KS4 NSM Pathway – St Christopher's MATHEMATICS: Programme of Study	
Prior learning: KS3	**An assumption is made that our cohort will have had access to mainstream school curriculum learning in KS3**
Working Mathematically	Through the mathematics content, pupils should be taught to: **Develop fluency** • consolidate their numerical and mathematical capability from key stage 2 and extend their understanding of the number system and place value to include decimals, fractions, powers and roots • select and use appropriate calculation strategies to solve increasingly complex problems • use algebra to generalise the structure of arithmetic, including to formulate mathematical relationships • substitute values in expressions, rearrange and simplify expressions, and solve equations • move freely between different numerical, algebraic, graphical and diagrammatic representations [for example, equivalent fractions, fractions and decimals, and equations and graphs] • develop algebraic and graphical fluency, including understanding linear and simple quadratic functions • use language and properties precisely to analyse numbers, algebraic expressions, 2-D and 3-D shapes, probability and statistics. **Reason mathematically** • extend their understanding of the number system; make connections between number relationships, and their algebraic and graphical representations • extend and formalise their knowledge of ratio and proportion in working with measures and geometry, and in formulating proportional relations algebraically • identify variables and express relations between variables algebraically and graphically • make and test conjectures about patterns and relationships; look for proofs or counter examples • begin to reason deductively in geometry, number and algebra, including using geometrical constructions • interpret when the structure of a numerical problem requires additive, multiplicative or proportional reasoning • explore what can and cannot be inferred in statistical and probabilistic settings, and begin to express their arguments formally. **Solve problems** • develop their use of formal mathematical knowledge to interpret and solve problems, including in financial mathematics • begin to model situations mathematically and express the results using a range of formal mathematical representations • select appropriate concepts, methods and techniques to apply to unfamiliar and non-routine problems.
KS3 Subject Content	**Number** Pupils should be taught to: • understand and use place value for decimals, measures and integers of any size

- order positive and negative integers, decimals and fractions; use the number line as a model for ordering of the real numbers; use the symbols =, ≠, , ≤, ≥
- use the concepts and vocabulary of prime numbers, factors (or divisors), multiples, common factors, common multiples, highest common factor, lowest common multiple, prime factorisation, including using product notation and the unique factorisation property
- use the four operations, including formal written methods, applied to integers, decimals, proper and improper fractions, and mixed numbers, all both positive and negative
- use conventional notation for the priority of operations, including brackets, powers, roots and reciprocals
- recognise and use relationships between operations including inverse operations
- use integer powers and associated real roots (square, cube and higher), recognise powers of 2, 3, 4, 5 and distinguish between exact representations of roots and their decimal approximations
- interpret and compare numbers in standard form $A \times 10^n$ $1 \leq A$ where n is a positive or negative integer or zero
- work interchangeably with terminating decimals and their corresponding fractions (such as 3.5 and $2\frac{7}{}$ or 0.375 and $\frac{8}{3}$)
- define percentage as 'number of parts per hundred', interpret percentages and percentage changes as a fraction or a decimal, interpret these multiplicatively, express one quantity as a percentage of another, compare two quantities using percentages, and work with percentages greater than 100%
- interpret fractions and percentages as operators
- use standard units of mass, length, time, money and other measures, including with decimal quantities
- round numbers and measures to an appropriate degree of accuracy [for example, to a number of decimal places or significant figures]
- use approximation through rounding to estimate answers and calculate possible resulting errors expressed using inequality notation $a < x \leq b$
- use a calculator and other technologies to calculate results accurately and then interpret them appropriately
- appreciate the infinite nature of the sets of integers, real and rational numbers

Algebra
Pupils should be taught to:
- use and interpret algebraic notation, including:
  - ο ab in place of a × b
  - ο 3y in place of y + y + y and 3 × y
  - ο a^2 in place of a × a, a^3 in place of a × a × a; $a^2 b$ in place of a × a × b
  - ο $\frac{b}{a}$ in place of a ÷ b
  - ο coefficients written as fractions rather than as decimals
  - ο brackets
- substitute numerical values into formulae and expressions, including scientific formulae

- understand and use the concepts and vocabulary of expressions, equations, inequalities, terms and factors
- simplify and manipulate algebraic expressions to maintain equivalence by: collecting like terms
  - multiplying a single term over a bracket
  - taking out common factors
  - expanding products of two or more binomials
- understand and use standard mathematical formulae; rearrange formulae to change the subject
- model situations or procedures by translating them into algebraic expressions or formulae and by using graphs
- use algebraic methods to solve linear equations in one variable (including all forms that require rearrangement)
- work with coordinates in all four quadrants
- recognise, sketch and produce graphs of linear and quadratic functions of one variable with appropriate scaling, using equations in x and y and the Cartesian plane
- interpret mathematical relationships both algebraically and graphically
- educe a given linear equation in two variables to the standard form y = mx + c; calculate and interpret gradients and intercepts of graphs of such linear equations numerically, graphically and algebraically
- use linear and quadratic graphs to estimate values of y for given values of x and vice versa and to find approximate solutions of simultaneous linear equations
- find approximate solutions to contextual problems from given graphs of a variety of functions, including piece-wise linear, exponential and reciprocal graphs
- generate terms of a sequence from either a term-to-term or a position-to-term rule
- recognise arithmetic sequences and find the nth term
- recognise geometric sequences and appreciate other sequences that arise
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Ratio, proportion and rates of change
Pupils should be taught to:
- change freely between related standard units [for example time, length, area, volume/capacity, mass]
- use scale factors, scale diagrams and maps
- express one quantity as a fraction of another, where the fraction is less than 1 and greater than 1
- use ratio notation, including reduction to simplest form
- 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
- understand that a multiplicative relationship between two quantities can be expressed as a ratio or a fraction
- relate the language of ratios and the associated calculations to the arithmetic of fractions and to linear functions
- solve problems involving percentage change, including: percentage increase, decrease and original value problems and simple interest in financial mathematics

- solve problems involving direct and inverse proportion, including graphical and algebraic representations
- use compound units such as speed, unit pricing and density to solve problems.

Geometry and measures

Pupils should be taught to:

- derive and apply formulae to calculate and solve problems involving: perimeter and area of triangles, parallelograms, trapezia, volume of cuboids (including cubes) and other prisms (including cylinders)
- calculate and solve problems involving: perimeters of 2-D shapes (including circles), areas of circles and composite shapes
- draw and measure line segments and angles in geometric figures, including interpreting scale drawings
- derive and 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); recognise and use the perpendicular distance from a point to a line as the shortest distance to the line
- describe, sketch and draw using conventional terms and notations: points, lines, parallel lines, perpendicular lines, right angles, regular polygons, and other polygons that are reflectively and rotationally symmetric
- use the standard conventions for labelling the sides and angles of triangle ABC, and know and use the criteria for congruence of triangles ▢ derive and illustrate properties of triangles, quadrilaterals, circles, and other plane figures [for example, equal lengths and angles] using appropriate language and technologies
- identify properties of, and describe the results of, translations, rotations and reflections applied to given figures
- identify and construct congruent triangles, and construct similar shapes by enlargement, with and without coordinate grids
- apply the properties of angles at a point, angles at a point on a straight line, vertically opposite angles
- understand and use the relationship between parallel lines and alternate and corresponding angles
- derive and use the sum of angles in a triangle and use it to deduce the angle sum in any polygon, and to derive properties of regular polygons
- apply angle facts, triangle congruence, similarity and properties of quadrilaterals to derive results about angles and sides, including Pythagoras' Theorem, and use known results to obtain simple proofs
- use Pythagoras' Theorem and trigonometric ratios in similar triangles to solve problems involving right-angled triangles
- use the properties of faces, surfaces, edges and vertices of cubes, cuboids, prisms, cylinders, pyramids, cones and spheres to solve problems in 3-D ▢ interpret mathematical relationships both algebraically and geometrically

Probability

Pupils should be taught to:

- record, describe and analyse the frequency of outcomes of simple probability experiments involving randomness, fairness, equally and unequally likely outcomes, using appropriate language and the 0-1 probability scale
- understand that the probabilities of all possible outcomes sum to 1
- enumerate sets and unions/intersections of sets systematically, using tables, grids and Venn diagrams

	• generate theoretical sample spaces for single and combined events with equally likely, mutually exclusive outcomes and use these to calculate theoretical probabilities. **Statistics** Pupils should be taught to: • describe, interpret and compare observed distributions of a single variable through: appropriate graphical representation involving discrete, continuous and grouped data; and appropriate measures of central tendency (mean, mode, median) and spread (range, consideration of outliers) • construct and interpret appropriate tables, charts, and diagrams, including frequency tables, bar charts, pie charts, and pictograms for categorical data, and vertical line (or bar) charts for ungrouped and grouped numerical data • describe simple mathematical relationships between two variables (bivariate data) in observational and experimental contexts and illustrate using scatter graphs

KS4 MATHEMATICS: Programme of Study – Taught Content, Knowledge and Skills Review of KS3 and linked with Functional skills

Number
- order positive and negative integers, decimals and fractions.
- apply the four operations, including formal written methods, to integers, decimals and simple fractions
- use inverse operations
- use the concepts and vocabulary of prime numbers, factors (divisors), multiples, common factors, common multiples, highest common factor, lowest common multiple,
- apply systematic listing strategies
- use positive integer powers and associated real roots (square, cube and higher), recognise powers of 2, 3, 4, 5
- calculate exactly with fractions and multiples of π
- calculate with and interpret standard form

Fractions, Decimals and Percentages
- work interchangeably with terminating decimals and their corresponding fractions
- identify and work with fractions in ratio problems
- interpret fractions and percentages as operators

Measures and accuracy
- use standard units of mass, length, time, money and other measures
- estimate answers; check calculations using approximation and estimation
- round numbers and measures to an appropriate degree of accuracy

Algebra
Notation, vocabulary and manipulation
- use and interpret algebraic manipulation
- substitute numerical values into formulae and expressions
- understand and use the concepts and vocabulary of expressions, equations, formulae, inequalities, terms and factors
- simplify and manipulate algebraic expressions by: collecting like terms, multiplying a single term over a bracket, taking out common factors, expanding products of two binomials ,factorising

quadratic expressions, including the difference of two squares; simplifying expressions involving sums, products and powers, including the laws of indices
- understand and use standard mathematical formulae; rearrange formulae to change the subject
- know the difference between an equation and an identity

Graphs
- work with coordinates in all four quadrants
- plot graphs of equations that correspond to straight-line graphs in the coordinate plane; use the form y = mx + c to identify parallel lines.
- identify and interpret gradients and intercepts of linear functions graphically and algebraically
- recognise, sketch and interpret graphs of linear functions, quadratic functions
- plot and interpret graphs of non-standard functions in real contexts to find approximate solutions to distance, speed and acceleration

Solving equations and inequalities
- solve linear equations in one unknown algebraically; find approximate solutions using a graph
- solve quadratic equations algebraically by factorising; find approximate solutions using a graph
- solve two simultaneous equations in two variables and find solutions using a graph
- create algebraic expressions or formulae;
- solve linear equations in one unknown algebraically; find approximate solutions using a graph

Sequences
- generate terms of a sequence from either a term-to-term or a position-to term rule
- calculate the nth term of linear sequences

Ratio, Proportion and Rates of Change
- Change freely between related standard units and compound units in numerical and algebraic contexts
- Use scale factors, scale diagrams and maps
- Express one quantity as a fraction of another,
- Use ratio notation, including reduction to simplest form
- 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
- Express a multiplicative relationship between two quantities as a ratio or a fraction
- Understand and use proportion as equality of ratios
- Relate ratios to fractions and to linear functions
- Define percentage as 'number of parts per 100'; interpret percentages and percentage changes as a fraction or a decimal; express one quantity as a percentage of another; work with percentages greater than 100%; solve problems involving percentage change, including percentage increase/decrease, and simple interest
- Solve problems involving direct and inverse proportion, including graphical and algebraic
- Use compound units such as speed, rates of pay, unit pricing, density and pressure
- Compare lengths, areas and volumes using ratio notation; make links to similarity and scale factors
- Understand that X is inversely proportional to Y is equivalent to X is proportional to 1/Y ;
- Interpret the gradient of a straight line graph as a rate of change; recognise and interpret graphs that illustrate direct and inverse proportion

Geometry and Measure
Properties & constructions
- Use conventional terms and notations: 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
- Use the standard ruler and compass constructions; 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
- 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
- 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

- 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
- 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)
- Identify and apply circle definitions and properties, including: centre, radius, chord, diameter, circumference, tangent, arc, sector and segment
- Solve geometrical problems on coordinate axes
- Identify properties of the faces, surfaces, edges and vertices of: cubes, cuboids, prisms, cylinders, ~~pyramids, cones and spheres~~
- Construct and interpret plans and elevations of 3D shapes

Mensuration & calculation
- Use standard units of measure and related concepts
- Measure line segments and angles in geometric figures, including interpreting maps and scale drawings and use of bearings
- Know and apply formulae to calculate: area of triangles, parallelograms, trapezia; volume of cuboids prisms
- Know the formulae: circumference of a circle , area of a circle; calculate: perimeters of 2D shapes, including circles; areas of circles and composite shapes;
- Calculate arc lengths, angles and areas of sectors of circles
- Apply the concepts of congruence/similarity, inc lengths, areas and volumes in similar figures
- Know the formulae for: Pythagoras' theorem and the trigonometric ratios,; apply them to find angles and lengths in right-angled triangles and, where possible, general triangles in two and three dimensional figures

Vectors
- describe translations as 2D vectors

Probability
- Record, describe and analyse the frequency of outcomes of probability experiments using tables and frequency trees
- Apply ideas of randomness, fairness and equally likely events to calculate expected outcomes of multiple future experiments
- Relate relative expected frequencies to theoretical probability, using appropriate language and the 0-1 probability scale
- Apply the property that the probabilities of an exhaustive set of outcomes sum to one;
- Understand that empirical unbiased samples tend towards theoretical probability distributions, with increasing sample size
- Enumerate sets and combinations of sets systematically, using tables, grids, Venn diagrams and tree diagrams
- Construct theoretical possibility spaces for single and combined experiments with equally likely outcomes and use these to calculate theoretical probabilities
- Calculate the probability of independent and dependent combined events, including using tree diagrams and other representations

Statistics
- 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
- 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)
  use and interpret scatter graphs; recognise correlation and know that it does not indicate causation; draw estimated lines of best fit; make predictions; interpolate and extrapolate apparent trends

Subsequent Learning:

Post 16