GCSE (9–1) Mathematics - Edexcel 2017

NUMBER			ALGEBRA			RATIO, PROPORTION AND RATES OF CHANGE			GEOMETRY AND MEASURES		
Structure and calculation			**Notation, vocabulary and manipulation**						**Properties and constructions**		
1	order positive and negative integers, decimals and fractions; use the symbols =, ≠, <, >, ≤, ≥		17	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		42	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. *Any necessary conversions from metric units to imperial units will be given within the question.*		58	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. #1 [1]	
2	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). #2 [2]		18	substitute numerical values into formulae and expressions, including scientific formulae. Numerical values could be given in any form (integer, decimal or fraction) or given in standard form.		43	use scale factors, scale diagrams and maps		59	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. #3 [3]	
3	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		19	understand and use the concepts and vocabulary of expressions, equations, formulae, identities, inequalities, terms and factors. *Examiners do not anticipate using the identity symbol on Foundation tier papers.*		44	express one quantity as a fraction of another, where the fraction is less than 1 or greater than 1		60	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). #4 [4]	
4	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. *The unique factorisation theorem will be tested by the requirement to carry out the prime factorisation of a given number.*		20	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. #5 [5]		45	use ratio notation, including reduction to simplest form		61	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	
5	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)		21	understand and use standard mathematical formulae; rearrange formulae to change the subject. *The rearrangement of formulae where the intended subject appears twice (and so needs to be taken out as a common factor) will be tested on Higher tier only.*		46	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). #6 [6]		62	use the basic congruence criteria for triangles (SSS, SAS, ASA, RHS). *The requirement to prove two triangles are congruent is Higher tier only.*	
6	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. #7 [7]		22	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		47	express a multiplicative relationship between two quantities as a ratio or a fraction		63	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. #8 [8]	
7	calculate with roots, and with integer and fractional indices. *To include the laws of indices applied to numbers with integer powers (integer power could be positive, negative or zero; positive and negative fractional powers on the Higher tier only).*		23	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). #9 [9]		48	understand and use proportion as equality of ratios		64	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)	

8	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. #10 [10]	
9	calculate with and interpret standard form $A \times 10n$, where $1 \leq A < 10$ and n is an integer	

Fractions, decimals and percentages

10	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. #11 [11]	
11	identify and work with fractions in ratio problems	
12	interpret fractions and percentages as operators	

Measures and accuracy

13	use standard units of mass, length, time, money and other measures (including standard compound measures) using decimal quantities where appropriate	
14	estimate answers; check calculations using approximation and estimation, including answers obtained using technology	
15	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	
16	apply and interpret limits of accuracy, including upper and lower bounds	

Graphs

24	work with coordinates in all four quadrants. *To include finding the midpoint of a line joining two coordinates.*	
25	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	
26	identify and interpret gradients and intercepts of linear functions graphically and algebraically. *When sketching the graph of a linear function then intercepts with the axes should be shown.*	
27	identify and interpret roots, intercepts, turning points of quadratic functions graphically; deduce roots algebraically and turning points by completing the square. #12 [12]	
28	recognise, sketch and interpret graphs of linear functions, quadratic functions, simple cubic functions, the reciprocal function $y = 1/x$ 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. #13 [13]	
29	sketch translations and reflections of a given function. *Stretches are not on the new specification; transformations are limited to reflections and translations.*	
30	plot and interpret graphs (including reciprocalgraphs 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. #15 [15]	
31	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). #17 [17]	
32	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

49	relate ratios to fractions and to linear functions	
50	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	
51	solve problems involving direct and inverse proportion, including graphical and algebraic representations	
52	use compound units such as speed, rates of pay, unit pricing, density and pressure	
53	compare lengths, areas and volumes using ratio notation; make links to similarity (including trigonometric ratios) and scale factors	
54	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. #14 [14]	
55	interpret the gradient of a straight line graph as a rate of change; recognise and interpret graphs that illustrate direct and inverse proportion	
56	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). #16 [16]	
57	set up, solve and interpret the answers in growth and decay problems, including compound interest and work with general iterative processes. *General iterative processes: for example, population growth or decay.*	

PROBABILITY

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

65	describe the changes and invariance achieved by combinations of rotations, reflections and translations	
66	identify and apply circle definitions and properties, including: centre, radius, chord, diameter, circumference, tangent, arc, sector and segment	
67	apply and prove the standard circle theorems concerning angles, radii, tangents and chords, and use them to prove related results	
68	solve geometrical problems on coordinate axes. *2D coordinates only*	
69	identify properties of the faces, surfaces, edges and vertices of: cubes, cuboids, prisms, cylinders, pyramids, cones and spheres	
70	construct and interpret plans and elevations of 3D shapes	

Mensuration and calculation

71	use standard units of measure and related concepts (length, area, volume/capacity, mass, time, money, etc.)	
72	measure line segments and angles in geometric figures, including interpreting maps and scale drawings and use of bearings	
73	know and apply formulae to calculate: area of triangles, parallelograms, trapezia; volume of cuboids and other right prisms (including cylinders)	
74	know the formulae: circumference of a circle $= 2\pi r = \pi d$, area of a circle $= \pi r^2$; calculate: perimeters of 2D shapes, including circles; areas of circles and composite shapes; surface area and volume of spheres, pyramids, cones and composite solids. #18 [18]	

STATISTICS

92	infer properties of populations or distributions from a sample, while knowing the limitations of sampling. #19 [19]	
93	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. #21 [21]	
94	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	
95	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)	
96	apply statistics to describe a population	
97	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	

33	solve linear equations in one unknown algebraically (including those with the unknown on both sides of the equation); find approximate solutions using a graph	
34	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. #20 [20]	
35	solve two simultaneous equations in two variables (linear/linear or linear/quadratic) algebraically; find approximate solutions using a graph	
36	find approximate solutions to equations numerically using iteration. #23 [23]	
37	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	
38	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. #24 [24]	

Sequences

39	generate terms of a sequence from either a term-to-term or a position-to-term rule	
40	recognise and use sequences of triangular, square and cube numbers, simple arithmetic progressions, Fibonacci type sequences, quadratic sequences, and simple geometric progressions (rn where n is an integer, and r is a rational number > 0 or a surd) and other sequences. #25 [25]	
41	deduce expressions to calculate the nth term of linear and quadratic sequences. #26 [26]	

84	apply ideas of randomness, fairness and equally likely events to calculate expected outcomes of multiple future experiments	
85	relate relative expected frequencies to theoretical probability, using appropriate language and the 0–1 probability scale	
86	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	
87	understand that empirical unbiased samples tend towards theoretical probability distributions, with increasing sample size	
88	enumerate sets and combinations of sets systematically, using tables, grids, Venn diagrams and tree diagrams. *To include set notation: ξ,∩, ∪ ,∈,A' Examiners will not be expecting students to use the ( ) bracket notation as part of set notation.*	
89	construct theoretical possibility spaces for single and combined experiments with equally likely outcomes and use these to calculate theoretical probabilities	
90	calculate the probability of independent and dependent combined events, including using tree diagrams and other representations, and know the underlying assumptions	
91	calculate and interpret conditional probabilities through representation using expected frequencies with two-way tables, tree diagrams and Venn diagrams	

75	calculate arc lengths, angles and areas of sectors of circles	
76	apply the concepts of congruence and similarity, including the relationships between lengths, areas and volumes in similar figures	
77	know the formulae for: Pythagoras' theorem and the trigonometric ratios (SOHCAHTOA); apply them to find angles and lengths in right-angled triangles and, where possible, general triangles in two and three dimensional figures. #22 [22]	
78	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°	
79	know and apply the Sine Rule and Cosine Rule to find unknown lengths and angles	
80	know and apply the Area Rule to calculate the area, sides or angles of any triangle	

Vectors

81	describe translations as 2D vectors	
82	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	

[1] Symmetry does not exist as a topic within the new GCSE (9–1) so there will no questions asking students about the number of lines of symmetry or the order of rotation symmetry. However, symmetry could be used to describe a shape. Students will have to carry out the transformations of reflection and rotation

[2] Examiners will test non-calculator arithmetic, including long multiplication and division, on the non-calculator paper. No method will be specified; any correct method will be accepted.

[3] To include the locus of points equidistant from a given point; the locus of points that are a given distance from a line.

[4] To include the sum of interior angles of polygons and the exterior angles of polygons.

[5] Will be limited to expanded products of three binomials (i.e. cubics).

[6] To include division of a quantity into three (or more) parts.

[7] The accuracy that candidates will be expected to estimate a square root of a positive number will depend on the context of the question. For a straightforward AO1 question such as "estimate the square root of 85", then knowing that the answer lies between 9 and 10 and closer to 9 is all that examiners would expect.

[8] At Higher tier, to include proving that two triangles are similar.

[9] Candidates could be asked to produce the graph of a function or an inverse function. It is possible that this could then be linked into a geometrical interpretation. Candidates will be expected to use notation f–1(x) for work on inverse functions and gf(x) for work on composite functions.

[10] Candidates could be asked to rationalise the denominator of any fraction which may involve utilising
the difference of two squares.

[11] Students may need to change a fraction into a recurring decimal in the context of a problem.

[12] The coordinates of the max/min could be determined either by completing the square or by considerations of symmetry. No use of calculus is expected – however, if candidates use an AS/A level skill correctly then they will be awarded marks if this is used correctly; partial marks would be awarded for a partially correct answer.
The only exception to this could be if a particular method is specified in the question in which case that method should be used. Candidates at Higher tier could be asked to complete
the square for any quadratic expression of the form ax2 + bx + c. The difficulty of the expression will affect the demand at which the question is set.

[13] Students will be expected to be able to sketch quadratic functions showing any intercepts with axes
and possibly the maximum / minimum as well. For recognition and/or sketching other functions then the general shape of the graph should be known.

[14] At Foundation tier it is appropriate to test y is directly proportional to x or 1/x only. Note that constructing equations that describe inverse and direct proportion is in bold in the spec and so is at higher only.

[15] At Higher tier, to include y= k/x and y = ak^x
Candidates will be expected to answer simple kinematics problems from graphs involving speed, distance and time. The suvat formulae were included on our formula sheet which has now been withdrawn. Knowledge of the suvat formulae is not part of our specification and will not form part of our assessment. There

may be questions that students could solve by using the suvat formulae but no questions will be set where these formulae have to be used. Students could be presented with one of the suvat equations and asked, for example, to change the subject of the formula or substitute in values to find the value of one of the variables but no application of these formulae will be expected.

[16] Unless the method of solution is specified in the question then any correct method, including calculus, is acceptable. However, be aware that questions do not always state the equation of the curve under consideration so candidates may have to use methods other than calculus.

[17] When estimating area under a curve, a maximum of four equal intervals will be expected. At Higher tier candidates will be expected to find gradients of graphs and areas under graphs and interpret these results in distance-time and velocity-time graphs.

[18] To include the surface area of cuboids and cylinders.

[19] Questions concerning questionnaires will no longer be set. To include the calculation of summary statistics from a sample, knowing that these are estimates for the population. Stratified sampling is not part of the GCSE 9–1 specification. However, the ability to infer properties of populations or distributions from a sample is part of the specification so candidates could be asked questions relating to this. At Higher tier, to include the Peterson capture–recapture method.

[20] The solution of quadratic equations on the Foundation tier will be limited to solution by factorising only and to the type $x^2 + bx + c = 0$. Candidates at Higher tier could be asked to complete the square for any quadratic expression of the form $ax^2 + bx + c$. The difficulty of the expression will affect the demand at which the question is set.

[21] To include stem and leaf diagrams and frequency polygons. Candidates will be expected to be able to draw a time series graph by plotting points from given information and take readings from time series graphs provided. Moving averages will not be tested and neither will average seasonal trends. Questions could be set on the general trend, however.

[22] To include the angle between a line and a plane.

[23] Examiners would expect to give students a rearranged equation to use in their iteration along with a starting value and ask them to carry out, say, three iterations, feeding their solution each time into $x_{n+1} = f(x_n)$ to get an improved solution and so generating x_2, x_3, etc, having been given a value for x_1. They may first be given an equation and asked to show that it can be rearranged into a given form. Students will be expected to realise that the values they are generating are converging to a root of the equation. Candidates will be given the iterative formula within the question but might also be asked to show the rearrangement of a given equation into a particular form. Students will be required to know the rule that "where there is a sign change, there is a solution".

[24] Examiners will not be expecting students to use the ( ] bracket notation as part of set notation. Representing solution sets on a graph: The examiners' wording will be along the lines of "Show, by shading, the region…label your region R." This is done deliberately to allow for candidates who are taught to shade the required region and those who are taught to shade the unwanted region. Either approach is accepted by mark schemes, provided that the candidate makes their approach clear – hence the requirement to label the region.

[25] Other sequences to include ar^n at Higher tier. Other sequences could include, for example,
1, 1/2, 1/3, 1/4, 1/5, 1/6, ….
1, 16, 81, 256, …

[26] At the Higher tier, students might have to find complex nth terms, such as $n^2 + 3n – 5$, when given the sequence only.