Pearson Edexcel

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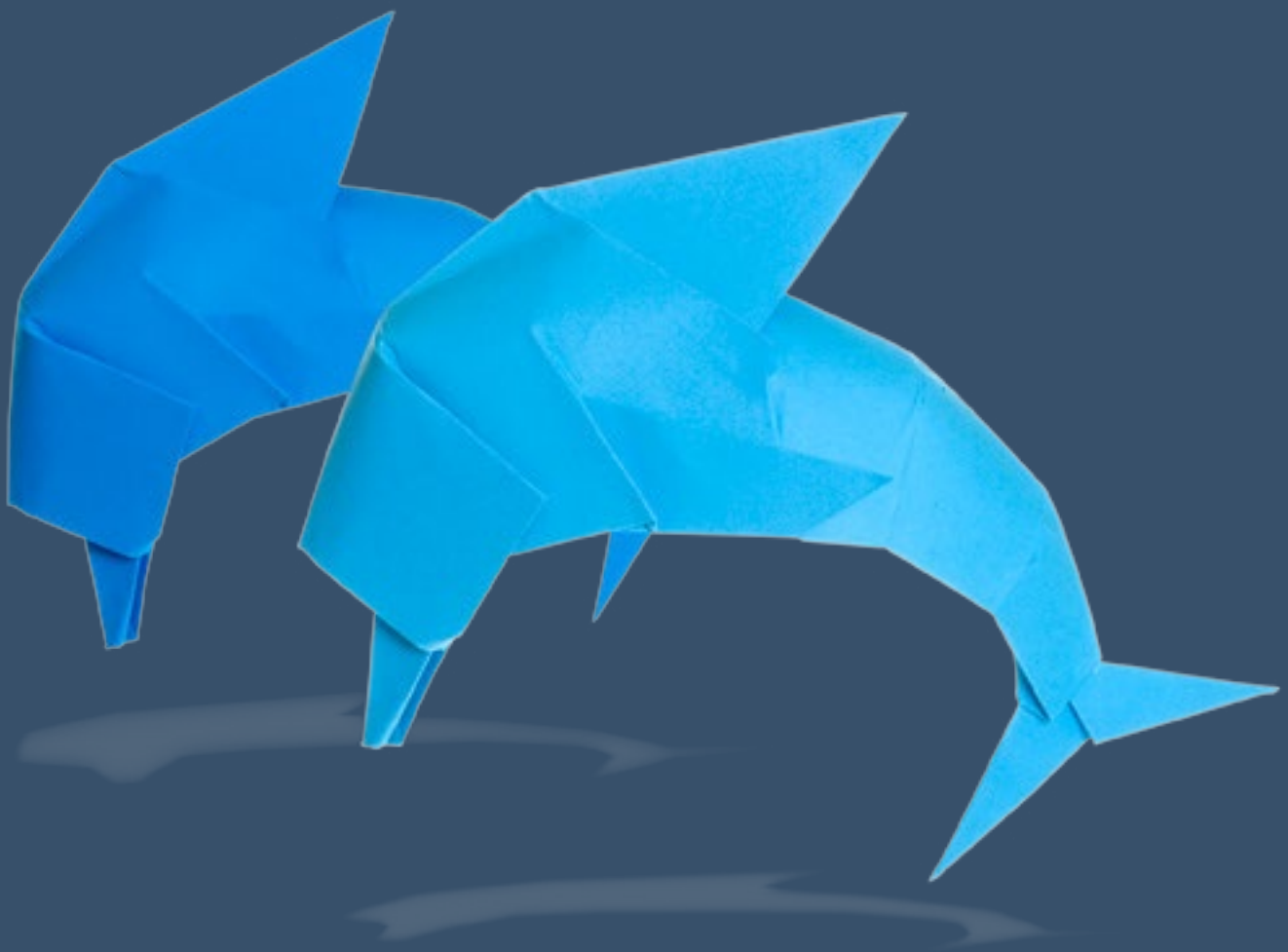
Level 1/Level 2 GCSE (9-1)
Mathematics (1MA1)



Content Guidance: FAQs

First teaching from September 2015
First certification from June 2017

Issue 5 (updated assessment examples)

About this content exemplification

This content guidance booklet has been produced to support mathematics teachers delivering the GCSE (9–1) in Mathematics specification (first assessment summer 2017).

This booklet provides commentary from the senior examiner team beneath the GCSE (9–1) in Mathematics content statements. The commentary is intended to provide more detail on how the specification is assessed, and supplies generic examples and relevant question references from recent exam papers and Specimen Papers (Sets 1 and 2) to exemplify this content, along with answers to frequently asked questions (FAQs).

Content

All students need to develop confidence and competence with the content identified by standard type.

All students are 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 are assessed on the content identified by **bold** type. The highest-attaining students need to develop confidence and competence with the bold content.

Content in standard and underlined type is assessed at Foundation tier; content in bold type is assessed at Higher tier only.

Assessment examples

The column for Assessment examples contains references to relevant questions from exam papers since June 2017, from the specimen papers and from the specimen assessment materials. SAMs stands for Specimen Assessment Materials,SP1 for Specimen Papers Set 1 and SP2 for Specimen Papers Set 2. All of these documents are available from the Pearson website or from the Mathematics Emporium.

Assessment: P marks

The P (process) mark denotes those questions that have been classified as AO3 (problem solving) and therefore may have a number of different methods of solution. In our mark schemes we exemplify the most common methods of solution seen; examiners are instructed to apply the mark scheme to alternative methods of solution (or refer these to their team leader if necessary).

The P mark works in exactly the same way as the M (method) mark. We use a different letter to remind examiners that they should be looking for alternative processes (and have used this language rather than method in our mark schemes for AO3 questions). So if a candidate gives a partially correct solution they will be awarded the appropriate P (process) marks provided the working they show is a possible route through to the solution. If a solution is fully correct, then full marks will usually be awarded. The exception will be in questions where candidates are specifically instructed to show working. In these questions, the correct solution with no working will score no marks.

Knowledge, skills and understanding

1. Number		Assessment examples
Structure and calculation		
What students need to learn:		
N1	order positive and negative integers, decimals and fractions; use the symbols =, ≠, <, >, ≤, ≥	**Foundation tier** June 2019 1F Q8 June 2019 2F Q2 June 2019 2F Q10 Nov 2018 1F Q1 Nov 2018 2F Q6 June 2018 1F Q2 **Higher tier** Nov 2017 1H Q8
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)	**Foundation tier** June 2019 1F Q6 June 2019 1F Q11 June 2019 1F Q19 June 2019 2F 6 June 2019 3F Q7 June 2019 3F Q11a June 2019 3F Q14 Nov 2018 2F Q1 Nov 2017 1F Q21 **Higher tier** June 2017 1H Q3
	Examiners test non-calculator arithmetic, including long multiplication and division, on the non-calculator paper. No method is specified; any correct method will be accepted.	For example, for the question 45 × 289, full marks would be given for a correct answer of 13 005. If the answer was incorrect then the working would be looked at and partial marks, if appropriate, would be awarded for **any** correct method used to multiply the two numbers – examiners will not be prescribing the method that candidates should use.

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	**Foundation tier** June 2019 1F Q3 Nov 2018 1F Q5 **Higher tier** June 2019 3H Q7 Nov 2017 2H Q8
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	**Foundation tier** June 2019 1F Q4, Q24 June 2019 2F Q3 June 2019 3F Q2 Nov 2018 1F Q3, Q10 Nov 2018 3F Q15 June 2018 2F Q21 Nov 2017 1F Q23 **Higher tier** June 2019 1H Q3 June 2018 2H Q2 June 2018 3H Q10 Nov 2017 1H Q1
	The unique factorisation theorem is tested by the requirement to carry out the prime factorisation of a given number.	
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)**	**Foundation tier** June 2018 2F Q7 June 2017 3F Q7 **Higher tier** June 2019 1H Q16 Nov 2018 2H Q11 June 2018 3H Q14
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**	**Foundation tier** June 2019 1F Q15 June 2019 3F Q4 Nov 2018 2F Q**4** **Higher tier** June 2019 1H Q8a
	The accuracy that candidates are expected to use in estimating a square root of a positive number depends on the context of the question. For a straightforward AO1 question such as “estimate the square root of 85”, knowing that the answer lies between 9 and 10 and is closer to 9 is all that examiners would expect.	

N7	calculate with roots, and with integer **and fractional** indices	**Foundation tier** Nov 2018 1F Q20 Nov 2017 1F Q22b **Higher tier** June 2019 1H Q8c Nov 2018 1H Q1, Q14 June 2018 1H Q9 Nov 2017 1H Q10
	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**).	Simplify $2^7 \times 2^{-4}$; write down the value of 3^0
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**	**Foundation tier** June 2019 1F Q14 Nov 2018 1F Q11b June 2018 1F Q19 **Higher tier** June 2019 1H Q9 June 2019 1H Q18 Nov 2018 1H Q20 June 2018 1H Q1 June 2018 1H Q13 June 2018 2H Q20
	Candidates could be asked to rationalise the denominator of any fraction, which may involve utilising the difference of two squares.	For example, $\frac{\sqrt{2}}{\sqrt{2}+1}$
N9	calculate with and interpret standard form $A \times 10^n$, where $1 \leq A < 10$ and n is an integer	**Foundation tier** June 2019 2F Q27 Nov 2018 2F Q27 June 2018 3F Q 18 Nov 2017 3F Q25 **Higher tier** Nov 2018 2H Q7 June 2018 3H Q9 Nov 2017 3F Q7

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**	**Foundation tier** June 2019 2F Q1 Nov 2018 2F Q5 **Higher tier** Nov 2018 1H Q16 Nov 2017 1H Q15
	Students may need to change a fraction into a recurring decimal in the context of a problem.	Order 30%, 0.35, $\frac{1}{3}$, 32%
N11	identify and work with fractions in ratio problems	**Foundation tier** June 2017 3F Q5
N12	interpret fractions and percentages as operators	**Foundation tier** June 2019 1F Q14 June 2019 3F Q6 June 2019 3F Q8 June 2019 3F Q23 Nov 2018 2F Q11 June 2018 1F Q14 **Higher tier** June 2017 3H Q4
		Interpret $\frac{2}{5}$ of 40 as $\frac{2}{5}$ × 40; interpret 20% of 40 as 0.2 × 40

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	**Foundation tier** Nov 2018 2F Q17 Nov 2018 3F Q8 June 2018 1F Q8, Q10 June 2018 1F Q13, Q21 **Higher tier** June 2018 1H Q3
		Standard compound measure: speed (e.g. m/s, miles per hour), acceleration (e.g. m/s^2), density (e.g. g/cm^3), pressure (e.g. N/m^2)

N14	estimate answers; check calculations using approximation and estimation, including answers obtained using technology	**Foundation tier** June 2019 3F Q11b Nov 2018 1F Q24 June 2018 1F Q22 Nov 2017 1F Q20 **Higher tier** Nov 2018 1H Q5 June 2018 1H Q4
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	**Foundation tier** June 2019 2F Q25 June 2019 3F Q1 Nov 2018 1F Q4 Nov 2018 3F Q20a Nov 2017 3F Q23b **Higher tier** Nov 2018 2H Q9 Nov 2018 3H Q1a Nov 2017 3H Q5b
		$x = 2.3$ correct to 2 s.f. implies that $2.25 \leq x < 2.35$ If a piece of wood has been measured as 7 cm to the nearest whole number. how long could the piece of wood actually be? (Answer: $6.5 \leq L < 7.5$) Jim used his calculator to work out the value of a number x. He wrote down the first two digits of the answer on his calculator. He wrote down 4.6 Write down the error interval for x. (Answer: $4.6 \leq x < 4.7$) **OR** (more suitable for Higher tier): Jim truncates to 1 digit a number x. The result is 5. Write down the error interval for x (Answer: $5 \leq x < 6$)

N16	apply and interpret limits of accuracy, **including upper and lower bounds**	**Foundation tier** June 2017 3F Q23a **Higher tier** June 2019 3H Q19 Nov 2018 3H Q18 June 2018 2H Q21
		A gap between two cupboards is 0.90 m correct to the nearest centimetre. Is it possible that a cupboard of width 90.4 cm will fit into this gap?

2. Algebra

Assessment examples

Notation, vocabulary and manipulation

What students need to learn:

A1 use and interpret algebraic manipulation, including:

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

Foundation tier

June 2019 2F Q8

June 2018 1F Q6a

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

Foundation tier

June 2019 2F Q11

June 2019 3F Q15

Nov 2018 1F Q9

June 2018 1F Q16a

Higher tier

June 2018 3H Q9

Numerical values could be given in any form (integer, decimal or fraction) or given in standard form.

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

Foundation tier

June 2019 2F Q7

Nov 2017 1F Q6

Nov 2017 3F Q17

Examiners do not anticipate using the identity symbol on Foundation tier papers.

Pick a word from the list of *equation*, *formula*, *identity* that would best describe

(i) $3x + 5 = 12$

(ii) $2x + 4 = 2(x + 2)$

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	**Foundation tier** June 2019 1F Q16 June 2019 3F Q9 Nov 2018 2F Q7 Nov 2018 2F Q19b, Q26 June 2018 1F Q6b, Q16b June 2018 2F Q20 June 2018 3F Q20 Nov 2017 2F Q24 **Higher tier** June 2019 2H Q13 June 2019 3H Q18a Nov 2018 1H Q10 Nov 2018 2H Q12 Nov 2018 3H Q9ab June 2018 1H Q15 June 2018 1H Q17 June 2018 2H Q1 June 2018 3H Q2
	This is limited to expanded products of **three** binomials (i.e. cubics).	
A5	understand and use standard mathematical formulae; rearrange formulae to change the subject	**Foundation tier** June 2019 3F Q19 Nov 2018 1F Q21 June 2018 3F Q28 **Higher tier** June 2019 2H Q15 Nov 2018 1H Q2
	The rearrangement of formulae where the intended subject appears twice (and so needs to be taken out as a common factor) is tested on Higher tier only.	
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**	**Foundation tier** Nov 2017 2F Q14 **Higher tier** June 2019 1H Q13 Nov 2018 3H Q15 June 2018 1H Q12

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)**	**Foundation tier** Nov 2018 2F Q10 **Higher tier** June 2019 1H Q21 Nov 2018 1H Q19 Nov 2018 3H Q10 June 2018 2H Q11
	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 are expected to use notation $f^{-1}(x)$ for work on inverse functions and $gf(x)$ for work on composite functions.	

Graphs

What students need to learn:

A8	work with coordinates in all four quadrants	**Foundation tier** Nov 2018 1F Q8 Nov 2018 3F Q22 June 2018 1F Q24 Nov 2017 1F Q7 **Higher tier** Nov 2018 3H Q3 June 2018 1H Q6
	To include finding the midpoint of a line joining two coordinates.	
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	**Foundation tier** June 2019 2F Q21 June 2018 1F Q25 June 2018 2F Q22 **Higher tier** June 2019 2H Q2 June 2019 2H Q16 Nov 2018 2H Q18 June 2018 1H Q19 Nov 2017 1H Q19
A10	identify and interpret gradients and intercepts of linear functions graphically and algebraically	**Foundation tier** Nov 2018 1F Q12 **Higher tier** Nov 2018 2H Q18
	When sketching the graph of a linear function then intercepts with the axes should be shown.	

A11	identify and interpret roots, intercepts, turning points of quadratic functions graphically; deduce roots algebraically **and turning points by completing the square**	**Foundation tier** June 2019 1F Q29 **Higher tier** June 2019 1H Q19
	The coordinates of the max/min can 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; 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 $ax^2 + bx + c$. The difficulty of the expression will affect the demand at which the question is set.**	
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**	**Foundation tier** Nov 2018 3F Q22 June 2018 3F Q13 **Higher tier** June 2019 3H Q17 Nov 2018 2H Q14 Nov 2018 3H Q3, Q11
	Students are 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.	
A13	**sketch translations and reflections of a given function**	**Higher tier** June 2019 3H Q15 Nov 2018 1H Q18 June 2018 1H Q18
	Stretches are **not** on the new specification; transformations are limited to reflections and translations.	Given the graph of $y = f(x)$, sketch the graph of $y = f(x + 2)$

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	**Foundation tier** SP1 1F Q24 SP1 3F Q7a, b SP2 2F Q10 SP2 3F Q11 **Higher tier** Nov 2017 2H Q10

At Higher tier, to include $y = \frac{k}{x}$ and $y = ak^x$.

Candidates are expected to be able 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 does 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 is expected.

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)**	**Higher tier** June 2019 2H Q14 June 2018 2H Q14 June 2018 3H Q15 Nov 2017 2H Q10 Nov 2017 3H Q18

When estimating area under a curve, a maximum of four equal intervals is expected.

At Higher tier, candidates are expected to be able to find gradients of graphs and areas under graphs and interpret these results in distance–time and velocity–time graphs.

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**	**Higher tier** Nov 2018 2H Q15 June 2018 2H Q16 Nov 2017 3H Q19

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	**Foundation tier** June 2019 1F Q10 Nov 2018 2F Q19a Nov 2018 3F Q17b June 2018 1F Q16c June 2018 3F Q25 Nov 2017 2F Q16 **Higher tier** June 2018 3H Q7 Nov 2017 2H Q1
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	**Foundation tier** Nov 2018 3F Q22c **Higher tier** June 2019 1H Q17 Nov 2018 3H Q3c Nov 2018 3H Q9c Nov 2017 1H Q23
	The solution of quadratic equations on the Foundation tier is 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.**	
A19	solve two simultaneous equations in two variables (linear/linear **or linear/quadratic**) algebraically; find approximate solutions using a graph	**Foundation tier** June 2019 3F Q30 Nov 2018 1F Q25 Nov 2017 3F Q27 **Higher tier** June 2019 1H Q10 June 2019 3H Q20 Nov 2018 1H Q6 Nov 2018 3H Q19 June 2018 2H Q16
		To include, **at Higher tier**, solve $x^2 + y^2 = 10$ and $x + y = 4$

A20	**find approximate solutions to equations numerically using iteration**	**Higher tier** June 2018 3H Q18 Nov 2017 3H Q15
	Students are given a rearranged equation to use in their iteration along with a starting value, x_1, and asked 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. They may first be given an equation and asked to show that it can be rearranged into a given form. Students are expected to realise that the values they are generating are converging to a root of the equation. Candidates are 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'.	
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	**Foundation tier** June 2019 1F Q28 Nov 2018 3F Q17a Nov 2017 1F Q24 Nov 2017 1F Q28 Nov 2017 3F Q24 **Higher tier** June 2019 1H Q7 Nov 2018 2H Q18 Nov 2017 1H Q2, Q6 Nov 2017 1H Q11, Q23 Nov 2017 3H Q6

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**	**Foundation tier** June 2019 2F Q20 Nov 2018 3F Q19 **Higher tier** June 2019 2H Q1 June 2019 3H Q18b Nov 2018 2H Q19 June 2018 1H Q20 Nov 2017 2H Q14
	Examiners do not expect students to use the ( ] bracket notation as part of set notation. Representing solution sets on a graph: The 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.	The solution of $x^2 - 1 < 0$ is $-1 < x < 1$ or $\{x : -1 < x < 1\}$ Represent the solution set to a given number of linear inequalities in two variables as a region 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	**Foundation tier** June 2019 3F Q13 June 2018 3F Q4 Nov 2017 1F Q5 **Higher tier** June 2018 3H Q16
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**	**Foundation tier** June 2019 2F Q28 Nov 2018 2F Q9 **Higher tier** June 2018 3H Q16 Nov 2017 2H Q23
	Other sequences to include ar^n at Higher tier. **Other sequences could include, for example,** **1, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, …** **1, 16, 81, 256, …**	Let $a = 2$ and $r = \sqrt{2}$ so the sequence reads: $2\sqrt{2}$, 4, $4\sqrt{2}$, 8, $8\sqrt{2}$, …

A25	deduce expressions to calculate the *n*th term of linear **and quadratic** sequences	**Foundation tier** Nov 2018 3F Q26 Nov 2017 3F Q18 **Higher tier** June 2019 3H Q16 June 2018 3H Q16
	At the Higher tier, students might have to find complex *n*th terms, such as $n^2 + 3n - 5$, when given the sequence only.	Questions using sequences such as $2n^2$, $n^2 - 3$, $n^2 + 5n$, etc, could be set.

3. Ratio, proportion and rates of change

Assessment examples

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	**Foundation tier** June 2019 1F Q13 June 2019 2F Q4 June 2019 3F Q3 Nov 2018 2F Q3 Nov 2018 3F Q7 **Higher tier** Nov 2018 3H Q18
	Any necessary conversions from metric units to imperial units will be given within the question.	A piece of wood has a mass of x kg and a volume of 0.002 m^3. Show that the density of the wood is $0.5x$ g/cm^3.
R2	use scale factors, scale diagrams and maps	**Foundation tier** June 2019 2F Q19 Nov 2018 2F Q8 June 2018 3F Q12 Nov 2017 2F Q9 **Higher tier** June 2017 2H Q3
R3	express one quantity as a fraction of another, where the fraction is less than 1 or greater than 1	**Foundation tier** June 2019 3F Q10 June 2018 3F Q11 **Higher tier** June 2019 1H Q12
R4	use ratio notation, including reduction to simplest form	**Foundation tier** June 2019 2F Q14 Nov 2018 3F Q16 June 2018 1F Q17 **Higher tier** June 2019 2H Q17 June 2018 2H Q4

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)	**Foundation tier** June 2019 1F Q27 June 2019 2F Q26 June 2019 3F Q21 June 2019 3F Q22 June 2019 3F Q23 Nov 2018 3F Q25 June 2018 1F Q14, Q20 Nov 2017 1F Q15, Q19 **Higher tier** June 2019 1H Q6 June 2019 2H Q7 Nov 2018 3H Q6 June 2018 1H Q2 June 2018 1H Q8
	To include division of a quantity into three (or more) parts.	
R6	express a multiplicative relationship between two quantities as a ratio or a fraction	**Foundation** June 2019 1F Q23 Nov 2018 1F Q13 June 2018 3F Q7 **Higher** June 2019 1H Q2
		There are twice as many blue beads as red beads in a jar. Write down the ratio of the number of blue beads to the number of red beads in the jar.
R7	understand and use proportion as equality of ratios	**Foundation tier** Nov 2017 1F Q11 **Higher tier** June 2019 2H Q17

R8	relate ratios to fractions and to linear functions	**Foundation tier** June 2019 3F Q12 Nov 2017 2F Q6 **Higher tier** SP2 2H Q21 SP2 3H Q10
		Purple paint is made using red paint and blue paint in the ratio 1 : 2. Write an equation for y in terms of x to show the relationship between the amount of red paint (y) and the amount of blue paint (x).
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	**Foundation tier** June 2019 3F Q5 Nov 2018 1F Q18 Nov 2018 2F Q15 Nov 2018 3F Q18, Q21 June 2018 1F Q21 June 2018 2F Q23 Nov 2017 1F Q15, Q18, Q30 **Higher tier** June 2019 3H Q10 Nov 2018 1H Q11 Nov 2018 2H Q10 Nov 2018 3H Q2 June 2018 1H Q3 June 2018 2H Q4 June 2018 3H Q11
R10	solve problems involving direct and inverse proportion, including graphical and algebraic representations	**Foundation tier** June 2019 2F Q17 June 2019 2F Q18 Nov 2018 1F Q23 Nov 2018 3F Q13 **Higher tier** June 2019 3H Q17 Nov 2018 1H Q4

R11	use compound units such as speed, rates of pay, unit pricing, density and pressure	**Foundation tier** June 2019 1F Q9 Nov 2018 1F Q24 June 2018 1F Q22 June 2018 2F Q9 June 2018 2F Q19, Q25 **Higher tier** June 2019 3H Q11 June 2019 3H Q13 Nov 2018 1H Q5 Nov 2018 2H Q20 Nov 2018 3H Q18 June 2018 1H Q4 June 2018 2H Q6
R12	compare lengths, areas and volumes using ratio notation; make links to similarity (including trigonometric ratios) and scale factors	**Foundation tier** June 2018 3F Q27 **Higher tier** June 2019 2H Q9 June 2018 3H Q13
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	**Foundation tier** SP2 3F Q27a **Higher tier** June 2019 1H Q20 Nov 2018 3H Q14 June 2018 1H Q14
	At Foundation tier it is appropriate to test y is directly proportional to x or $\frac{1}{x}$ only. **Note that constructing equations that describe inverse and direct proportion is in bold in the specification and so is Higher tier only.**	
R14	interpret the gradient of a straight line graph as a rate of change; recognise and interpret graphs that illustrate direct and inverse proportion	**Foundation tier** SP2 2F Q14 **Higher tier** June 2018 2H Q12 June 2018 3H Q12

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)**	**Higher tier** June 2018 2H Q14
	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.	
R16	set up, solve and interpret the answers in growth and decay problems, including compound interest **and work with general iterative processes**	**Foundation tier** June 2019 3F Q25 Nov 2018 2F Q23 **Higher tier** June 2019 1H Q12 June 2019 3H Q2 Nov 2018 2H Q4 Nov 2018 3H Q13 June 2018 2H Q9 Nov 2017 2H Q18
	General iterative processes: for example, population growth or decay.	For example, $P_{n+1} = kP_n$ Given $N_{t+1} = kN_t$ and $N_0 = 120$, find the value of N_3.

4. Geometry and measures		Assessment examples
Properties and constructions		
What students need to learn:		
G1	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.	**Foundation tier** June 2019 3F Q28 June 2018 2F Q15b Nov 2017 1F Q25 **Higher tier** June 2019 3H Q5 Nov 2017 1H Q3
	Symmetry does not exist as a topic within 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 (see G7).	
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.	**Foundation tier** June 2019 2F Q19 **Higher tier** SAMs 1H Q4
	To include the locus of points equidistant from a given point; the locus of points that are a given distance from a 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)	**Foundation tier** June 2019 1F Q12 Nov 2018 1F Q28 Nov 2018 2F Q22 June 2018 3F Q26 Nov 2017 1F Q25 **Higher tier** Nov 2018 2H Q3 June 2018 3H Q8 Nov 2017 1H Q3
	To include the sum of interior angles of polygons and the exterior angles of 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	**Foundation tier** June 2019 3F Q20 Nov 2018 1F Q14 June 2018 2F Q15a **Higher tier** SP1 3H Q5a
G5	use the basic congruence criteria for triangles (SSS, SAS, ASA, RHS)	**Foundation tier** Nov 2018 3F Q9b **Higher tier** June 2018 3H Q 21
	The requirement to prove two triangles are congruent is Higher tier only.	
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	**Foundation tier** Nov 2018 1F Q14 **Higher tier** June 2018 1H Q11
	To include proving that two triangles are similar at Higher tier only.	
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)	**Foundation tier** Nov 2018 1F Q19 Nov 2018 2F Q16 Nov 2018 3F Q10 June 2018 2F Q18 Nov 2017 2F Q20 **Higher tier** Nov 2018 1H Q13 June 2018 2H Q7 Nov 2017 2H Q5

G8	**describe the changes and invariance achieved by combinations of rotations, reflections and translations**	**Higher tier** Nov 2018 2H Q8 Nov 2018 3H Q20 June 2018 1H Q7
		Describe the single transformation that would map A onto C given that shape A is mapped onto shape B by a reflection in the *x*-axis. Shape B is mapped onto shape C by a reflection in the line $y = -2$ Given the above mappings, would shape C be in the same orientation as shape A? If the triangle with vertices at coordinates (0, 0), (0, 2) and (2, 0) is reflected in the *y*-axis, which vertices will stay in the same position?
G9	identify and apply circle definitions and properties, including: centre, radius, chord, diameter, circumference, tangent, arc, sector and segment	**Foundation tier** June 2018 1F Q9 **Higher tier** Nov 2018 2H Q13
G10	**apply and prove the standard circle theorems concerning angles, radii, tangents and chords, and use them to prove related results**	**Higher tier** June 2019 2H Q18 Nov 2018 1H Q12 Nov 2018 2H Q21 June 2018 1H Q11 Nov 2017 3H Q20
G11	solve geometrical problems on coordinate axes	**Foundation tier** June 2018 1F Q24 **Higher tier** June 2018 1H Q6
	2D coordinates only.	
G12	identify properties of the faces, surfaces, edges and vertices of: cubes, cuboids, prisms, cylinders, pyramids, cones and spheres	**Foundation tier** Nov 2018 3F Q5 SP2 1F Q 4

G13	construct and interpret plans and elevations of 3D shapes	**Foundation tier** June 2019 1F Q25 June 2018 1F Q23a **Higher tier** June 2019 1H Q4 June 2018 1H Q5a

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.)	**Foundation tier** SP2 1F Q23 SP2 2F Q6a **Higher tier** SP2 1H Q5
G15	measure line segments and angles in geometric figures, including interpreting maps and scale drawings and use of bearings	**Foundation tier** Nov 2017 2F Q9 Nov 2017 3F Q8 **Higher tier** SP1 2H Q9
G16	know and apply formulae to calculate: area of triangles, parallelograms, trapezia; volume of cuboids and other right prisms (including cylinders)	**Foundation tier** June 2019 2F Q23 June 2019 3F Q29 Nov 2018 2F Q13 Nov 2018 2F Q24 June 2018 2F Q25 **Higher tier** June 2019 2H Q4 June 2019 3H Q6 Nov 2018 2H Q5, Q13 June 2018 1H Q 8

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	**Foundation tier** June 2019 3F Q16 Nov 2018 2F Q24 June 2018 1F Q23b June 2018 2F Q19 Nov 2017 1F Q13 **Higher tier** June 2019 1H Q15 Nov 2018 2H Q5, Q13 Nov 2018 2H Q20 Nov 2018 3H Q8, Q16 June 2018 1H Q5b June 2018 2H Q19
	To include the surface area of cuboids and cylinders.	
G18	calculate arc lengths, angles and areas of sectors of circles	**Foundation tier** Nov 2018 1F Q26 June 2018 2F Q19 **Higher tier** June 2019 2H Q12 Nov 2018 1H Q7 Nov 2018 3H Q16
G19	apply the concepts of congruence and similarity, including the relationships between lengths, **areas and volumes** in similar figures	**Foundation tier** June 2018 3F Q27 **Higher tier** Nov 2018 1H Q15 June 2018 3H Q13 Nov 2017 1H Q22 Nov 2017 3H Q14

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 **and, where possible, general triangles** in two **and three** dimensional figures **To include finding the angle between a line and a plane at Higher tier only.**	**Foundation tier** June 2019 2F Q24 Nov 2018 3F Q25 June 2018 2F Q25 June 2018 3F Q23 Nov 2017 2F Q22 **Higher tier** June 2019 2H Q5 June 2019 2H Q19 Nov 2018 1H Q8b Nov 2018 3H Q6, Q12 June 2018 3H Q5 June 2018 2H Q18 Nov 2017 2H Q7
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 $60°$	**Higher tier** June 2019 1H Q14 Nov 2018 1H Q8a Nov 2017 1H Q20
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**	**Higher tier** June 2019 3H Q23 Nov 2018 3H Q16 June 2018 3H Q17 Nov 2017 3H Q17
G23	**know and apply Area = $\frac{1}{2}ab\sin C$ to calculate the area, sides or angles of any triangle**	**Higher tier** June 2019 3H Q14 Nov 2017 2H Q20 Nov 2017 3H Q17

Vectors

What students need to learn:

G24	describe translations as 2D vectors	**Foundation tier** June 2019 1F Q26 **Higher tier** June 2019 1H Q5

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**	**Foundation tier** June 2019 2F q29 June 2018 1F Q26 **Higher tier** June 2019 2H Q20 Nov 2018 1H Q21 June 2018 2H Q10 Nov 2017 3H Q21

5. Probability

Assessment examples

What students need to learn:

P1	record, describe and analyse the frequency of outcomes of probability experiments using tables and frequency trees	**Foundation tier** Nov 2018 1F Q17 Nov 2017 1F Q12 Nov 2017 1F Q17 Nov 2017 2F Q12 **Higher tier** June 2018 2H Q8
P2	apply ideas of randomness, fairness and equally likely events to calculate expected outcomes of multiple future experiments	**Foundation tier** June 2019 2F Q16c Nov 2018 3F Q14c **Higher tier** June 2017 2H Q1
P3	relate relative expected frequencies to theoretical probability, using appropriate language and the 0–1 probability scale	**Foundation tier** June 2019 2F Q16a Nov 2018 1F Q17 Nov 2018 2F Q12 Nov 2018 3F Q6 June 2018 1F Q7 **Higher tier** June 2018 1H Q16 June 2018 2H Q8
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	**Foundation tier** June 2019 1F Q22 Nov 2018 3F Q14a June 2018 3F Q24 **Higher tier** June 2019 1F Q1 June 2018 3H Q6
P5	understand that empirical unbiased samples tend towards theoretical probability distributions, with increasing sample size	**Foundation tier** June 2019 1F Q17 Nov 2017 3F Q26 **Higher tier** Nov 2017 3H Q8

P6	enumerate sets and combinations of sets systematically, using tables, grids, Venn diagrams and tree diagrams	**Foundation tier** June 2019 3F Q24 Nov 2018 2F Q14c Nov 2018 2F Q20 June 2018 1F Q18 June 2018 3F Q22 **Higher tier** June 2019 3H Q1 Nov 2018 2H Q1 June 2018 3H Q4
	To include set notation: ξ, $\cap$, $\cup$, $\in$, A′ Students are not expected to use the ( ] bracket notation as part of set notation.	
P7	construct theoretical possibility spaces for single and combined experiments with equally likely outcomes and use these to calculate theoretical probabilities	**Foundation tier** Nov 2018 2F Q14c **Higher tier** Nov 2017 2H Q21
P8	calculate the probability of independent and dependent combined events, including using tree diagrams and other representations, and know the underlying assumptions	**Foundation tier** Nov 2018 1F Q27 **Higher tier** June 2019 1H Q22 June 2019 2H Q10 Nov 2018 1H Q22 Nov 2018 2H Q16
P9	**calculate and interpret conditional probabilities through representation using expected frequencies with two-way tables, tree diagrams and Venn diagrams**	**Higher tier** June 2018 2H Q15 June 2018 3H Q20

6. Statistics

Assessment examples

What students need to learn:

S1	infer properties of populations or distributions from a sample, while knowing the limitations of sampling	**Foundation tier** June 2019 2F Q22 **Higher tier** June 2019 2H Q3|
	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. **At Higher tier, to include the Peterson capture–recapture method.**	
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	**Foundation tier** June 2019 1F Q7 June 2019 2F Q5 June 2019 3F Q26b June 2019 3F Q27 Nov 2018 1F Q7 Nov 2018 3F Q12, Q23 June 2018 1F Q12 June 2018 3F Q14 Nov 2017 1F Q10b Nov 2017 3F Q19 **Higher tier** June 2019 3H Q3b June 2019 3H Q4 Nov 2018 3H Q4 Nov 2018 3F Q7 Nov 2017 3H Q1
	To include stem and leaf diagrams and frequency polygons. Candidates are expected to be able to draw a time series graph by plotting points from given information and take readings from time series graphs provided. Neither moving averages nor average seasonal trends are included. However, questions could be set on general trends.	

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**	**Higher tier** June 2019 2H Q11 June 2019 3H Q21 Nov 2018 1H Q9 Nov 2018 3H Q17 June 2018 2H Q17
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**)	**Foundation tier** June 2019 3F Q18 Nov 2018 3F Q23b Nov 2017 1F Q27 **Higher tier** June 2019 1H Q11 Nov 2018 1H Q9 Nov 2018 3F Q4b June 2018 1H Q10 Nov 2017 1H Q5 Nov 2017 1H Q12
S5	apply statistics to describe a population	**Foundation tier** June 2018 2F Q16 Nov 2017 1F Q10a Nov 2017 1F Q27 **Higher tier** Nov 2017 1H Q5 Nov 2017 1H Q12
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	**Foundation tier** Nov 2018 2F Q21 June 2018 3F Q19 **Higher tier** Nov 2018 2H Q2 June 2018 3H Q1

Geometrical statements in GCSE Maths papers

These notes refer to the 2017 GCSE Edexcel Mathematics specifications.

In questions that relate to Geometry, candidates can be asked to give a reason for a calculation or proof. In many cases this is related to angles. This could also be part of a requirement for candidates to communicate in mathematical terms.

In Geometry, the need to communicate in mathematics terms is embodied in mathematical statements relating to geometrical properties. It is important that candidates show with clarity their understanding of the use of any geometrical property that they might use in solving problems.

The list below gives some examples of responses to questions that would be considered clear communication in these respects. These are not unique: there are other similar statements that could be used to earn the marks, but these statements contain those key words and phrases that are judged to be minimal in terms of a request to give reasons for mathematical deduction in geometry.

Lines

Vertically opposite angles are equal.

Angles on a straight line add up to 180°.

Angles at a point add up to 360°.

Triangles and quadrilaterals

Angles in a triangle add up to 180°.

Base angles of an isosceles triangle are equal.

Angles in an equilateral triangle are equal.

Angles in a quadrilateral add up to 360°.

An exterior angle (of a triangle) is equal to the sum of the internal opposite angles.

Polygons

Exterior angles of a polygon add up to 360°.

The interior and exterior angle of any polygon add up to 180°.

Parallel lines

Alternate angles are equal.

Corresponding angles are equal.

Allied (or co-interior) angles add up to 180°.

Circle theorems

The tangent to a circle is perpendicular (90°) to the radius.

Tangents from an external point are equal in length.

Angles in a semicircle are 90°.

Angles in the same segment are equal.

The angle at the centre of a circle is twice the angle at the circumference.

Opposite angles of a cyclic quadrilateral add to 180°.

Alternate segment theorem.

GCSE – command words

Note that this table is not exhaustive but lists the most commonly used command words.

Command word	What you need to know
Calculate	A calculator and some working will be needed.
Change	Usually convert from one unit to another; either using known metric unit conversions or the use of a conversion graph.
Complete	Fill in missing values.
	For example, on a probability tree diagram or a table of values.
Describe	Write a sentence that gives the features of the situation.
	For example, describing a transformation or trend in a graph.
Draw	Produce an accurate drawing (unless a sketch is being drawn).
	For example, draw a graph, draw an accurate elevation of a pyramid.
Draw a sketch of ... **Sketch**	Produce a drawing that does not have to be drawn to scale **or** a graph that is drawn without working out each coordinate.
	For example, sketch a graph, sketch a cylinder.
Expand	Remove brackets.
Expand and simplify	Remove brackets and then collect like terms.
Explain	Write a sentence or a mathematical statement to show how you got to your answer or reached your conclusion.
Express	Re-write in another form; some working may be needed.
Factorise	Insert brackets by taking out common factors.
Factorise fully	Insert brackets by taking out **all** the common factors.
Find	Some working will be needed to get to the final answer.
Give a reason	Must be clear and accurate reasons. If the reasons are geometrical then make sure you: provide a reason for each stage of working (if required) use correct geometric terminology.
Justify	Show all working and/or give a written explanation.
Prove	More formal than 'show' – all steps must be present. In the case of a geometrical proof, reasons must be given.
Prove algebraically	Use algebra in the proof.
Show	All working needed to get to a given answer **or** complete a diagram to show given information.
Simplify	Simplify the given expression.
Simplify fully	Simplify the given expression. Answer must be given in its simplest form.
Solve	Find the solution of an equation or inequality.
Solve algebraically	Find the solution of an equation or inequality; algebraic manipulation **must** be shown.
Write down	No working is needed.
Write	No working needed for 1 mark questions. Working may be needed questions with more than 1 mark.
Work out	Some working will be needed in order to get the answer.