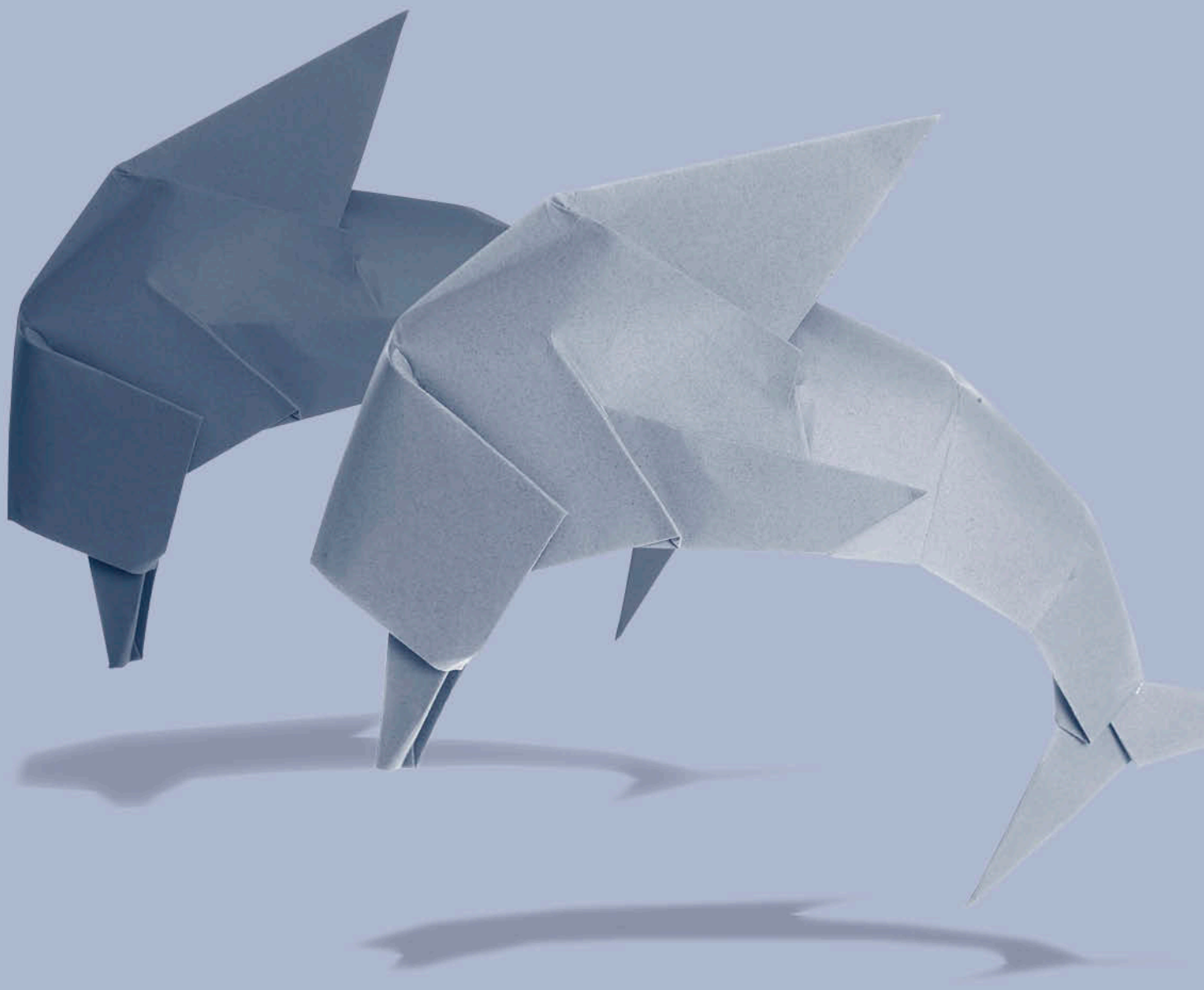
edexcel

GCSE (9–1) Mathematics



Content Exemplification: FAQs

Pearson Edexcel Level 1/Level 2 GCSE (9–1) in Mathematics (1MA1)

First teaching from September 2015
First certification from June 2017 Issue 3 (now with added FAQs)

ALWAYS LEARNING PEARSON

About this content exemplification

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

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

Content

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

All students will be assessed on the content identified by the standard and the underlined type; more highly attaining students will develop confidence and competence with all of this content.

Only the more highly attaining students will be assessed on the content identified by **bold** type. The highest-attaining students will develop confidence and competence with the bold content.

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

Assessment Examples

In the column for Assessment Examples, SAMs stands for Specimen Assessment Materials, SP1 for Specimen Papers Set 1 and SP2 for Specimen Papers Set 2. All these documents are available from the Pearson website or from the Mathematics Emporium.

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** SP1: 1F, qu. 4(a) SP1: 1F, qu. 9 SP1: 2F, qu. 8 SP2: 2F, qu. 2
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** SAMs :1F, qu. 3(a) SP1: 1F, qu. 5 SP1: 1F, qu. 8(a) SP1: 2F, qu. 1 SP1: 2F, qu. 6 SP1: 2F, qu. 19 SP2: 1F, qu. 3 SP2: 2F, qu. 12 **Higher Tier** SP2: 1H, qu. 6
	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.	If the question was, for example, 45 × 289, then full marks would be given for a correct answer of 13005. 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 (as at present) – 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** SP1: 3F, qu. 2 SP1: 3F, qu. 3 **Higher Tier** SP1: 2H, qu. 12(a)

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** SAMs :1F, qu. 3(a) SP1: 2F, qu. 2 SP1: 3F, qu. 4 SP2: 1F, qu. 11 SP2: 2F, qu. 21 SP2: 3F, qu. 3 SP2: 3F, qu. 7
	The unique factorisation theorem will be 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** SAMs: 2F, qu. 4(b) SP1: 1F, qu. 6(b) **Higher Tier** SAMs: 2H, qu. 12 SP1: 3H, qu. 13
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** SP1: 2F, qu. 15(b) SP1: 3F, qu. 11 SP1: 3F, qu. 12 SP2: 2F, qu. 4 SP2: 3F, qu. 9 **Higher Tier** SP2: 1H, qu. 8
	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.	

N7	calculate with roots, and with integer **and fractional** indices	Simplify $2^7 \times 2^{-4}$; write down the value of 3^0. **Higher Tier** SP1: 1H, qu. 11 SP1: 2H, qu. 12 SP2: 3H, qu. 16
	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**).	
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** SP1: 1F, qu. 19 SP1: 2F, qu. 15(a) **Higher Tier** SP1: 1H, qu. 19 SP2: 1H, qu. 14
	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	**Higher Tier** SP1: 3H, qu. 19

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**	Order 30%, 0.35, $\frac{1}{3}$, 32% **Foundation Tier** SP1: 2F, qu. 3 SP2: 3F, qu. 2 **Higher Tier** SP2: 3H, qu. 19
	Students may need to change a fraction into a recurring decimal in the context of a problem.	
N11	identify and work with fractions in ratio problems	**Foundation Tier** SP2: 2F, qu. 5

N12	interpret fractions and percentages as operators	Interpret $\frac{2}{5}$ of 40 as $\frac{2}{5} \times 40$; interpret 20% of 40 as 0.2×40 **Foundation Tier** SP1: 1F, qu. 18 SP1: 2F, qu. 12 SP2: 3F, qu. 17

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	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). **Foundation Tier** SP1: 2F, qu. 5 SP1: 2F, qu. 21 SP1: 3F, qu. 13 SP2: 2F, qu. 6(b) SP2: 3F, qu. 6(a) **Higher Tier** SP1: 2H, qu. 13
N14	estimate answers; check calculations using approximation and estimation, including answers obtained using technology	**Foundation Tier** SP1: 1F, qu. 14 SP1: 3F, qu. 8

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	$x = 2.3$ correct to 2 sf implies that $2.25 \leq x < 2.35$ **Foundation Tier** SP1: 1F, qu. 3 SP1: 3F, qu. 1 SP1: 3F, qu. 22 SP2: 2F, qu. 1 SP2: 3F, qu. 25 **Higher Tier** SP1: 3H, qu. 2 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**	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? **Higher Tier** SP1: 2H, qu. 22 SP2: 2H, qu. 17

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

SP1: 2F, qu. 4(a, b)

A2 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.

Foundation Tier

SP1: 1F, qu. 21

SP1: 3F, qu. 10

SP2: 1F, qu. 10

SP2: 3F, qu. 14(a)

Higher Tier

SP1: 1H, qu. 2

A3 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.

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** SP1: 1F, qu. 27 SP1: 1F, qu. 28 SP1: 2F, qu. 4(a) SP1: 2F, qu. 16(c) SP1: 3F, qu. 7(c) SP1: 3F, qu. 25 SP1: 3F, qu. 26 SP2: 1F, qu. 19 SP2: 2F, qu. 24 SP2: 3F, qu. 24 **Higher Tier** SP1: 1H, qu. 15 SP1: 1H, qu. 20 SP1: 2H, qu. 13 SP1: 3H, qu. 6 SP1: 3H, qu. 14 SP2: 1H, qu. 1 SP2: 2H, qu. 3 SP2: 2H, qu. 18 SP2: 3H, qu. 15 SP2: 3H, qu. 20
	Will be limited to expanded products of **three** binomials (i.e. cubics).	SAMs 2H qu. 8(a)
A5	understand and use standard mathematical formulae; rearrange formulae to change the subject	**Foundation Tier** SP1: 2F, qu. 20 **Higher Tier** SP1: 1H, qu. 13 SP1: 2H, qu. 1 SP1: 3H, qu. 21 SP2: 3H, qu. 3
	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**.	
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**	**Higher Tier** SP1: 2H, qu. 18 SP2: 3H, qu. 17

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)**	**Higher Tier** SAMs: 1H, qu.12 SP1: 2H, qu. 18 SP2: 2H, qu. 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.	

Graphs

What students need to learn:

A8	work with coordinates in all four quadrants	**Foundation Tier** SP1: 2F, qu. 14(a) SP2: 1F, qu. 5(a, b)
	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** SP1: 3F, qu. 23 SP2: 1F, qu. 5(c) **Higher Tier** SP1: 1H, qu. 23 SP1: 3H, qu. 3 SP1: 3H, qu. 7
A10	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.	

A11	identify and interpret roots, intercepts, turning points of quadratic functions graphically; deduce roots algebraically **and turning points by completing the square**	**Higher Tier** SAMs: 1H, qu. 16 SP1: 3H, qu. 11 SP2: 3H, qu. 23
	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 if 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**	**Higher Tier** SAMs :1H, qu. 16 SP1: 3H, qu. 16 SP2: 2H, qu. 19
	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.	
A13	**sketch translations and reflections of a given function**	Given the graph of $y = f(x)$, sketch the graph of $y = f(x + 2)$
	Stretches are **not** on the new specification; transformations are limited to reflections and translations.	

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, qu. 24 SP1: 3F, qu. 7(a, b) SP2: 2F, qu. 10 SP2: 3F, qu. 11
	At Higher tier, to include $y = \frac{k}{x}$ 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.	
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** SAMs: 1H, qu. 13 SP1: 2H, qu. 20 SP2: 2H, qu. 15 SP2: 3H, qu. 18
	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.	
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** SP1: 2H, qu. 23

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** SP1: 2F, qu. 16(a, b) SP2: 1F, qu. 10(a) **Higher Tier** SP1: 1H, qu. 14 SP2: 3H, qu. 8(a)
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	**Higher Tier** SP1: 2H, qu. 19 SP2: 1H, qu. 17 SP2: 2H, qu. 8(b) SP2: 2H, qu. 21 SP2: 3H, qu. 22(b)
	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.	
A19	solve two simultaneous equations in two variables (linear/linear **or linear/quadratic**) algebraically; find approximate solutions using a graph	To include, **at Higher tier**, solve $x^2 + y^2 = 10$ and $x + y = 4$ **Foundation Tier** SP1: 1F, qu. 29 **Higher Tier** SP2: 1H, qu. 22 SP2: 3H, qu. 11

A20	**find approximate solutions to equations numerically using iteration**	**Higher Tier** SP1: 3H, qu. 21(b, c)
	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".	
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** SP1: 1F, qu. 20 SP1: 1F, qu. 23 SP1: 2F, qu. 26 SP1: 3F, qu. 10 SP2: 1F, qu. 18 SP2: 3F, qu. 14(b) SP2: 3F, qu. 21 SP2: 3F, qu. 30 **Higher Tier** SP1: 1H, qu. 1 SP1: 1H, qu. 4 SP1: 2H, qu. 7 SP1: 2H, qu. 19 SP2: 1H, qu. 9 SP2: 3H, qu. 22(a)

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**	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 **Foundation Tier** SP2: 3F, qu. 20 **Higher Tier** SP1: 1H, qu. 21 SP2: 3H, qu. 10
	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.	

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** SP1: 1F, qu. 13(a) SP1: 3F, qu. 13 SP2: 1F, qu. 24(a) SP2: 2F, qu. 11
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**	Let $a = 2$ and $r = \sqrt{2}$ so the sequence reads: $2,\ 2\sqrt{4},\ 4\sqrt{2},\ 8,\ 8\sqrt{2}, \ldots$ **Foundation Tier** SP1: 1F, qu. 13(b) SP2: 1F, qu. 24(b)
	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, …	

A25	deduce expressions to calculate the *n*th term of linear **and quadratic** sequences	**Foundation Tier** SP1: 1F, qu. 13(c) **Higher Tier** SP1: 2H, qu. 17 SP1: 3H, qu. 22
	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** SAMs: 2F, qu. 17 SP1: 1F, qu. 1 SP1: 1F, qu. 2 SP1: 1F, qu. 10 SP1: 2F, qu. 5 SP2: 2F, qu. 20 SP2: 3F, qu. 1 SP2: 3F, qu. 11
	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** SP1: 1F, qu. 15 SP1: 2F, qu. 12 SP2: 3F, qu. 8
R3	express one quantity as a fraction of another, where the fraction is less than 1 or greater than 1	**Foundation Tier** SP2: 3F, qu. 1(a)
R4	use ratio notation, including reduction to simplest form	**Foundation Tier** SP1: 1F, qu. 12 SP1: 2F, qu. 18(a) SP2: 2F, qu. 18 SP2: 3F, qu. 1(b) SP2: 3F, qu. 22

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** SAMs: 1F, qu. 13 SP1: 1F, qu. 18 SP1: 2F, qu. 9 SP1: 2F, qu. 28 SP2: 1F, qu. 6 SP2: 1F, qu. 12 **Higher Tier** SAMs: 1H, qu. 1 SP1: 1H, qu. 10 SP2: 2H, qu. 6 SP2: 3H, qu. 1
	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	
		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** SP1: 2F, qu. 15
R8	relate ratios to fractions and to linear functions	**Foundation Tier** SP1: 2F, qu. 18(b) **Higher Tier** SP2: 2H, qu. 21 SP2: 3H, qu. 10
		Purple paint is made from 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** SP1: 1F, qu. 4 SP1: 1F, qu. 18 SP1: 2F, qu. 7 SP1: 2F, qu. 9 SP1: 2F, qu. 11 SP1: 2F, qu. 27 SP2: 1F, qu. 2 SP2: 1F, qu. 13 SP2: 1F, qu. 17 SP2: 2F, qu. 8(b) SP2: 2F, qu. 13 SP2: 3F, qu. 50 SP2: 3F, qu. 17 **Higher Tier** SP1: 3H, qu. 5(b) SP2: 1H, qu. 7 SP2: 3H, qu. 9(a)
R10	solve problems involving direct and inverse proportion, including graphical and algebraic representations	**Foundation Tier** SP1: 1F, qu. 19 SP1: 1F, qu. 24 SP1: 2F, qu. 15 SP2: 1F, qu. 8 SP2: 2F, qu. 15 SP2: 3F, qu. 27(b) **Higher Tier** SP2: 2H, qu. 14 SP2: 3H, qu. 6(b)

R11	use compound units such as speed, rates of pay, unit pricing, density and pressure	**Foundation Tier** SP1: 1F, qu. 14(a) SP1: 1F, qu. 21 SP1: 2F, qu. 24 SP2: 2F, qu. 16 SP2: 3F, qu. 29 **Higher Tier** SAMs: 1H, qu. 12 SP2: 1H, qu. 2 SP2: 1H, qu. 12 SP2: 2H, qu. 5 SP2: 3H, qu. 8 SP2: 3H, qu. 12
R12	compare lengths, areas and volumes using ratio notation; make links to similarity (including trigonometric ratios) and scale factors	**Higher Tier** SP1: 3H, qu. 9 SP2: 1H, qu. 18
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, qu. 27(a) **Higher Tier** SP1: 2H, qu. 15 SP2: 3H, qu. 6(a)
	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.	
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, qu. 14 **Higher Tier** SP1: 1H, qu. 16 SP1: 2H, qu. 6 SP1: 2H, qu. 10

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** SAMs: 3H, qu. 14
	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**	For example, $P_{n+1} = kP_n$ **Higher Tier** SP1: 2H, qu. 6 SP1: 2H, qu. 21 SP1: 3H, qu. 8 SP1: 3H, qu. 15 SP2: 2H, qu. 10 SP2: 2H, qu. 13 SP2: 3H, qu. 9(b)
	General iterative processes: for example, population growth or decay.	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** SP1: 3F, qu. 14(a)
	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 (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** SAMs: 1F, qu. 16 **Higher Tier** SAMs: 1H, qu. 4
	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** SAMs: 1F, qu. 12 SP1: 1F, qu. 20 SP2: 1F, qu. 16 SP2: 2F, qu. 25 SP2: 2F, qu. 29 SP2: 3F, qu. 13 **Higher Tier** SAMs: 2H, qu. 9 SP2: 2H, qu. 4
	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** SP1: 2F, qu. 17 SP1: 3F, qu. 17 SP2: 3F, qu. 4 **Higher Tier** SP1: 3H, qu. 5(a)
G5	use the basic congruence criteria for triangles (SSS, SAS, ASA, RHS)	**Higher Tier** SP1: 1H, qu. 17 SP2: 1H, qu. 12
	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** SP2: 1F, qu. 22 **Higher Tier** SAMs: 2H, qu. 10 SP2: 1H, qu. 4
	At Higher tier, to include proving that two triangles are similar.	
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** SP1: 1F, qu. 17 SP2: 2F, qu. 22 **Higher Tier** SP2: 2H, qu. 1 SP2: 3H, qu. 13

G8	**describe the changes and invariance achieved by combinations of rotations, reflections and translations**	
		Describe the single transformation that would map A onto C given that shape A is mapped onto shape B by a refection 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) (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	
G10	**apply and prove the standard circle theorems concerning angles, radii, tangents and chords, and use them to prove related results**	**Higher Tier** SP1: 2H, qu. 24 SP2: 2H, qu. 20
G11	solve geometrical problems on coordinate axes	**Foundation Tier** SP1: 1F, qu. 14(b, c)
	2D coordinates only	
G12	identify properties of the faces, surfaces, edges and vertices of: cubes, cuboids, prisms, cylinders, pyramids, cones and spheres	**Foundation Tier** SP1: 3F, qu. 14(b, c) SP2: 1F, qu. 4
G13	construct and interpret plans and elevations of 3D shapes	**Foundation Tier** SP2: 3F, qu. 23 **Higher Tier** SP2: 3H, qu. 2

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, qu. 23 SP2: 2F, qu. 6(a) **Higher Tier** SP2: 1H, qu. 5
G15	measure line segments and angles in geometric figures, including interpreting maps and scale drawings and use of bearings	**Foundation Tier** SP1: 3F, qu. 6 SP2: 3F, qu. 18 **Higher Tier** SP1: 2H, qu. 9
G16	know and apply formulae to calculate: area of triangles, parallelograms, trapezia; volume of cuboids and other right prisms (including cylinders)	**Foundation Tier** SP1: 1F, qu. 16 SP1: 1F, qu. 24 SP2: 1F, qu. 20 **Higher Tier** SP1: 1H, qu. 5 SP2: 1H, qu. 2 SP2: 1H, qu. 9 SP2: 2H, qu. 7 SP2: 3H, qu. 7 SP2: 3H, qu. 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** SP1: 1F, qu. 23 SP1: 2F, qu. 27 SP2: 3F, qu. 16 SP2: 2F, qu. 28 SP2: 3F, qu. 30 **Higher Tier** SP1: 1H, qu. 4 SP1: 1H, qu. 18 SP1: 2H, qu. 8 SP1: 3H, qu. 17 SP2: 1H, qu. 7 SP2: 2H, qu. 11

To include the surface area of cuboids and cylinders.

G18	calculate arc lengths, angles and areas of sectors of circles	**Higher Tier** SP2: 3H, qu. 16
G19	apply the concepts of congruence and similarity, including the relationships between lengths, **areas and volumes** in similar figures	**Foundation Tier** SP2: 2F, qu. 9 **Higher Tier** SP1: 2H, qu. 14 SP1: 3H, qu. 20 SP2: 1H, qu. 18
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	**Foundation Tier** SP1: 1F, qu. 26(b) SP1: 2F, qu. 28 SP2: 1F, qu. 22 SP2: 3F, qu. 28 **Higher Tier** SP1: 1H, qu. 7(b) SP1: 3H, qu. 9 SP1: 3H, qu. 12 SP2: 1H, qu. 4 SP2: 2H, qu. 17
	To include the angle between a line and a plane.	
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 $60°$	**Foundation Tier** SP1: 1F, qu. 26(a) **Higher Tier** SP1: 1H, qu. 7(a)
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** SP2: 3H, qu. 22
G23	**know and apply Area $= \frac{1}{2}ab\sin C$ to calculate the area, sides or angles of any triangle**	**Higher Tier** SP2: 3H, qu. 23

Vectors

What students need to learn:

G24	describe translations as 2D vectors	**Foundation Tier** SP2: 2F, qu. 22 **Higher Tier** SP2: 2H, qu. 1
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**	**Higher Tier** SP1: 1H, qu. 22 SP2: 3H, qu. 20

5. Probability

What students need to learn:

P1	record, describe and analyse the frequency of outcomes of probability experiments using tables and frequency trees	
P2	apply ideas of randomness, fairness and equally likely events to calculate expected outcomes of multiple future experiments	**Foundation Tier** SP2: 1F, qu. 7
P3	relate relative expected frequencies to theoretical probability, using appropriate language and the 0–1 probability scale	**Foundation Tier** SP1: 1F, qu. 25(b) SP2: 3F, qu. 10(c) SP2: 3F, qu. 19(b)
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** SP1: 1F, qu. 22 SP2: 3F, qu. 19(a) **Higher Tier** SP1: 1H, qu. 3
P5	understand that empirical unbiased samples tend towards theoretical probability distributions, with increasing sample size	**Foundation Tier** SP1: 1F, qu. 25(a) SP2: 1F, qu. 22 **Higher Tier** SP1: 1H, qu. 6(a) SP2: 1H, qu. 3
P6	enumerate sets and combinations of sets systematically, using tables, grids, Venn diagrams and tree diagrams	**Foundation Tier** SP1: 3F, qu. 20 SP2: 2F, qu. 26 **Higher Tier** SP2: 2H, qu. 5

To include set notation: $\mathscr{E}$, $\cap$, $\cup$, $\in$, A'

Examiners will not be expecting students 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** SP1: 2F, qu. 13(b) SP2: 2F, qu. 19 **Higher Tier** SP2: 1H, qu. 6(b)
P8	calculate the probability of independent and dependent combined events, including using tree diagrams and other representations, and know the underlying assumptions	**Foundation Tier** SP1: 1F, qu. 25(c) **Higher Tier** SP1: 1H, qu. 6(c) SP1: 1H, qu. 21 SP1: 2H, qu. 11 SP2: 1H, qu. 16
P9	**calculate and interpret conditional probabilities through representation using expected frequencies with two-way tables, tree diagrams and Venn diagrams**	**Higher Tier** SP1: 3H, qu. 18 SP1: 3H, qu. 22(a)

6. Statistics

What students need to learn:

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

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.

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

SAMs: 3F, qu. 19

SP1: 1F, qu. 7

SP1: 1F, qu. 11

SP1: 2F, qu. 22

SP1: 2F, qu. 23(b)

SP2: 1F, qu. 14(a)

SP2: 2F, qu. 15

SP2: 3F, qu. 8(c)

SP2: 2F, qu. 23(a)

Higher Tier

SP1: 2H, qu. 3

SP1: 2H, qu. 4(b)

SP2: 2H, qu. 2(a)

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.

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** SP1: 2H, qu. 16 SP2: 1H, qu. 19 SP2: 2H, qu. 11 SP2: 3H, qu. 14
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** SP1: 2F, qu. 10 SP1: 2F, qu. 13(a) SP1: 2F, qu. 22 SP1: 2F, qu. 23(a) SP1: 3F, qu. 21(a) SP1: 3F, qu. 24 SP2: 2F, qu. 8(a) SP2: 3F, qu. 10(a, b) SP2: 3F, qu. 16 **Higher Tier** SP1: 1H, qu. 9 SP1: 2H, qu. 3 SP1: 2H, qu. 4(a) SP1: 3H, qu. 1(a) SP1: 3H, qu. 4 SP2: 1H, qu. 13
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	**Foundation Tier** SP1: 3F, qu. 21(b, c d) SP2: 2F, qu. 23(b) SP2: 3F, qu. 26 **Higher Tier** SP2: 3H, qu. 1(b, c, d) SP2: 2H, qu. 2(b) SP2: 3H, qu. 5

Geometrical statements in GCSE Maths papers

The notes overleaf refer to the new 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 statement 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 attached list gives some examples of responses to questions which 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 which are judged to be minimal in terms of a request to give reasons for mathematical deduction in geometry.

Rules 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.