percentage conversion N6 - Fractions N7 - Percentages N8 - Directed numbers N9 - Routes, powers, indices and surds	**Ratio & Proportion** R1 - Metric Units R2 - Ratio R3 - Proportion R4 - Compound Units	**Algebra** A1 - Sequences A2 - Functions, Formula and Expressions A3 - Expanding and Factorising A4 - Indices A5 - Algebraic Fractions* A6 - Solving Equations and Inequalities A7 - Graphs and Graph Transformations.	**Geometry** G1 - Area, Perimeter, Surface Area, and Volume G2 - Angles and Bearings G3 - Constructions G4 - Similarity G5 - Polygons and 3D Shapes G6 - Transformations G7 - Pythagoras and Trigonometry G8 - Vectors	**Statistics** S1 - Data and Averages S2 - Charts and Diagrams	**Probability** P1 - Sets and Venn Diagrams P2 - Basic Probability P3 - Tree Diagrams
Links to teaching of National Curriculum	At the end of this document is Edexcel maths GCSE (9-1) knowledge, skills and understanding which is a refence to the notations below: (the national curriculum for KS3 and KS4 states that KS3 is an overlap for foundation level at KS4 and so the bridge academies mathematical curriculum and sequencing has been based on the Edexcel specification but takes on board the following from both the KS3 and KS4 national curriculum) KS3/4 The national curriculum for mathematics aims to ensure that all pupils: become fluent in the fundamentals of mathematics, including through varied and frequent practice with increasingly complex problems over time, so that pupils develop conceptual understanding and the ability to recall and apply knowledge rapidly and accurately. reason mathematically by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language can solve problems by applying their mathematics to a variety of routine and nonroutine problems with increasing sophistication, including breaking down problems into a series of simpler steps and persevering in seeking solutions**.** Mathematics is an interconnected subject in which pupils need to be able to move fluently between representations of mathematical ideas. The programme of study for key stage 3 is organised into apparently distinct domains, but pupils should build on key stage 2 and connections across mathematical ideas to develop fluency, mathematical reasoning and competence in solving increasingly sophisticated problems. They should also apply their mathematical knowledge in science, geography, computing and other subjects. Decisions about progression should be based on the security of pupils' understanding and their readiness to progress to the next stage. Pupils who grasp concepts rapidly should be challenged through being offered rich and sophisticated problems before any acceleration through new content in preparation for key stage 4. Those who are not sufficiently fluent should consolidate their understanding, including through additional practice, before moving on.					
	Foundation N1-N16 Higher N1-N16	Foundation R1- R16 Higher R1- R16	Foundation A1-A25 Higher A1-A25	Foundation G1-G25 Higher G1-G25	Foundation S1-S6 Higher S1-S6	Foundation P1-P8 Higher P1-P8
Links to teaching of SMSC	**Spiritual** Many topics in maths are designed to develop a world view based in scientific rigour. Many topics give rise to the opportunity of developing our pupils' senses of "awe and wonder" – none more so than the topic of standard index form where astronomically large and microscopically small worlds are considered and accurately described in detail. Concepts such as a "light year" or "angstrom" cannot fail to inspire amazement and fascination. Even some more trivial pure mathematics investigations produce beautiful elegance in their surprising symmetries, patterns or results. Pi is a number	**Cultural** All mathematics has a rich history and a cultural context in which it was first discovered or used. The most ancient of our knowledge we owe to the Babylonians, Egyptians, Greeks and Arab and Vedic mathematicians. The opportunity to consider the lives of specific mathematicians isn't lost (eg Newton, Pythagoras, Galileo or Fibonacci). A study of Imperial units specifically is no longer on the GCSE syllabus, although students are still required to make conversions between any given units. An understanding of the deep emotional and cultural	**Spiritual** An example is our insistence on algebraic fluency throughout the curriculum. Algebra is a uniquely powerful set of tools that enable us to describe and model reality. When understood as a language, algebra enables us to express truth in its purest form. It is the language of science, but it also develops the type of intuitive logic in pupils that equips them to recognise when an argument (e.g. political, religious, social) is valid or nonsensical. **Cultural** The world of modern computing would be impossible without the fundamental mathematics upon which they are built. Algorithmic	**Spiritual** Pupils learn geometrical reasoning through knowledge and application of angle rules. The whole purpose is to demonstrate the power of deductive logic and problem solving through use of rigorous, proven techniques. This should encourage pupils to question "why" more often, to interrogate motives and to avoid assumption when analysing any given problem. These skills should transfer to the less abstract situations facing our students daily. **Social** Mathematics lessons use a range of teaching and learning strategies. Sometimes	**Moral** A statistical example is our requirement to teach experimental design. Questionnaires should not be (mis)leading, culturally biased or poorly operationalised. Ethical considerations must be made before recruiting participants for a study. Students are taught that meaning should not be imposed at the analysis stage either, rather uncertainty is made explicit. **Social** We develop each pupil's understanding of statistics to a depth which should equip them with the ability to tell when statistics are meaningful or being used inappropriately (eg in	**Spiritual** Another example is the number of ways a pack of cards can be shuffled. It is so unbelievably vast that we need convoluted descriptions to even get close to understanding its magnitude. http://czep.net/weblog/52cards.html. **Moral** We get many opportunities to develop our moral values incidentally through the mathematics we teach. For example, around 20% of a GCSE maths course is based on data and probability. A study of probability lends itself to considerations of gambling, betting, lotteries, raffles and

	that goes on forever in a non-repeating and unpredictable way. As such, your birthday WILL be in the decimal digits of pi. This never fails to blow the students' minds! **Social** Even simpler skills such as numerical fluency or confidence with estimation benefit our students' functioning in society. When is something a poor/good deal? Is this really a special offer, or a rip off? Is €9 a good price? How long will it take to get to Canterbury from here? **Cultural** Mathematics has deep links to music, art and sport. Factors and multiples build rhythm and design percussion. An understanding of scale, similarity and surds help to explain the strange numbers associated with focal length in photography, packaging design in technology and the standard paper sizing used throughout Europe.	attachment to these is normally discussed. Mathematics has deep links to music, art and sport. Ratios mathematically explain pitch and tuning (especially from a physical perspective). An understanding of scale, similarity and surds help to explain the strange numbers associated with focal length in photography, packaging design in technology and the standard paper sizing used throughout Europe. As a product of The Enlightenment, Renaissance artists were often obsessed with mathematics, and many incorporated the Golden Ratio or applied their knowledge of perspective in new ways.	approaches to problem solving are first introduced at GCSE level (iterative processes) - the historical and cultural significance of which cannot be understated (e.g. the work of Turing at Bletchley or the seminal work of Lovelace).	independent study is required, other times pair work or group work essential. Among others we use debates, dominoes, jigsaws, sort cards and team quizzes to structure group work. Verbalising and discussing mathematical problems are one of the most powerful tools we have in arriving at their solutions (or at least gaining a deeper understanding of the problem at hand). The Standards Unit produced a whole set of resources (used regularly in the department) specifically designed to tap into this learning style. Many topics have a direct and deep sociological impact or effect. We teach co-ordinate geometry, bearings and vectors (plus calculus, logs and exponentials at KS5) which are the bedrock of so many "real life" applications of mathematics that have had and still have profound consequences to human development (e.g. wireless communications, GPS, flight, electronics). **Cultural** Mathematics has deep links to music, art and sport. Furthermore, trigonometric functions mathematically explain pitch and tuning (especially from a physical perspective) and describe and illuminate the structure of sound waves.	newspapers or on social media). We encourage pupils to consider sample size, bias, methodology and overall meaning. Correlations are not the same as causations – many correlations are totally spurious. **Cultural** Mathematics has deep links to music, art, and sport. The world of professional sport has been revolutionised by statistics and their analysis.	games of chance. Our students are encouraged to weigh up the pros and cons of taking part in such activities. Even a Court of Law could be understood in probabilistic terms – what burden of evidence is required before we are happy to sentence someone for a misdemeanour? What probability is unacceptably unsafe? Is DNA evidence perfect? The famous Sally Clark case is an excellent and tragic example of how mathematics, law, ethics and history are related.
Links to teaching of Fundamental British Values	**Tolerance and mutual respect for different faiths and beliefs and promotion of the Equality duty** Student code of conduct. Good working relationships in the classroom and around the college that promote effective learning. Ensuring that behaviour in the classroom demonstrates respect for those with different faiths and beliefs and those with the protected characteristics set out in the Equality duty.					
	Individual liberty Students might explore the extent of individual liberty bearing in mind legal constraints that are numerical in nature, e.g., taxation of income, speed limits in cars.			**Rule of law** Within maths, there are opportunities to study areas where numerical data is part of the rule of law. Examples to teach different aspects of	

				maths can come directly from statistics used in law. This might include taxation or calculations that need to be made to make sure that industry complies with health and safety legislation. Statistics can also be used to identify the impact of legislative change. The Office of National Statistics may be helpful. The level of analysis will obviously vary according to the level of maths being taught. **Democracy** Maths and the use of data have a significant role in the democratic decision making and influencing change. Students will hear statistics quoted to justify and argue for particular positions. Within maths, again using varied levels of complexity, the validity of these statistics can be explored. A useful resource is the BBC Radio 4: More or Less programme helpful in this. The development of critical thinking skills using maths will help develop student resilience to being exploited by extremists.	
Links to teaching of RAISE Values	Respect During class discussions about possible methods and answers students have to listen to others, demonstrate actively listening within the learning environment and communicate with another person and/or a peer. Aspiration When working through any problem it is important to identify and evaluate key strengths and weaknesses in relation to a key topic, so strengths, weaknesses and improvements needed in a particular area can be identification and help asked for. Independence Work with maths allows students to have the opportunity to make choices of methods for themselves. Success The independent work allows the students to see and strive for their own success. Engagement During lessons students are encouraged to choose to engage in the mathematical work or take the time out to self-regulate before returning to the work.				
			Aspiration To understand how to create smaller steps to achieve a bigger goal. In solving equations, the	Engagement To know the time.	

			method is broken down into smaller steps all needed to get to the answer.	To know the purpose of good time management for now and the future.		

Long Term Planning

Milestone 1						
Theme mapping	**Number**	**Ratio & Proportion**	**Algebra**	**Geometry**	**Statistics**	**Probability**
Learning Outcomes *Sound understanding of powerful* ***knowledge*** *to be reviewed and retained for future learning.* *becomes…* *Successful application of transferable* ***skills***	**N1 Operations with Number** • Addition and Subtraction of integers. • Addition and Subtraction of decimals. • Multiplication and division of integers including formal methods. • Order of operations. **N2 Place Value and Standard Form** • Recognise place value. • Position integers and decimals on number lines. • Use =, <, >. • Compare and order numbers. • Multiply and divide by powers of 10. **N3 Rounding and Estimation** • Rounding to powers of ten. • Use estimation to check calculations. **N4 Primes, Factors and Multiples** • Understand factors and multiples. • Recognise prime numbers. **N5 Fractions, Decimals & Percentages Conversion** • Convert between simple fractions, decimals and percentages. • Convert between all decimals and percentages. **N6 Fractions** • Convert between all fractions, decimals (including all recurring decimals) and percentages.	**R1 Metric Units** • Convert metric units. **R2 Ratio** **x** **R3 Proportion** **x** **R4 Compound Units** **x**	**A1 Sequences** *Term to term rule* • Describe a linear and non-linear sequence. • Continue a linear and non-linear sequence. **A2 Functions, Formula and Expressions** • Find the output or input of function machines. • Substitute values into one and two operations. • Understand like terms. • Simplify by collecting like terms. **A3 Expanding and Factorising** **x** **A4 Indices** • Understand what an indices is. • Write strings as indices. **A5 Algebraic Fractions*** **x** **A6 Solving Equations and Inequalities** • Understand equality and equivalence. • Solve one step linear equations. • Solve two step equations. • Understand equivalence. **A7 Graphs and Graph Transformations.** • Coordinates in the first quadrant.	**G1 Area, Perimeter, Surface Area and Volume** • Perimeter of shapes by counting squares. • Perimeter of shapes by using measurements. • Area of rectangles, parallelograms and triangles. **G2 Angles and Bearings** • Draw angles. • Measure angles. • Identify parallel lines. • Identify perpendicular lines. • Angles around a point. • Angles on a straight line. • Vertically opposite angles. • Angles in a triangle and quadrilateral. • Use cardinal directions. **G3 Constructions** • Draw and measure line segments. **G4 Similarity** **x** **G5 Polygons and 3D Shapes** • Types and triangles. • Types of quadrilaterals. • Identify polygons. • Names of 2D and 3D shapes. **G6 Transformations** • Reflect a shape in a horizontal or vertical line. **G7 Pythagoras and Trigonometry** **x** **G8 Vectors**	**S1 Data and Averages** • Range, median of a list. **S2 Charts and Diagrams** • Use and interpret simple pie charts. • Tables and timetables. • Use =, <, >. • Compare and order numbers. • Multiply and divide by powers of 10.	**P1 Sets and Venn Diagrams** • Identify and represent sets. **P2 Basic Probability** • Vocabulary of probability. • Probability scale. • Single event probabilities. **P3 Tree Diagrams** **x**

	N7 Percentages • Percentages of an amount with a calculator. **N8 Directed Number** • Order directed number. **N9 Roots, Powers, Indices and Surds** • Roots and powers of positive numbers. • Squares up to and including 15. • Cubes from 1 to 5 and 10.			**x**		
Vocabulary *for literacy, reading & oracy*	**N1 Operations with Number** Addition Subtraction Integers Decimals Multiplication Division Order Operations **N2 Place Value and Standard Form** Integers Decimals Greater than Less than Equal to Multiply Divide Powers of 10 **N3 Rounding and Estimation** Rounding Decimal places Significant Figures Powers Estimation **N4 Primes, Factors and Multiples** Factors Multiples Prime numbers	**R1 Metric Units** Convert Metric Units Milli Centi Kilo Tonnes Metres Grams Litres	**A1 Sequences** *Term to term rule* Linear Non-linear Sequence. **A2 Functions, Formula and Expressions** Output Input Function machines Substitute Operations Like terms Simplify **A4 Indices** Indices **A6 Solving Equations and Inequalities** Equality Equivalence Solve Linear Equations **A7 Graphs and Graph Transformations.** Coordinates First Quadrant	**G1 Area, Perimeter, Surface Area and Volume** Perimeter Area Rectangles Parallelograms Triangles. **G2 Angles and Bearings** **Draw angles.** Measure Angles Acute Obtuse Reflex Parallel lines Perpendicular lines Vertically opposite angles Triangle Quadrilateral. Cardinal directions North East South West **G3 Constructions** Line Segments Protractor **G5 Polygons and 3D Shapes** Triangles Equilateral Triangles	**S1 Data and Averages** Range Median **S2 Charts and Diagrams** Interpret Pie charts Tables Timetables Greater than Less than Equal to Compare	**P1 Sets and Venn Diagrams** Identify Represent Sets **P2 Basic Probability** Probability Probability scale Impossible Unlikely Evens Likely Certain Single event probabilities

	N5 Fractions, Decimals & Percentages Conversion Fractions Decimals Percentages Convert **N6 Fractions** Convert Fractions Decimals Recurring Decimals Percentages **N7 Percentages** Percentages **N8 Directed Number** Order Directed number Negative **N9 Roots, Powers, Indices and Surds** Roots Powers Squares Square Numbers Cubes Cube Numbers			Isosceles Triangles Scalene Triangles Quadrilaterals Square Rectangle Rhombus Parallelogram Kite Trapezium Delta Polygons Pentagon Hexagon Heptagon Octagon Nonagon Decagon Circle Dimensional Cube Cuboid Prism Cylinder Pyramid Tetrahedron **G6 Transformations** Reflect Horizontal Vertical		
Sequenced *FROM and TO*	FROM – understanding of place value TO – understanding of basic four operations understanding of ordering of numbers understanding of rounding numbers understand the make-up of numbers understanding of special numbers understand conversion between FPD understand percentage of amounts understand directed numbers understand roots powers, squares, and cubes	FROM – Basic measurements TO – Converting between metric measures	FROM – Understanding times tables Using basic operations TO – Identifying basic sequences Using operations with basic algebra Understanding the first quadrant co-ordinates	FROM – Basic understanding of shape TO – Calculating area Calculating perimeter Understanding angles Understanding shapes Reflecting shapes	FROM – understanding of data points TO – Calculating the median Calculating the range Creating simple data charts	FROM – understanding of categories understanding of chance TO – Understanding of sets Understanding of basic probability

Milestone 2						
Theme mapping	**Number**	**Ratio & Proportion**	**Algebra**	**Geometry**	**Statistics**	**Probability**
Learning Outcomes *Sound understanding of powerful* ***knowledge*** *to be reviewed and retained for future learning.* *becomes…* *Successful application of transferable* ***skills***	**N1 Operations with Number** •Multiplication and division of decimals, including formal methods. •Order of operations with directed numbers. •Calculate with money. **N2 Place Value and Standard Form** •Write 10, 100, 1000 etc as powers of 10 **N3 Rounding and Estimation** • Round to 1 significant figure. • Round numbers to decimal places. **N4 Primes, Factors and Multiples** •Find HCF and LCM. **N5 Fractions, Decimals & Percentages Conversion** • Convert between most fractions, decimals and percentages. **N6 Fractions** •Convert between mixed numbers and improper fractions. •Add and subtract fractions. **N7 Percentages** • Percentages of certain amounts. **N8 Directed Number** • Add and subtract directed numbers. **N9 Roots, Powers, Indices and Surds**	**R1 Metric Units** •Convert metric lengths, weight and capacity. **R2 Ratio** •Understand ratio and ratio notation. •Simplify ratio. **R3 Proportion** •Direct proportion. •Conversion graphs. •Convert currencies. **R4 Compound Units** **x**	**A1 Sequences** •Find missing numbers in a linear and non-linear sequences. •Generate a sequence given a rule in words or an algebraic expression.* **A2 Functions, Formula and Expressions** •Multiplication and division of algebraic expressions. • Evaluate algebraic expressions with directed number. • Identify formulas, expressions, identities and equations. • Collect like terms with indices. **A3 Expanding and Factorising** • Expand a single bracket. Factorise into a single bracket. **A4 Indices** •Simplify expressions by multiplying and dividing indices. **A5 Algebraic Fractions*** **x** **A6 Solving Equations and Inequalities** •Understand and solve simple inequalities. •Represent inequalities on a number line. •Interpret inequalities on a number line. **A7 Graphs and Graph Transformations.** • Coordinates in all four quadrants.	**G1 Area, Perimeter, Surface Area and Volume** •Area of trapeziums. •Area and perimeter of compound shapes. •Understand pi as the ratio between diameter and circumference. •Area of a circle and parts of a circle **G2 Angles and Bearings** •Basic angle rules and notation. •Angles in parallel lines and transversal. • Alternate, corresponding, and co-interior angles. • Angles in any polygon. •Interior and exterior angles of regular and irregular polygons **G3 Constructions** • Construct triangles. • Construct special quadrilaterals. • Construct polygons. **G4 Similarity** •Relationships in similar shapes. •Scale factors. **G5 Polygons and 3D Shapes** • Properties of quadrilaterals. • Sides and angles in special quadrilaterals. **G6 Transformations** •Reflect a shape in a horizontal, vertical, or diagonal line. **G7 Pythagoras and Trigonometry** **x**	**S1 Data and Averages** •Calculate the mean from a list. •Find and interpret the range. •Understand mean, median and mode. **S2 Charts and Diagrams** •Frequency trees. •Bar charts and line charts. •Draw and use scatter graphs. •Pictograms, bar charts, line charts. •Draw and interpret multiple bar charts. •Draw and interpret line graphs.	**P1 Sets and Venn Diagrams** •Interpret and create Venn diagrams. **P2 Basic Probability** •Sample space for single events. •Know that probabilities sum to one. **P3 Tree Diagrams** **x**

	x		• Represent one and two step functions graphically. • Plot using a table of values. • Plot graphs y=mx+c. • Identify and draw horizontal and vertical lines.	**G8 Vectors** **x**		
Vocabulary *for literacy, reading & oracy*	**N1 Operations with Number** Multiplication Division Decimals Order of operations Directed numbers Calculate Money **N2 Place Value and Standard Form** Powers of 10 **N3 Rounding and Estimation** significant figure Decimal places **N4 Primes, Factors and Multiples** HCF LCM Prime Factors Multiples **N5 Fractions, Decimals & Percentages Conversion** Fractions Decimals Percentages **N6 Fractions** Convert Mixed numbers Improper fractions Add Subtract **N7 Percentages** Percentages	**R1 Metric Units** Convert Metric Lengths Milli Centi Kilo Tonnes Metres Grams Litres Weight Capacity **R2 Ratio** Ratio Simplify **R3 Proportion** Direct Conversion Currencies Pounds Pence Euros Dollars	**A1 Sequences** Linear Non-linear Sequences **A2 Functions, Formula and Expressions** Multiplication Division Algebraic Expressions Evaluate Directed numbers Formulas Expressions Identities Equations Collecting like Indices **A3 Expanding and Factorising** Expand Single bracket. Factorise **A4 Indices** Simplify Expressions Multiplying Dividing Indices **A6 Solving Equations and Inequalities** Inequalities Represent Number line Interpret **A7 Graphs and Graph Transformations.**	**G1 Area, Perimeter, Surface Area, and Volume** Area Trapezium perimeter Compound shapes Pi Diameter Circumference Area Circle Centre Radius Chord Arc Tangent Segment Sector **G2 Angles and Bearings** Parallel Transversal Alternate Corresponding Co-interior Polygon Interior Exterior Regular Irregular Polygons **G3 Constructions** Construct Pair of compasses **G4 Similarity** Relationships Similar Scale factors	**S1 Data and Averages** Calculate Mean Interpret Range Mean Median Mode **S2 Charts and Diagrams** Frequency trees Bar charts Line charts Scatter graphs Pictograms Interpret Multiple bar charts	**P1 Sets and Venn Diagrams** Interpret Create Venn diagrams. **P2 Basic Probability** Sample space Single events Probabilities Sum to

	N8 Directed Number Directed numbers		Coordinates Quadrants Functions Graphically Plot Graphs Gradient Intercept Horizontal Vertical	**G5 Polygons and 3D Shapes** Quadrilaterals Adjacent Diagonal Opposite **G6 Transformations** Reflect Horizontal Vertical Diagonal		
Sequenced *FROM and TO*	FROM – understanding of basic four operations understanding of ordering of numbers understanding of rounding numbers understand the make-up of numbers understanding of special numbers understand conversion between FPD understand percentage of amounts understand directed numbers understand roots powers, squares and cubes TO – Understanding operations with decimals Understanding operations with money Understanding powers of 10 Understanding rounding to significant figures Understanding HCF Understanding LCM Converting between different number notations Adding and subtracting fractions Adding and subtracting directed numbers	FROM – Converting between metric measures TO – Converting between all metric measurements Understanding basic ratio Understand basic proportion	FROM – Identifying basic sequences Using operations with basic algebra Understanding the first quadrant co-ordinates TO – Manipulating more complex sequences Use directed numbers with algebra Factorise and expand within algebra Understand basic indice laws Solve basic equations Use basic inequalities Understanding all four quadrant co-ordinates	FROM – Calculating area Calculating perimeter Understanding angles Understanding shapes Reflecting shapes TO – Calculating area of more complex shapes Calculating perimeter of more complex shapes Understanding angles in parallel lines Understanding shapes and their angles enlarging shapes	FROM – Calculating the median Calculating the range Creating simple data charts TO – Calculating the mode Calculating the mean Creating more complex data charts	FROM – Understanding of sets Understanding of basic probability TO – Understanding of venn diagrams Understanding of probability using sample spaces

Milestone 3						
Theme mapping	**Number**	**Ratio & Proportion**	**Algebra**	**Geometry**	**Statistics**	**Probability**

Learning Outcomes *Sound understanding of powerful* ***knowledge*** *to be reviewed and retained for future learning.* *becomes…* *Successful application of transferable* ***skills***	**N1 Operations with Number** x **N2 Place Value and Standard Form** • Investigate negative powers of 10. • Write integers and decimals in standard form. • Work with big and small numbers in standard form. • Order numbers in standard form. • Add and subtract numbers in standard form. **N3 Rounding and Estimation** • Error interval notation. **N4 Primes, Factors and Multiples** • Write a number as the product of primes. **N5 Fractions, Decimals & Percentages Conversion** • Convert between all fractions, decimals (including some recurring decimals) and percentages. **N6 Fractions** • Multiplication of fractions by an integer and another fraction. • Divide a fraction by an integer and another fraction. **N7 Percentages** • Percentages of any amounts. • One number as a percentage of another using a calculator. **N8 Directed Number** • Multiplication and division of directed numbers.	**R1 Metric Units** x **R2 Ratio** • Share in a ratio and use a given value in a ratio. • Solve ratio problems given the whole or part. **R3 Proportion** • Direct proportion graphs. • Solve problems with exchange rates. • Solve problems with unit pricing. • Problems with direct proportion. **R4 Compound Units** • Solve speed, distance, time calculations. • Use distance time graphs. • Solve density, mass, volume problems. • Solve flow problems including graphs. • Rates of change and units.	**A1 Sequences** *Position to term rule* • Find the nth term of a linear sequence. **A2 Functions, Formula and Expressions** • Substitution into formula and equations. • Re-arrange formula – one and two step. **A3 Expanding and Factorising** • Expand multiple single brackets and simplify. **A4 Indices** • Laws for indices, power to a power. **A5 Algebraic Fractions*** • Add and subtract simple algebraic fractions. • Multiply and divide simple algebraic fractions. **A6 Solving Equations and Inequalities** • Solve equations with brackets • Solve equations and inequalities with unknowns both sides. **A7 Graphs and Graph Transformations.** • Recognise and use the lines y=x, y=kx (including negative) and y=x + a. • Link graphs to linear sequences. • Draw straight line graphs. • Understand gradient of a line as a ratio. • Compare gradients. • Compare intercepts. • Understand and use y=mx+c. • Write an equation in the form y=mx+c.	**G1 Area, Perimeter, Surface Area and Volume** • Areas of 2D shapes. • Surface area of cubes, cuboids, triangular prisms. • Surface area of cylinders. • Volumes of cubes and cuboids. • Volumes of prisms and cylinders. **G2 Angles and Bearings** • Angle problems with geometric reasoning. **G3 Constructions** • Locus of distance from a point. • Locus of distance from a line. • Locus equidistance from two points. • Construct perpendicular bisector. • Construct perpendicular from a point. • Construct angle bisector. **G4 Similarity** • Scale diagrams. • Maps using scale factors and ratios. • Construct and interpret scale drawings. • Congruent Shapes. • Recognise similarity. **G5 Polygons and 3D Shapes** • properties of diagonals of quadrilaterals. • Recognise prisms. **G6 Transformations** • Order of rotational symmetry. • Compare rotational symmetry with line symmetry. • Rotate and shape about a point.	**S1 Data and Averages** • Read and interpret grouped and ungrouped frequency tables. • Design and criticise questionaries. • Choose appropriate average. **S2 Charts and Diagrams** • Draw and interpret pie charts. • Understand and describe linear corelation. • Draw and use lines of best fit. • Represent and interpret grouped quantitative data.	**P1 Sets and Venn Diagrams** • Intersection and union of sets. **P2 Basic Probability** • Probabilities from sample space for 1 or more events. • Probabilities from two-way tables. • Expected outcomes. • Independent events. • Probability from diagrams. **P3 Tree Diagrams** x

	N9 Roots, Powers, Indices and Surds • Understand and use negative indices. • Understand and use fractional indices.			• Translate shapes by a vector.* • Recognise enlargement and similarity. **G7 Pythagoras and Trigonometry** • Identify the hypotenuse. • Calculate missing sides with Pythagoras. **G8 Vectors** • Translate shapes by a vector.*		
Vocabulary *for literacy, reading & oracy*	**N2 Place Value and Standard Form** Negative powers of 10. Integers Decimals Standard form Add Subtract numbers **N3 Rounding and Estimation** Error interval **N4 Primes, Factors and Multiples** product of primes Prime number decomposition **N5 Fractions, Decimals & Percentages Conversion** Fractions decimals recurring decimals percentages **N6 Fractions** Multiplication Integer Divide **N7 Percentages** Percentages. Calculator **N8 Directed Number**	**R2 Ratio** Ratio **R3 Proportion** Direct proportion Exchange rates Unit pricing **R4 Compound Units** Compound measures Compound units Speed Distance Time Distance time graphs Density Mass Volume Rates of change Units	**A1 Sequences** *Position to term rule* nth term Linear sequence **A2 Functions, Formula and Expressions** Substitution Formula Equations. Re-arrange **A3 Expanding and Factorising** Expand Multiple Single brackets Simplify **A4 Indices** Laws for indices Power to a power **A5 Algebraic Fractions*** Add Subtract Algebraic Fractions. Multiply Divide **A6 Solving Equations and Inequalities** Solve Equations	**G1 Area, Perimeter, Surface Area and Volume** Areas Surface area Volumes **G2 Angles and Bearings** Angle Geometric reasoning **G3 Constructions** Locus of distance from a point. Locus of distance from a line. Locus equidistance from two points. Construct perpendicular bisector. Construct perpendicular from a point. Construct angle bisector. **G4 Similarity** Scale diagrams. Maps Scale factors Ratios Construct Interpret Scale drawings Congruent Shapes Recognise similarity **G5 Polygons and 3D Shapes**	**S1 Data and Averages** Read Interpret Grouped Ungrouped Frequency tables Design Criticise Questionaries. Average. **S2 Charts and Diagrams** Draw Interpret Pie charts Understand Linear corelation Lines of best fit. Quantitative data.	**P1 Sets and Venn Diagrams** Intersection Union Sets **P2 Basic Probability** Probabilities Sample space Events Two-way tables Expected outcomes Independent events

	Multiplication Division Directed numbers **N9 Roots, Powers, Indices and Surds** Negative indices Fractional indices Reciprocal		Brackets Inequalities Unknowns **A7 Graphs and Graph Transformations.** Recognise Negative Linear sequences Straight line graphs Gradient of a line Ratio Compare Intercepts Equation y=mx+c.	Properties of diagonals of quadrilaterals Recognise prisms **G6 Transformations** Order of rotational symmetry Line symmetry Translate Vector Enlargement Similarity **G7 Pythagoras and Trigonometry** Hypotenuse. Pythagoras. **G8 Vectors** Translate Vector		
Sequenced *FROM and TO*	FROM – Understanding operations with decimals Understanding operations with money Understanding powers of 10 Understanding rounding to significant figures Understanding HCF Understanding LCM Converting between different number notations Adding and subtracting fractions Adding and subtracting directed numbers TO – Understanding negative powers of 10 Understanding standard form notation and adding and subtracting numbers in that form Understand prime number decomposition and writing numbers as a product of primes Converting between all different number notations multiplying and dividing fractions understand writing a number as a percentage of another (using a calculator)	FROM – Converting between all metric measurements Understanding basic ratio Understand basic proportion TO – Understand calculations involving speed/distance/time Understand and use distance time graphs Understand calculations involving density/mass/volume Understand calculations involving rates of change and the units involved	FROM – Manipulating more complex sequences Use directed numbers with algebra Factorise and expand within algebra Understand basic indice laws Solve basic equations Use basic inequalities Understanding all four quadrant co-ordinates TO – Understand nth term of a linear sequence. Understand substitution into formula and equations Understand Re-arrange formula Understand how to expand multiple single brackets and simplify Understand laws for indices, power to a power Understand how to add and subtract simple algebraic fraction Understand how to multiply and divide simple algebraic fractions	FROM – Calculating area of more complex shapes Calculating perimeter of more complex shapes Understanding angles in parallel lines Understanding shapes and their angles enlarging shapes TO – Understand areas of 2D shapes. Understand surface area of cubes, cuboids, triangular prisms. Understand surface area of cylinders. Understand volumes of cubes and cuboids. Understand volumes of prisms and cylinders. Understand angle problems with geometric reasoning. Understand locus of distance from a point, locus of distance from a line, locus equidistance from two points.	FROM – Calculating the mode Calculating the mean Creating more complex data charts TO – Be able to read and interpret grouped and ungrouped frequency tables. Be able to design and criticise questionaries. Choose appropriate average. Draw and interpret pie charts. Understand and describe linear corelation. Draw and use lines of best fit. Represent and interpret grouped quantitative data.	FROM – Understanding of venn diagrams Understanding of probability using sample spaces TO – Understand intersection and union of sets. Understand probabilities from sample space for 1 or more events. Understand probabilities from two-way tables. Understand expected outcomes. Understand independent events. Understand probability from diagrams.

	Understand both negative and fractional indices		Understand how to solve equations with brackets Understand how to solve equations and inequalities with unknowns both sides. Understand how to recognise and use the lines y=x, y=kx (including negative) and y=x + a. Understand how to link graphs to linear sequences. Understand how to draw straight line graphs. Understand and compare gradients and intercepts of a line as a ratio. Understand and use y=mx+c. Understand how to write an equation in the form y=mx+c.	Understand how to construct perpendicular bisector, construct perpendicular from a point, construct angle bisector. Understand scale diagrams, maps using scale factors and ratios. Understand how to construct and interpret scale drawings. Understand congruent shapes. Recognise similarity. Understand properties of diagonals of quadrilaterals. Recognise prisms. Understand order of rotational symmetry. Compare rotational symmetry with line symmetry. Understand how to rotate and shape about a point. Understand how to translate shapes by a vector. Recognise enlargement and similarity. Identify the hypotenuse. Understand how to calculate missing sides with Pythagoras. Understand how to translate shapes by a vector.		

Milestone 4						
Theme mapping	**Number**	**Ratio & Proportion**	**Algebra**	**Geometry**	**Statistics**	**Probability**
Learning Outcomes *Sound understanding of powerful* ***knowledge*** *to be reviewed and retained for future learning.* *becomes…*	**N1 Operations with Number x** **N2 Place Value and Standard Form** • Multiply and divide numbers in standard form. **N3 Rounding and Estimation** • Estimating calculations. • Understand and use limits of accuracy.	**R1 Metric Units** •Convert metric units of area. **R2 Ratio** • Write a ratio in the form 1:n. **R3 Proportion** • Real life graphs involving inverse proportion. • Problems with inverse proportion.	**A1 Sequences** • State whether a number appears in a sequence, when given the nth term. **A2 Functions, Formula and Expressions** • Simplify algebraic expressions. • Change the subject of a simple formula. **A3 Expanding and Factorising**	**G1 Area, Perimeter, Surface Area and Volume** • Volumes of cones, pyramids and spheres. • Recognise and label parts of a circle. • Volume of cone and sphere. • Surface area of cylinder, cone and sphere. **G2 Angles and Bearings**	**S1 Data and Averages** •Mean from a group or ungrouped frequency table. •Identify outliers. •Compare distributions using averages and ranges. **S2 Charts and Diagrams** • Compare distributions using charts. • Construct and interpret two-way tables.	**P1 Sets and Venn Diagrams** • Complement of a set. **P2 Basic Probability** • Relative frequency. • Probability from diagrams. • Find probabilities from equally likely outcomes. • Use experimental data to estimate probabilities. **P3 Tree Diagrams**

Successful application of transferable ***skills***	**N4 Primes, Factors and Multiples** • Use Venn diagrams to find HCF and LCM. **N5 Fractions, Decimals & Percentages Conversion** • Convert between decimals and percentages greater than 1. **N6 Fractions** • Understand and use reciprocal. • Multiply and divide improper and mixed fractions. **N7 Percentages** • Percentages greater than 100% of an amount. • Percentage increase and decrease. • One number as a percentage of another. • Express change as a percentage. **N8 Directed Number** • Work with directed number. **N9 Roots, Powers, Indices and Surds** • Calculate with powers and roots.	• Direct proportion and conversion graphs **R4 Compound Units** • Convert compound units.	• Expand a pair of binomials. **A4 Indices** • Laws for indices, power of zero. • Laws for indices, fractional powers. **A5 Algebraic Fractions*** • Simplify algebraic fractions. **A6 Solving Equations and Inequalities** • Form and solve equations with brackets. • Form and solve equations and inequalities with unknowns both sides. • Understand, form and solve simple inequalities. • Show solutions to inequalities on a number line. • Solve linear simultaneous equations by elimination. **A7 Graphs and Graph Transformations.** • Explore non-linear graphs. • Midpoint of a line segment. • Find an equation from a graph. • Gradients and intercepts from real-life graphs. • Explore perpendicular lines. • Draw and interpret quadratic graphs. • Identify and interpret roots from quadratics. • Solve linear simultaneous equations graphically.	• Use parallel lines to find missing angles. • Understand and represent bearings • Draw and measure bearings. **G3 Constructions** • Perform standard constructions. • Solve loci problems. **G4 Similarity** • Identify similar shapes. • Difference between congruent and similar. • Work out missing sides and angles in similar shapes. **G5 Polygons and 3D Shapes** • Nets of 3D shapes • Plans and Elevations. **G6 Transformations** • Compare rotation and reflection. • Enlarge a shape by a positive integer and positive fraction including from a point. **G7 Pythagoras and Trigonometry** • Pythagoras with coordinates. **G8 Vectors** • Understand and represent vectors and vector notation. • Vectors multiplied by scalars. • Addition and subtraction of vectors.	• Construct and interpret line and bar charts, including composite. • Construct and interpret pie charts. • Construct and interpret time series graphs. • Construct and interpret stem and leaf diagrams. • Construct and interpret scatter graphs, including lines of best fit. • Use scatter graphs.	**x**
Vocabulary *for literacy, reading & oracy*	**N2 Place Value and Standard Form** Multiply Divide Standard form. **N3 Rounding and Estimation** Estimating	**R1 Metric Units** Convert Metric units of area mm^2 cm^2 m^2 km^2	**A1 Sequences** Sequence nth term **A2 Functions, Formula and Expressions** Simplify Algebraic	**G1 Area, Perimeter, Surface Area and Volume** Volumes Parts of a circle. Surface area **G2 Angles and Bearings** Parallel lines	**S1 Data and Averages** Mean Group Ungrouped Frequency table Outliers Compare Distributions	**P1 Sets and Venn Diagrams** Complement of a set. **P2 Basic Probability** Relative frequency. Probability Equally likely outcomes. Experimental data

	Limits of accuracy Decimal places Significant figures Bounds **N4 Primes, Factors and Multiples** Venn diagrams HCF LCM Universe Set Intersection Union **N5 Fractions, Decimals & Percentages Conversion** Convert between Decimals Percentages **N6 Fractions** Reciprocal Multiply Divide Improper Mixed fractions **N7 Percentages** Percentages Increase Decrease Express Change Percentage change **N8 Directed Number** Directed number. **N9 Roots, Powers, Indices and Surds** Powers Roots	**R2 Ratio** Unitary ratio 1:n. **R3 Proportion** Real life graphs Inverse proportion Direct proportion Conversion graphs **R4 Compound Units** Compound units.	Expressions Change the subject Formula **A3 Expanding and Factorising** Expand Pair of binomials **A4 Indices** Laws for indices Power of zero. Fractional powers. **A5 Algebraic Fractions*** Simplify Algebraic fractions. **A6 Solving Equations and Inequalities** Form Solve Equations Brackets. Inequalities Unknowns Number line Linear Simultaneous equations Elimination **A7 Graphs and Graph Transformations.** Explore Non-linear graphs. Midpoint of a line segment Equation Gradients Intercepts Real-life graphs Perpendicular lines. Draw Interpret Quadratic graphs Identify Interpret Roots from quadratics Linear Simultaneous equations Graphically	Bearings Constructions Loci **G4 Similarity** Similar shapes. Congruent **G5 Polygons and 3D Shapes** Nets Plans Elevations **G6 Transformations** Rotation Reflection Enlarge Integer Fraction **G7 Pythagoras and Trigonometry** Pythagoras Coordinates **G8 Vectors** Vectors Vector notation. Scalars.	Averages Ranges **S2 Charts and Diagrams** Compare Distributions Construct Interpret Two-way tables Line charts Bar charts Composite Pie charts. Time series graphs. Stem and leaf diagrams. Scatter graphs Lines of best fit.	Estimate probabilities.

Sequenced *FROM and TO*	FROM – Understanding negative powers of 10 Understanding standard form notation and adding and subtracting numbers in that form Understand prime number decomposition and writing numbers as a product of primes Converting between all different number notations multiplying and dividing fractions understand writing a number as a percentage of another (using a calculator) Understand both negative and fractional indices TO – Understanding standard form notation and multiplying and dividing numbers in that form Understanding the use of estimation Understanding of limits of accuracy Understanding the use of Venn diagrams to calculate HCF and LCM Understanding of fractions, decimals, and percentages above 1/100 and calculations with such numbers Understanding percentage change Understanding calculations with powers and roots	FROM – Understand calculations involving speed/distance/time Understand and use distance time graphs Understand calculations involving density/mass/volume Understand calculations involving rates of change and the units involved TO – Understand conversions involving area Understand unitary ratio Understand and use real life graphs Understand inverse proportionality Understand compound unit conversions	FROM – Understand nth term of a linear sequence. Understand substitution into formula and equations Understand Re-arrange formula Understand how to expand multiple single brackets and simplify Understand laws for indices, power to a power Understand how to add and subtract simple algebraic fraction Understand how to multiply and divide simple algebraic fractions Understand how to solve equations with brackets Understand how to solve equations and inequalities with unknowns both sides. Understand how to recognise and use the lines y=x, y=kx (including negative) and y=x + a. Understand how to link graphs to linear sequences. Understand how to draw straight line graphs. Understand and compare gradients and intercepts of a line as a ratio. Understand and use y=mx+c. Understand how to write an equation in the form y=mx+c. TO – Understand numbers appearing in a sequence, when given the nth term. Understand how to simplify algebraic expressions. Understand how to change the subject of a simple formula.	FROM – Understand areas of 2D shapes. Understand surface area of cubes, cuboids, triangular prisms. Understand surface area of cylinders. Understand volumes of cubes and cuboids. Understand volumes of prisms and cylinders. Understand angle problems with geometric reasoning. Understand locus of distance from a point, locus of distance from a line, locus equidistance from two points. Understand how to construct perpendicular bisector, construct perpendicular from a point, construct angle bisector. Understand scale diagrams, maps using scale factors and ratios. Understand how to construct and interpret scale drawings. Understand congruent shapes. Recognise similarity. Understand properties of diagonals of quadrilaterals. Recognise prisms. Understand order of rotational symmetry. Compare rotational symmetry with line symmetry. Understand how to rotate and shape about a point. Understand how to translate shapes by a vector. Recognise enlargement and similarity. Identify the hypotenuse. Understand how to calculate missing sides with Pythagoras.	FROM – Be able to read and interpret grouped and ungrouped frequency tables. Be able to design and criticise questionaries. Choose appropriate average. Draw and interpret pie charts. Understand and describe linear corelation. Draw and use lines of best fit. Represent and interpret grouped quantitative data. TO – Understand mean from a group or ungrouped frequency table. Understand identify outliers. Compare distributions using averages and ranges. Compare distributions using charts. Construct and interpret two-way tables. Construct and interpret line and bar charts, including composite. Construct and interpret pie charts. Construct and interpret time series graphs. Construct and interpret stem and leaf diagrams. Construct and interpret scatter graphs, including lines of best fit. Use scatter graphs.	FROM – Understand intersection and union of sets. Understand probabilities from sample space for 1 or more events. Understand probabilities from two-way tables. Understand expected outcomes. Understand independent events. Understand probability from diagrams. TO – Understand complement of a set. Understand relative frequency. Understand probability from diagrams. Find probabilities from equally likely outcomes. Use experimental data to estimate probabilities.

			Understand how to expand a pair of binomials. Understand how to Laws for indices, power of zero and fractional powers. Understand how to simplify algebraic fractions. Understand how to form and solve equations with brackets and inequalities with unknowns both sides and simple inequalities. Understand how to show solutions to inequalities on a number line. Understand how to solve linear simultaneous equations by elimination. Understand how to explore non-linear graphs. Understand the midpoint of a line segment. Understand how to find an equation from a graph. Understand how to use and find gradients and intercepts from real-life graphs. Understand how to explore perpendicular lines. Understand how to draw and interpret quadratic graphs. Understand how to identify and interpret roots from quadratics. Understand how to solve linear simultaneous equations graphically.	Understand how to translate shapes by a vector. TO – Understand volumes of cones, pyramids and spheres. Recognise and label parts of a circle. Understand Volume of cone and sphere. Understand Surface area of cylinder, cone and sphere. Use parallel lines to find missing angles. Understand and represent bearings Draw and measure bearings. Perform standard constructions. Solve loci problems. Identify similar shapes. Understand difference between congruent and similar. Work out missing sides and angles in similar shapes. Understand nets of 3D shapes Understand plans and Elevations. Compare rotation and reflection. Enlarge a shape by a positive integer and positive fraction including from a point. Understand Pythagoras with coordinates. Understand and represent vectors and vector notation. Understand vectors multiplied by scalars. Understand addition and subtraction of vectors.		

Milestone 5						
Theme mapping	**Number**	**Ratio & Proportion**	**Algebra**	**Geometry**	**Statistics**	**Probability**

Learning Outcomes *Sound understanding of powerful* ***knowledge*** *to be reviewed and retained for future learning.* *becomes…* *Successful application of transferable* ***skills***	**N1 Operations with Number** **x** **N2 Place Value and Standard Form** **x** **N3 Rounding and Estimation** • Upper and lower bounds. • Upper and lower bounds calculations. **N4 Primes, Factors and Multiples** **x** **N5 Fractions, Decimals & Percentages Conversion** **x** **N6 Fractions** • Fraction arithmetic within problems. **N7 Percentages** • Reverse percentage • Simple interest. • Compound interest. • Calculate with wages and taxes. **N8 Directed Number** **x** **N9 Roots, Powers, Indices and Surds** • Numbers to the power zero and to negative powers. • Powers of powers.	**R1 Metric Units** •Convert metric units of volume. **R2 Ratio** • Solve problems using ratio and algebra. • Solve ratio problems given the whole or part. • Compare ratio and fractions. • Use and interpret 1:n and n:1. • Combine ratios. • Changing ratio problems. **R3 Proportion** • Graphs of inverse proportion. • Solve best buy problems. • Construct and interpret conversion and real-life graphs. • Recognise and interpret proportion and inverse proportion graphs. • Understand direct proportion. **R4 Compound Units** • Use and interpret distance time graphs. • Use and interpret speed time graphs. • Calculate with pressure and density.	**A1 Sequences** **x** **A2 Functions, Formula and Expressions** • Re-arrange complex formula with brackets and squares. • Change the subject of a complex formula. • Use function notation. • Simplify complex expressions. **A3 Expanding and Factorising** • Factor quadratics. **A4 Indices** • Laws for indices, non-unitary fractional indices. **A5 Algebraic Fractions*** **x** **A6 Solving Equations and Inequalities** • Solve quadratics by factorising. **A7 Graphs and Graph Transformations.** • Interpret graphs including reciprocal • Plot and read quadratic, cubic, reciprocal graphs. • Recognise graph shapes. • Solve simultaneous equations where one is linear and one is quadratic graphically. • Equation of a line from a point and gradient. • Equation of a line from two points. • Determine whether a point is a on a line. • Find approximate solutions using graphs.	**G1 Area, Perimeter, Surface Area and Volume** •Areas and volumes of similar shapes. •Length of an arc. •Area of a sector. •Area and volume involving similar shapes. **G2 Angles and Bearings** •Solve bearings using Pythagoras and trigonometry. **G3 Constructions** •Constructions and geometric reasoning. **G4 Similarity** •Problems and ratios in similar triangles. •Establish whether triangles are similar. •Understand and use congruent triangle conditions. **G5 Polygons and 3D Shapes** • Construct and interpret plans and elevations. **G6 Transformations** • Find the result of multiple trans-formations. • Identify transformations of shapes. **G7 Pythagoras and Trigonometry** • Pythagoras in 3D. • Label sides in triangles. • Find missing side lengths using sine, cosine and tangent. • Find missing angles using sine, cosine and tangent. • Solve bearings using Pythagoras and trigonometry. **G8 Vectors**	**S1 Data and Averages** •Populations and samples. •Primary and secondary data. •Averages from a list and a table. •Compare distributions. **S2 Charts and Diagrams** •Probability from frequency trees. •Construct and interpret frequency tables and frequency polygons. •Compare distributions using charts and measures.	**P1 Sets and Venn Diagrams** • Probability from Venn diagrams. • Product rule for counting outcomes. **P2 Basic Probability** • Conditional probability from two way tables. **P3 Tree Diagrams** • Tree diagrams for independent and dependent events.

				• Vector journeys around shapes. • Parallel vectors. • Solve problems with vectors.		
Vocabulary *for literacy, reading & oracy*	**N3 Rounding and Estimation** Upper bounds Lower bounds Decimal places Significant figures Rounding **N6 Fractions** Fraction Arithmetic **N7 Percentages** Reverse percentage Simple interest Compound interest Wages Taxes **N9 Roots, Powers, Indices and Surds** power of zero Negative powers reciprocals Powers of powers	**R1 Metric Units** Convert Metric units of area mm^3 cm^3 m^3 km^3 **R2 Ratio** Solve Ratio Algebra Compare Fractions Interpret Unitary ratio 1:n and n:1 Combine ratios Changing ratio **R3 Proportion** Graphs Inverse proportion Solve Best buy Construct Interpret Conversion Real-life graphs Recognise Proportion graphs Direct proportion. **R4 Compound Units** Interpret Distance time graphs Speed time graphs. Pressure Density	**A2 Functions, Formula and Expressions** Re-arrange Complex formula Brackets Squares Change the subject Function notation Simplify Complex expressions **A3 Expanding and Factorising** Factor Quadratics. **A4 Indices** Laws for indices Non-unitary Fractional indices **A6 Solving Equations and Inequalities** Solve Quadratics Factorising **A7 Graphs and Graph Transformations.** Interpret reciprocal Plot Quadratic graphs Cubic graphs Reciprocal graphs Recognise Graph shapes Solve Simultaneous equations Linear Quadratic Graphically. Equation of a line From a point	**G1 Area, Perimeter, Surface Area and Volume** Areas Volumes Similar shapes. Length of an arc. sector. **G2 Angles and Bearings** Bearings Pythagoras Trigonometry. **G3 Constructions** Constructions Geometric reasoning. **G4 Similarity** Ratios Similar Triangles. Congruent **G5 Polygons and 3D Shapes** Construct Interpret Plans Elevations. **G6 Transformations** Transformations. **G7 Pythagoras and Trigonometry** Pythagoras Opposite Adjacent Hypotenuse Sine Cosine Tangent Inverse Bearings	**S1 Data and Averages** Populations Samples Primary data Secondary data Averages Compare Distributions **S2 Charts and Diagrams** Probability Frequency trees Construct Interpret Frequency tables Frequency polygons Compare distributions Charts Measures	**P1 Sets and Venn Diagrams** Probability Venn diagrams Product rule Outcomes **P2 Basic Probability** Conditional probability Two way tables. **P3 Tree Diagrams** Tree Independent events Dependent events

			Gradient. Determine Approximate Solutions	Trigonometry. **G8 Vectors** Vector Parallel		
Sequenced *FROM and TO*	FROM – Understanding standard form notation and multiplying and dividing numbers in that form Understanding the use of estimation Understanding of limits of accuracy Understanding the use of Venn diagrams to calculate HCF and LCM Understanding of fractions, decimals, and percentages above 1/100 and calculations with such numbers Understanding percentage change Understanding calculations with powers and roots TO – Understanding estimations and its use in upper and lower bound calculations Understanding of problems containing fractions Understanding reverse percentages Understanding of interest calculations (both simple and compound) Understanding numbers to the power of zero Understanding a power to a power Understanding of negative powers	FROM – Understand conversions involving area Understand unitary ratio Understand and use real life graphs Understand inverse proportionality Understand compound unit conversions TO – Understand conversions involving volume Understand and solve ration and algebra problems Understand comparisons between ratio and fractions Understand how to combine ratios Understand how to deal with changing ratios Understand how to interpret distance time graphs Understand how to interpret speed time graphs Understand how to interpret pressure Understand how to interpret density	FROM – Understand numbers appearing in a sequence, when given the nth term. Understand how to simplify algebraic expressions. Understand how to change the subject of a simple formula. Understand how to expand a pair of binomials. Understand how to Laws for indices, power of zero and fractional powers. Understand how to simplify algebraic fractions. Understand how to form and solve equations with brackets and inequalities with unknowns both sides and simple inequalities. Understand how to show solutions to inequalities on a number line. Understand how to solve linear simultaneous equations by elimination. Understand how to explore non-linear graphs. Understand the midpoint of a line segment. Understand how to find an equation from a graph. Understand how to use and find gradients and intercepts from real-life graphs. Understand how to explore perpendicular lines. Understand how to draw and interpret quadratic graphs. Understand how to identify and interpret roots from quadratics.	FROM – Understand volumes of cones, pyramids and spheres. Recognise and label parts of a circle. Understand Volume of cone and sphere. Understand Surface area of cylinder, cone and sphere. Use parallel lines to find missing angles. Understand and represent bearings Draw and measure bearings. Perform standard constructions. Solve loci problems. Identify similar shapes. Understand difference between congruent and similar. Work out missing sides and angles in similar shapes. Understand nets of 3D shapes Understand plans and Elevations. Compare rotation and reflection. Enlarge a shape by a positive integer and positive fraction including from a point. Understand Pythagoras with coordinates. Understand and represent vectors and vector notation. Understand vectors multiplied by scalars. Understand addition and subtraction of vectors. TO – Understand areas and volumes of similar shapes.	FROM – Understand mean from a group or ungrouped frequency table. Understand identify outliers. Compare distributions using averages and ranges. Compare distributions using charts. Construct and interpret two-way tables. Construct and interpret line and bar charts, including composite. Construct and interpret pie charts. Construct and interpret time series graphs. Construct and interpret stem and leaf diagrams. Construct and interpret scatter graphs, including lines of best fit. Use scatter graphs. TO – Understand populations and samples. Understand primary and secondary data. Understand averages from a list and a table. Compare distributions. Understand probability from frequency trees. Construct and interpret frequency tables and frequency polygons. Compare distributions using charts and measures.	FROM – Understand complement of a set. Understand relative frequency. Understand probability from diagrams. Find probabilities from equally likely outcomes. Use experimental data to estimate probabilities. TO – Understand probability from Venn diagrams. Understand product rule for counting outcomes. Understand conditional probability from two way tables. Understand tree diagrams for independent and dependent events.

			Understand how to solve linear simultaneous equations graphically. TO – Understand how to re-arrange complex formula with brackets and squares. Change the subject of a complex formula. Understand how to use function notation. Understand how to simplify complex expressions. Understand how to factorise quadratics. Understand Laws for indices, non-unitary fractional indices. Understand how to solve quadratics by factorising. Understand how to interpret graphs including reciprocal Understand how to plot and read quadratic, cubic, reciprocal graphs. Understand how to recognise graph shapes. Understand how to solve simultaneous equations where one is linear and one is quadratic graphically. Understand how to equation of a line from a point and gradient, equation of a line from two points. Understand how to determine whether a point is a on a line. Understand how to find approximate solutions using graphs.	Understand length of an arc. Understand area of a sector. Understand area and volume involving similar shapes. Solve bearings using Pythagoras and trigonometry. Constructions and geometric reasoning. Understand problems and ratios in similar triangles. Establish whether triangles are similar. Understand and use congruent triangle conditions. Construct and interpret plans and elevations. Find the result of multiple trans-formations. Identify transformations of shapes. Understand Pythagoras in 3D, label sides in triangles, find missing side lengths using sine, cosine and tangent, find missing angles using sine, cosine and tangent. Solve bearings using Pythagoras and trigonometry. Understand vector journeys around shapes. Understand parallel vectors. Solve problems with vectors.		

Milestone *						
Theme mapping	**Number**	**Ratio & Proportion**	**Algebra**	**Geometry**	**Statistics**	**Probability**
Learning Outcomes	**N1 Operations with Number** **x**	**R1 Metric Units** **x**	**A1 Sequences** • nth term for a quadratic sequence.	**G1 Area, Perimeter, Surface Area and Volume** • Frustum.	**S1 Data and Averages** •Stratified samples.	**P1 Sets and Venn Diagrams** • Conditional probability from Venn diagrams.

*Sound understanding of powerful **knowledge** to be reviewed and retained for future learning.* *becomes…* *Successful application of transferable **skills***	**N2 Place Value and Standard Form** x **N3 Rounding and Estimation** x **N4 Primes, Factors and Multiples** x **N5 Fractions, Decimals & Percentages Conversion** • Convert between all fractions, decimals (including all recurring decimals) and percentages. **N6 Fractions** x **N7 Percentages** • Reverse percentage problems. • Repeated percentage change. **N8 Directed Number** x **N9 Roots, Powers, Indices and Surds** • Rational and irrational numbers. • Understand and use fractional indices. • Understand and use surds. • Calculate with surds.	**R2 Ratio** • Ratio problems. **R3 Proportion** • Direct proportion equations. • Understand inverse proportion. • Inverse proportion equations. **R4 Compound Units** x	• Describe and continue sequences with surds.* **A2 Functions, Formula and Expressions** • Change the subject where the subject appears more than once. • Understand iterative processes. • Use identities. • Algebraic arguments and proof. • Formal algebraic proof. • Use composite and inverse functions. **A3 Expanding and Factorising** • Expand three binomials. • Factorise complex quadratics. **A4 Indices** • Laws for indices, negative fractional indices. **A5 Algebraic Fractions*** • Add and subtract algebraic fractions. • Multiply and divide algebraic fractions. • Form and solve equations and inequalities with algebraic fractions. **A6 Solving Equations and Inequalities** • Represent solutions to inequalities using set notation. • Solution to equations using straight line graphs. • Represent solutions to single and multiple inequalities on a graph. • Solve complex quadratics by factorising. • Solve quadratic inequalities. • Solve simultaneous equations where one is linear and one is quadratic by substitution.	**G2 Angles and Bearings** • Solve bearings using sine and cosine rule. • Circle theorems: angle at the centre, angles in a semicircle, angles in same segments, angles in cyclic quadrilateral. • Circle theorems: angle between radius and chord, radius and tangent, two tangents, alternate segment theorem. **G3 Constructions** x **G4 Similarity** • Prove triangles are congruent. **G5 Polygons and 3D Shapes** x **G6 Transformations** • Enlarge a shape by a negative scale factor. • Identify invariant points. **G7 Pythagoras and Trigonometry** • Trigonometry in 3D shapes. • Use ½ ab sin C to find area of a triangle. • Use the sine rule to find sides and angles. • Use the cosine rule to find sides and angles. • Choose between the sine and cosine rules. • Solve bearings using sine and cosine rule. **G8 Vectors** • Collinear vectors. • Geometric proofs with vectors.	**S2 Charts and Diagrams** • Construct and interpret histograms. • Construct and interpret cumulative frequency graphs. • Use cumulative frequency graphs to find values. • Construct and interpret box plots. • Compare distributions using box plots and cumulative frequency graphs. • Understand extrapolation.	**P2 Basic Probability** x **P3 Tree Diagrams** • Conditional probabilities from Tree diagrams.

			• Complete the square. • Solve quadratics by using the formula. • Solve equations by iteration. **A7 Graphs and Graph Transformations.** • Equations of perpendicular lines. • Understand and use exponential graphs. • Equation of a circle. • Find the equation of the tangent to a graph. • Estimate the area under a curve. • Graphs of trigonometric functions. • Sketch and identify graph translations. • Sketch and identify graph reflections.			
Vocabulary *for literacy, reading & oracy*	**N5 Fractions, Decimals & Percentages Conversion** Convert Fractions Decimals Recurring decimals percentages **N7 Percentages** Reverse percentage Repeated percentage change **N9 Roots, Powers, Indices and Surds** Rational numbers Irrational number fractional indices surds	**R2 Ratio** Ratio **R3 Proportion** Direct proportion Equations Inverse proportion.	**A1 Sequences** nth term Quadratic sequence Describe Continue sequences Surds **A2 Functions, Formula and Expressions** Change the subject Understand Iterative processes Identities Algebraic arguments proof Formal algebraic proof Composite functions Inverse functions **A3 Expanding and Factorising** Expand Binomials Factorise Complex quadratics **A4 Indices**	**G1 Area, Perimeter, Surface Area and Volume** Frustum **G2 Angles and Bearings** Solve Bearings Sine rule Cosine rule Circle theorems Angle at the centre Angles in a semicircle Angles in same segments Angles in cyclic quadrilateral Angle between radius and chord Angle between radius and tangent Angle between two tangents Angle between alternate segment theorem **G4 Similarity** Congruent	**S1 Data and Averages** Stratified samples **S2 Charts and Diagrams** Construct Interpret Histograms. Cumulative frequency graphs. Box plots. Extrapolation.	**P1 Sets and Venn Diagrams** Conditional probability Venn diagrams. **P3 Tree Diagrams** Conditional probabilities Tree diagrams.

			Laws for indices Negative fractional indices **A5 Algebraic Fractions*** Add Subtract Algebraic fractions Multiply Divide Form Solve Equations Inequalities Algebraic fractions **A6 Solving Equations and Inequalities** Represent Solutions Inequalities Set notation. Equations Straight line graphs Complex quadratics Factorising Quadratic inequalities Simultaneous equations Quadratic Substitution Complete the square Quadratic formula Iteration **A7 Graphs and Graph Transformations.** Perpendicular lines Exponential graphs Equation of a circle Tangent to a graph Estimate Trigonometric functions. Translations Reflections.	**G6 Transformations** Enlarge Scale factor. Invariant points. **G7 Pythagoras and Trigonometry** Trigonometry ½ ab sin C Sine rule Cosine rule Bearings **G8 Vectors** Collinear vectors Geometric proofs with vectors.		
Sequenced *FROM and TO*	FROM – Understanding estimations and its use in upper and lower bound calculations	FROM – Understand conversions involving volume Understand and solve ration and algebra problems	FROM – Understand how to re-arrange complex formula with brackets and squares.	FROM – Understand areas and volumes of similar shapes. Understand length of an arc. Understand area of a sector.	FROM – Understand populations and samples. Understand primary and secondary data.	FROM – Understand probability from Venn diagrams. Understand product rule for counting outcomes.

	Understanding of problems containing fractions Understanding reverse percentages Understanding of interest calculations (both simple and compound) Understanding numbers to the power of zero Understanding a power to a power Understanding of negative powers TO – Understand all possible conversions between different number notation Understand reverse percentage Understand repeated percentage changes Understand the differences between rational and irrational numbers Understand fractional indices Understand using and manipulating surds	Understand comparisons between ratio and fractions Understand how to combine ratios Understand how to deal with changing ratios Understand how to interpret distance time graphs Understand how to interpret speed time graphs Understand how to interpret pressure Understand how to interpret density TO – Understand and manipulate ratio problems Understand, manipulate and interpret both direct and inverse proportionality equations	Change the subject of a complex formula. Understand how to use function notation. Understand how to simplify complex expressions. Understand how to factorise quadratics. Understand Laws for indices, non-unitary fractional indices. Understand how to solve quadratics by factorising. Understand how to interpret graphs including reciprocal Understand how to plot and read quadratic, cubic, reciprocal graphs. Understand how to recognise graph shapes. Understand how to solve simultaneous equations where one is linear and one is quadratic graphically. Understand how to equation of a line from a point and gradient, equation of a line from two points. Understand how to determine whether a point is a on a line. Understand how to find approximate solutions using graphs. TO – Understand how to find the nth term for a quadratic sequence. Understand how to describe and continue sequences with surds. Understand how to change the subject where the subject appears more than once. Understand iterative processes. Be able to use identities. Understand algebraic arguments and proof and formal algebraic proof. Understand how to use composite and inverse functions.	Understand area and volume involving similar shapes. Solve bearings using Pythagoras and trigonometry. Constructions and geometric reasoning. Understand problems and ratios in similar triangles. Establish whether triangles are similar. Understand and use congruent triangle conditions. Construct and interpret plans and elevations. Find the result of multiple trans-formations. Identify transformations of shapes. Understand Pythagoras in 3D, label sides in triangles, find missing side lengths using sine, cosine and tangent, find missing angles using sine, cosine and tangent. Solve bearings using Pythagoras and trigonometry. Understand vector journeys around shapes. Understand parallel vectors. Solve problems with vectors. TO – Understand frustum. Understand how to solve bearings using sine and cosine rule. Understand circle theorems: angle at the centre, angles in a semicircle, angles in same segments, angles in cyclic quadrilateral. Understand circle theorems: angle between radius and chord, radius and tangent, two tangents, alternate segment theorem. Prove triangles are congruent. Enlarge a shape by a negative scale factor. Identify invariant points.	Understand averages from a list and a table. Compare distributions. Understand probability from frequency trees. Construct and interpret frequency tables and frequency polygons. Compare distributions using charts and measures. TO – Understand stratified samples. Construct and interpret histograms. Construct and interpret cumulative frequency graphs. Use cumulative frequency graphs to find values. Construct and interpret box plots. Compare distributions using box plots and cumulative frequency graphs. Understand extrapolation.	Understand conditional probability from two way tables. Understand tree diagrams for independent and dependent events. TO – Understand conditional probability from Venn diagrams. Understand conditional probabilities from Tree diagrams.

			Understand how to expand three binomials. Understand how to factorise complex quadratics. Understand laws for indices, negative fractional indices. Understand how to add and subtract, multiply and divide algebraic fractions. Understand how to form and solve equations and inequalities with algebraic fractions. Understand how to represent solutions to inequalities using set notation. Understand how to solution to equations using straight line graphs. Understand how to represent solutions to single and multiple inequalities on a graph. Understand how to solve complex quadratics by factorising. Understand how to solve quadratic inequalities. Understand how to solve simultaneous equations where one is linear and one is quadratic by substitution. Understand how to complete the square. Understand how to solve quadratics by using the formula. Understand how to solve equations by iteration. Understand equations of perpendicular lines and equations of a circle. Understand and use exponential graphs. Find the equation of the tangent to a graph. Understand how to estimate the area under a curve. Understand graphs of trigonometric functions. Understand how to sketch and identify graph translations.	Understand Trigonometry in 3D shapes. Use ½ ab sin C to find area of a triangle. Use the sine rule to find sides and angles. Use the cosine rule to find sides and angles. Choose between the sine and cosine rules. Solve bearings using sine and cosine rule. Understand collinear vectors. Understand geometric proofs with vectors.		

			Understand how to sketch and identify graph reflections.			

GCSE Maths (9-1) Knowledge, skills and understanding

Overview

The table below illustrates the topic areas covered in this qualification and the topic area weightings for the assessment of the Foundation tier and the assessment of the Higher tier.

Tier	Topic area	Weighting
Foundation	Number	22–28%
	Algebra	17–23%
	Ratio, Proportion and Rates of change	22–28%
	Geometry and Measures	12–18%
	Statistics & Probability	12–18%
Higher	Number	12–18%
	Algebra	27–33%
	Ratio, Proportion and Rates of change	17–23%
	Geometry and Measures	17–23%
	Statistics & Probability	12–18%

Content

- All students will develop confidence and competence with the content identified by standard type.
- All students will be assessed on the content identified by the standard and the underlined type; more highly attaining students will develop confidence and competence with all of this content.
- Only the more highly attaining students will be assessed on the content identified by **bold** type. The highest attaining students will develop confidence and competence with the bold content.
- The distinction between standard, underlined and **bold** type applies to the content statements only, not to the Assessment Objectives or to the mathematical formulae in *Appendix 3: Formulae sheet*.

Foundation tier

Foundation tier students will be assessed on content identified by the standard and underlined type. Foundation tier students will not be assessed on content identified by bold type. Foundation tier content is on *pages 2–8*.

Higher tier

Higher tier students will be assessed on all the content which is identified by the standard, underlined and bold type. Higher tier content is on *pages 8–16*.

Foundation tier knowledge, skills and understanding

1. Number

Structure and calculation

What students need to learn:

N1 order positive and negative integers, decimals and fractions; use the symbols $=, \neq, <, >, \leq, \geq$

N2 apply the four operations, including formal written methods, to integers, decimals and simple fractions (proper and improper), and mixed numbers – all both positive and negative; understand and use place value (e.g. when working with very large or very small numbers, and when calculating with decimals)

N3 recognise and use relationships between operations, including inverse operations (e.g. cancellation to simplify calculations and expressions); use conventional notation for priority of operations, including brackets, powers, roots and reciprocals

N4 use the concepts and vocabulary of prime numbers, factors (divisors), multiples, common factors, common multiples, highest common factor, lowest common multiple, prime factorisation, including using product notation and the unique factorisation theorem

N5 apply systematic listing strategies

N6 use positive integer powers and associated real roots (square, cube and higher), recognise powers of 2, 3, 4, 5

N7 calculate with roots, and with integer indices

N8 calculate exactly with fractions and multiples of π

N9 calculate with and interpret standard form $A \times 10^n$, where $1 \leq A < 10$ and n is an integer

Fractions, decimals and percentages

What students need to learn:

N10 work interchangeably with terminating decimals and their corresponding fractions (such as 3.5 and $\frac{7}{2}$ or 0.375 or $\frac{3}{8}$)

N11 identify and work with fractions in ratio problems

N12 interpret fractions and percentages as operators

Measures and accuracy

What students need to learn:

N13 use standard units of mass, length, time, money and other measures (including standard compound measures) using decimal quantities where appropriate

N14 estimate answers; check calculations using approximation and estimation, including answers obtained using technology

N15 round numbers and measures to an appropriate degree of accuracy (e.g. to a specified number of decimal places or significant figures); use inequality notation to specify simple error intervals due to truncation or rounding

N16 apply and interpret limits of accuracy

2. Ratio, proportion and rates of change

What students need to learn:

R1 change freely between related standard units (e.g. time, length, area, volume/capacity, mass) and compound units (e.g. speed, rates of pay, prices, density, pressure) in numerical and algebraic contexts

R2 use scale factors, scale diagrams and maps

R3 express one quantity as a fraction of another, where the fraction is less than 1 or greater than 1

R4 use ratio notation, including reduction to simplest form

R5 divide a given quantity into two parts in a given part:part or part:whole ratio; express the division of a quantity into two parts as a ratio; apply ratio to real contexts and problems (such as those involving conversion, comparison, scaling, mixing, concentrations)

R6 express a multiplicative relationship between two quantities as a ratio or a fraction

R7 understand and use proportion as equality of ratios

R8 relate ratios to fractions and to linear functions

R9 define percentage as 'number of parts per hundred'; interpret percentages and percentage changes as a fraction or a decimal, and interpret these multiplicatively; express one quantity as a percentage of another; compare two quantities using percentages; work with percentages greater than 100%; solve problems involving percentage change, including percentage increase/decrease and original value problems, and simple interest including in financial mathematics

R10 solve problems involving direct and inverse proportion, including graphical and algebraic representations

R11 use compound units such as speed, rates of pay, unit pricing, density and pressure

R12 compare lengths, areas and volumes using ratio notation; make links to similarity (including trigonometric ratios) and scale factors

R13 understand that X is inversely proportional to Y is equivalent to X is proportional to $\frac{1}{Y}$; interpret equations that describe direct and inverse proportion

R14 interpret the gradient of a straight line graph as a rate of change; recognise and interpret graphs that illustrate direct and inverse proportion

R16 set up, solve and interpret the answers in growth and decay problems, including compound interest

3. Algebra

Notation, vocabulary and manipulation

What students need to learn:

A1 **use and interpret algebraic manipulation, including:**

- ***ab* in place of *a* × *b***
- **3*y* in place of *y* + *y* + *y* and 3 × *y***
- **a^2 in place of *a* × *a*, a^3 in place of *a* × *a* × *a*, a^2b in place of *a* × *a* × *b***
- $\frac{a}{b}$ **in place of *a* ÷ *b***
- **coefficients written as fractions rather than as decimals**
- **brackets**

A2 **substitute numerical values into formulae and expressions, including scientific formulae**

A3 **understand and use the concepts and vocabulary of expressions, equations, formulae, identities, inequalities, terms and factors**

A4 **simplify and manipulate algebraic expressions (including those involving surds) by:**

- **collecting like terms**
- **multiplying a single term over a bracket**
- **taking out common factors**
- **expanding products of two binomials**
- **factorising quadratic expressions of the form $x^2 + bx + c$, including the difference of two squares**
- **simplifying expressions involving sums, products and powers, including the laws of indices**

A5 **understand and use standard mathematical formulae; rearrange formulae to change the subject**

A6 **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**

A7 **where appropriate, interpret simple expressions as functions with inputs and outputs**

Graphs

What students need to learn:

A8 **work with coordinates in all four quadrants**

A9 **plot graphs of equations that correspond to straight-line graphs in the coordinate plane; use the form *y* = *mx* + *c* to identify parallel lines; find the equation of the line through two given points or through one point with a given gradient**

A10 **identify and interpret gradients and intercepts of linear functions graphically and algebraically**

A11 **identify and interpret roots, intercepts, turning points of quadratic functions graphically; deduce roots algebraically**

A12 **recognise, sketch and interpret graphs of linear functions, quadratic functions, simple cubic functions, the reciprocal function $y = \frac{1}{x}$ with *x* ≠ 0**

A14 **plot and interpret graphs (including reciprocal 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**

Solving equations and inequalities

What students need to learn:

A17 **solve linear equations in one unknown algebraically (including those with the unknown on both sides of the equation); find approximate solutions using a graph**

A18 **solve quadratic equations algebraically by factorising; find approximate solutions using a graph**

A19 **solve two simultaneous equations in two variables (linear/linear) algebraically; find approximate solutions using a graph**

A21 **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**

A22 **solve linear inequalities in one variable; represent the solution set on a number line**

Sequences

What students need to learn:

A23 **generate terms of a sequence from either a term-to-term or a position-to-term rule**

A24 **recognise and use sequences of triangular, square and cube numbers, simple arithmetic progressions, Fibonacci type sequences, quadratic sequences, and simple geometric progressions (r^n where n is an integer, and r is a rational number > 0)**

A25 **deduce expressions to calculate the nth term of linear sequences**

4. Geometry and measures

Properties and constructions

What students need to learn:

G1 use conventional terms and notation: points, lines, vertices, edges, planes, parallel lines, perpendicular lines, right angles, polygons, regular polygons and polygons with reflection and/or rotation symmetries; use the standard conventions for labelling and referring to the sides and angles of triangles; draw diagrams from written description

G2 use the standard ruler and compass constructions (perpendicular bisector of a line segment, constructing a perpendicular to a given line from/at a given point, bisecting a given angle); use these to construct given figures and solve loci problems; know that the perpendicular distance from a point to a line is the shortest distance to the line

G3 apply the properties of angles at a point, angles at a point on a straight line, vertically opposite angles; understand and use alternate and corresponding angles on parallel lines; derive and use the sum of angles in a triangle (e.g. to deduce and use the angle sum in any polygon, and to derive properties of regular polygons)

G4 derive and apply the properties and definitions of special types of quadrilaterals, including square, rectangle, parallelogram, trapezium, kite and rhombus; and triangles and other plane figures using appropriate language

G5 use the basic congruence criteria for triangles (SSS, SAS, ASA, RHS)

G6 apply angle facts, triangle congruence, similarity and properties of quadrilaterals to conjecture and derive results about angles and sides, including Pythagoras' Theorem and the fact that the base angles of an isosceles triangle are equal, and use known results to obtain simple proofs

G7 identify, describe and construct congruent and similar shapes, including on coordinate axes, by considering rotation, reflection, translation and enlargement (including fractional scale factors)

G9 identify and apply circle definitions and properties, including: centre, radius, chord, diameter, circumference, tangent, arc, sector and segment

G11 solve geometrical problems on coordinate axes

G12 identify properties of the faces, surfaces, edges and vertices of: cubes, cuboids, prisms, cylinders, pyramids, cones and spheres

G13 construct and interpret plans and elevations of 3D shapes

Mensuration and calculation

What students need to learn:

G14 use standard units of measure and related concepts (length, area, volume/capacity, mass, time, money, etc.)

G15 measure line segments and angles in geometric figures, including interpreting maps and scale drawings and use of bearings

G16 know and apply formulae to calculate: area of triangles, parallelograms, trapezia; volume of cuboids and other right prisms (including cylinders)

G17 know the formulae: circumference of a circle = $2\pi r = \pi d$, area of a circle = πr^2; calculate: perimeters of 2D shapes, including circles; areas of circles and composite shapes; surface area and volume of spheres, pyramids, cones and composite solids

G18 calculate arc lengths, angles and areas of sectors of circles

G19 apply the concepts of congruence and similarity, including the relationships between lengths in similar figures

G20 know the formulae for: Pythagoras' theorem $a^2 + b^2 = c^2$, and the trigonometric ratios, $\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$, $\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$ and $\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$; apply them to find angles and lengths in right-angled triangles in two-dimensional figures

G21 know the exact values of $\sin\theta$ and $\cos\theta$ for $\theta = 0°, 30°, 45°, 60°$ and $90°$; know the exact value of $\tan\theta$ for $\theta = 0°, 30°, 45°$ and $60°$

Vectors

What students need to learn:

G24 describe translations as 2D vectors

G25 apply addition and subtraction of vectors, multiplication of vectors by a scalar, and diagrammatic and column representations of vectors

5. Statistics

What students need to learn:

S1 **infer properties of populations or distributions from a sample, while knowing the limitations of sampling**

S2 **interpret and construct tables, charts and diagrams, including frequency tables, bar charts, pie charts and pictograms for categorical data, vertical line charts for ungrouped discrete numerical data, tables and line graphs for time series data and know their appropriate use**

S4 **interpret, analyse and compare the distributions of data sets from univariate empirical distributions through:**

- **appropriate graphical representation involving discrete, continuous and grouped data,**
- **appropriate measures of central tendency (median, mean, mode and modal class) and spread (range, including consideration of outliers)**

S5 **apply statistics to describe a population**

S6 **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 while knowing the dangers of so doing.**

5. Probability

What students need to learn:

P1 **record, describe and analyse the frequency of outcomes of probability experiments using tables and frequency trees**

P2 **apply ideas of randomness, fairness and equally likely events to calculate expected outcomes of multiple future experiments**

P3 **relate relative expected frequencies to theoretical probability, using appropriate language and the 0-1 probability scale**

P4 **apply the property that the probabilities of an exhaustive set of outcomes sum to one; apply the property that the probabilities of an exhaustive set of mutually exclusive events sum to one**

P5 **understand that empirical unbiased samples tend towards theoretical probability distributions, with increasing sample size**

P6 **enumerate sets and combinations of sets systematically, using tables, grids, Venn diagrams and tree diagrams**

P7 **construct theoretical possibility spaces for single and combined experiments with equally likely outcomes and use these to calculate theoretical probabilities**

P8 **calculate the probability of independent and dependent combined events, including using tree diagrams and other representations, and know the underlying assumptions**

Higher tier knowledge, skills and understanding

1. Number

Structure and calculation

What students need to learn:

N1 order positive and negative integers, decimals and fractions; use the symbols $=, \neq, <, >, \leq, \geq$

N2 apply the four operations, including formal written methods, to integers, decimals and simple fractions (proper and improper), and mixed numbers – all both positive and negative; understand and use place value (e.g. when working with very large or very small numbers, and when calculating with decimals)

N3 recognise and use relationships between operations, including inverse operations (e.g. cancellation to simplify calculations and expressions); use conventional notation for priority of operations, including brackets, powers, roots and reciprocals

N4 use the concepts and vocabulary of prime numbers, factors (divisors), multiples, common factors, common multiples, highest common factor, lowest common multiple, prime factorisation, including using product notation and the unique factorisation theorem

N5 apply systematic listing strategies, including use of the product rule for counting (i.e. if there are m ways of doing one task and for each of these, there are n ways of doing another task, then the total number of ways the two tasks can be done is $m \times n$ ways)

N6 use positive integer powers and associated real roots (square, cube and higher), recognise powers of 2, 3, 4, 5; estimate powers and roots of any given positive number

N7 calculate with roots, and with integer and fractional indices

N8 calculate exactly with fractions, surds and multiples of π; simplify surd expressions involving squares (e.g. $\sqrt{12} = \sqrt{(4 \times 3)} = \sqrt{4} \times \sqrt{3} = 2\sqrt{3}$) and rationalise denominators

N9 calculate with and interpret standard form $A \times 10^n$, where $1 \leq A < 10$ and n is an integer

Fractions, decimals and percentages

What students need to learn:

N10 work interchangeably with terminating decimals and their corresponding fractions (such as 3.5 and $\frac{7}{2}$ or 0.375 or $\frac{3}{8}$); change recurring decimals into their corresponding fractions and vice versa

N11 identify and work with fractions in ratio problems

N12 interpret fractions and percentages as operators

Measures and accuracy

What students need to learn:

N13 use standard units of mass, length, time, money and other measures (including standard compound measures) using decimal quantities where appropriate

N14 estimate answers; check calculations using approximation and estimation, including answers obtained using technology

N15 round numbers and measures to an appropriate degree of accuracy (e.g. to a specified number of decimal places or significant figures); use inequality notation to specify simple error intervals due to truncation or rounding

N16 apply and interpret limits of accuracy, including upper and lower bounds

2. Ratio, proportion and rates of change

What students need to learn:

R1 change freely between related standard units (e.g. time, length, area, volume/capacity, mass) and compound units (e.g. speed, rates of pay, prices, density, pressure) in numerical and algebraic contexts

R2 use scale factors, scale diagrams and maps

R3 express one quantity as a fraction of another, where the fraction is less than 1 or greater than 1

R4 use ratio notation, including reduction to simplest form

R5 divide a given quantity into two parts in a given part:part or part:whole ratio; express the division of a quantity into two parts as a ratio; apply ratio to real contexts and problems (such as those involving conversion, comparison, scaling, mixing, concentrations)

R6 express a multiplicative relationship between two quantities as a ratio or a fraction

R7 understand and use proportion as equality of ratios

R8 relate ratios to fractions and to linear functions

R9 define percentage as 'number of parts per hundred'; interpret percentages and percentage changes as a fraction or a decimal, and interpret these multiplicatively; express one quantity as a percentage of another; compare two quantities using percentages; work with percentages greater than 100%; solve problems involving percentage change, including percentage increase/decrease and original value problems, and simple interest including in financial mathematics

R10 solve problems involving direct and inverse proportion, including graphical and algebraic representations

R11 use compound units such as speed, rates of pay, unit pricing, density and pressure

R12 compare lengths, areas and volumes using ratio notation; make links to similarity (including trigonometric ratios) and scale factors

R13 understand that X is inversely proportional to Y is equivalent to X is proportional to $\frac{1}{Y}$; construct and interpret equations that describe direct and inverse proportion

R14 interpret the gradient of a straight line graph as a rate of change; recognise and interpret graphs that illustrate direct and inverse proportion

R15 interpret the gradient at a point on a curve as the instantaneous rate of change; apply the concepts of average and instantaneous rate of change (gradients of chords and tangents) in numerical, algebraic and graphical contexts (this does not include calculus)

R16 set up, solve and interpret the answers in growth and decay problems, including compound interest and work with general iterative processes

3. Algebra

Notation, vocabulary and manipulation

What students need to learn:

A1 **use and interpret algebraic manipulation, including:**

- ***ab* in place of *a* × *b***
- **3*y* in place of *y* + *y* + *y* and 3 × *y***
- **a^2 in place of *a* × *a*, a^3 in place of *a* × *a* × *a*, a^2b in place of *a* × *a* × *b***
- $\frac{a}{b}$ **in place of *a* ÷ *b***
- **coefficients written as fractions rather than as decimals**
- **brackets**

A2 **substitute numerical values into formulae and expressions, including scientific formulae**

A3 **understand and use the concepts and vocabulary of expressions, equations, formulae, identities, inequalities, terms and factors**

A4 **simplify and manipulate algebraic expressions (including those involving surds and algebraic fractions) by:**

- **collecting like terms**
- **multiplying a single term over a bracket**
- **taking out common factors**
- **expanding products of two or more binomials**
- **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**

A5 **understand and use standard mathematical formulae; rearrange formulae to change the subject**

A6 **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**

A7 **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' (the use of formal function notation is expected)**

Graphs

What students need to learn:

A8 **work with coordinates in all four quadrants**

A9 **plot graphs of equations that correspond to straight-line graphs in the coordinate plane; 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**

A10 **identify and interpret gradients and intercepts of linear functions graphically and algebraically**

A11 **identify and interpret roots, intercepts, turning points of quadratic functions graphically; deduce roots algebraically and turning points by completing the square**

A12 **recognise, sketch and interpret graphs of linear functions, quadratic functions, simple cubic functions, the reciprocal function $y = \frac{1}{x}$ with $x \neq 0$, exponential functions $y = k^x$ 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**

A13 **sketch translations and reflections of a given function**

A14 **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**

A15 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 (this does not include calculus)

A16 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

Solving equations and inequalities

What students need to learn:

A17 solve linear equations in one unknown algebraically (including those with the unknown on both sides of the equation); find approximate solutions using a graph

A18 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

A19 solve two simultaneous equations in two variables (linear/linear or linear/quadratic) algebraically; find approximate solutions using a graph

A20 find approximate solutions to equations numerically using iteration

A21 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

A22 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

Sequences

What students need to learn:

A23 generate terms of a sequence from either a term-to-term or a position-to-term rule

A24 recognise and use sequences of triangular, square and cube numbers, simple arithmetic progressions, Fibonacci type sequences, quadratic sequences, and simple geometric progressions (r^n where n is an integer, and r is a rational number > 0 or a surd) and other sequences

A25 deduce expressions to calculate the nth term of linear and quadratic sequences

4. Geometry and measures

Properties and constructions

What students need to learn:

G1 use conventional terms and notation: points, lines, vertices, edges, planes, parallel lines, perpendicular lines, right angles, polygons, regular polygons and polygons with reflection and/or rotation symmetries; use the standard conventions for labelling and referring to the sides and angles of triangles; draw diagrams from written description

G2 use the standard ruler and compass constructions (perpendicular bisector of a line segment, constructing a perpendicular to a given line from/at a given point, bisecting a given angle); use these to construct given figures and solve loci problems; know that the perpendicular distance from a point to a line is the shortest distance to the line

G3 apply the properties of angles at a point, angles at a point on a straight line, vertically opposite angles; understand and use alternate and corresponding angles on parallel lines; derive and use the sum of angles in a triangle (e.g. to deduce and use the angle sum in any polygon, and to derive properties of regular polygons)

G4 derive and apply the properties and definitions of special types of quadrilaterals, including square, rectangle, parallelogram, trapezium, kite and rhombus; and triangles and other plane figures using appropriate language

G5 use the basic congruence criteria for triangles (SSS, SAS, ASA, RHS)

G6 apply angle facts, triangle congruence, similarity and properties of quadrilaterals to conjecture and derive results about angles and sides, including Pythagoras' Theorem and the fact that the base angles of an isosceles triangle are equal, and use known results to obtain simple proofs

G7 identify, describe and construct congruent and similar shapes, including on coordinate axes, by considering rotation, reflection, translation and enlargement (including fractional and negative scale factors)

G8 describe the changes and invariance achieved by combinations of rotations, reflections and translations

G9 identify and apply circle definitions and properties, including: centre, radius, chord, diameter, circumference, tangent, arc, sector and segment

G10 apply and prove the standard circle theorems concerning angles, radii, tangents and chords, and use them to prove related results

G11 solve geometrical problems on coordinate axes

G12 identify properties of the faces, surfaces, edges and vertices of: cubes, cuboids, prisms, cylinders, pyramids, cones and spheres

G13 construct and interpret plans and elevations of 3D shapes

Mensuration and calculation

What students need to learn:

G14 use standard units of measure and related concepts (length, area, volume/capacity, mass, time, money, etc.)

G15 measure line segments and angles in geometric figures, including interpreting maps and scale drawings and use of bearings

G16 know and apply formulae to calculate: area of triangles, parallelograms, trapezia; volume of cuboids and other right prisms (including cylinders)

G17 know the formulae: circumference of a circle = $2\pi r = \pi d$, area of a circle = πr^2; calculate: perimeters of 2D shapes, including circles; areas of circles and composite shapes; surface area and volume of spheres, pyramids, cones and composite solids

G18 calculate arc lengths, angles and areas of sectors of circles

G19 apply the concepts of congruence and similarity, including the relationships between lengths, areas and volumes in similar figures

G20 know the formulae for: Pythagoras' theorem $a^2 + b^2 = c^2$, and the trigonometric ratios, $\sin\vartheta = \frac{\text{opposite}}{\text{hypotenuse}}$, $\cos\vartheta = \frac{\text{adjacent}}{\text{hypotenuse}}$ and $\tan\vartheta = \frac{\text{opposite}}{\text{adjacent}}$; apply them to find angles and lengths in right-angled triangles and, where possible, general triangles in two- and three-dimensional figures

G21 know the exact values of $\sin\vartheta$ and $\cos\vartheta$ for $\vartheta = 0°, 30°, 45°, 60°$ and $90°$; know the exact value of $\tan\vartheta$ for $\vartheta = 0°, 30°, 45°$ and $60°$

G22 know and apply the sine rule $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$, and cosine rule $a^2 = b^2 + c^2 - 2bc\cos A$, to find unknown lengths and angles

G23 know and apply Area = $\frac{1}{2}$ *ab* sin *C* to calculate the area, sides or angles of any triangle

Vectors

What students need to learn:

G24 describe translations as 2D vectors

G25 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

5. Statistics

What students need to learn:

S1 **infer properties of populations or distributions from a sample, while knowing the limitations of sampling**

S2 **interpret and construct tables, charts and diagrams, including frequency tables, bar charts, pie charts and pictograms for categorical data, vertical line charts for ungrouped discrete numerical data, tables and line graphs for time series data and know their appropriate use**

S3 **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**

S4 **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 (median, mean, mode and modal class) and spread (range, including consideration of outliers), quartiles and inter-quartile range**

S5 **apply statistics to describe a population**

S6 **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 while knowing the dangers of so doing**

6. Probability

What students need to learn:

P1 record, describe and analyse the frequency of outcomes of probability experiments using tables and frequency trees

P2 apply ideas of randomness, fairness and equally likely events to calculate expected outcomes of multiple future experiments

P3 relate relative expected frequencies to theoretical probability, using appropriate language and the 0-1 probability scale

P4 apply the property that the probabilities of an exhaustive set of outcomes sum to one; apply the property that the probabilities of an exhaustive set of mutually exclusive events sum to one

P5 understand that empirical unbiased samples tend towards theoretical probability distributions, with increasing sample size

P6 enumerate sets and combinations of sets systematically, using tables, grids, Venn diagrams and tree diagrams

P7 construct theoretical possibility spaces for single and combined experiments with equally likely outcomes and use these to calculate theoretical probabilities

P8 calculate the probability of independent and dependent combined events, including using tree diagrams and other representations, and know the underlying assumptions

P9 calculate and interpret conditional probabilities through representation using expected frequencies with two-way tables, tree diagrams and Venn diagrams