REFERENCE	STATEMENT FROM EDEXCEL SPECIFICATION FOR GCSE (9-1) MATHEMATICS
Higher tier students will be assessed on all content. Foundation tier students will be assessed on content identified by the standard and underlined type.	
N1	order positive and negative integers, decimals and fractions; use the symbols =, ≠, <, > , ≤, ≥
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 × 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. √12 = √(4 × 3) = √4 × √3 = 2√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
N10	work interchangeably with terminating decimals and their corresponding fractions (such as 3.5 and 7/2 or 0.375 or 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
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**
A1	use and interpret algebraic manipulation, including: ● ab in place of a × b ● 3y 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 ● 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)**
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 = 1/x with x ≠ 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**
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**
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
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 betweeb 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 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**
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
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, $\sin\theta$ = opposite/hypotenuse, $\cos\theta$ = adjacent/hypotenuse and $\tan\theta$ = opposite/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 θ and cos θ for θ = 0°, 30°, 45°, 60° and 90°; know the exact value of tan θ for θ = 0°, 30°, 45° and 60°
G22	**know and apply the sine rule a/sin A = b/sin B = 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 = 1/2 ab sin C to calculate the area, sides or angles of any triangle**
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**
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 ependent 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**
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