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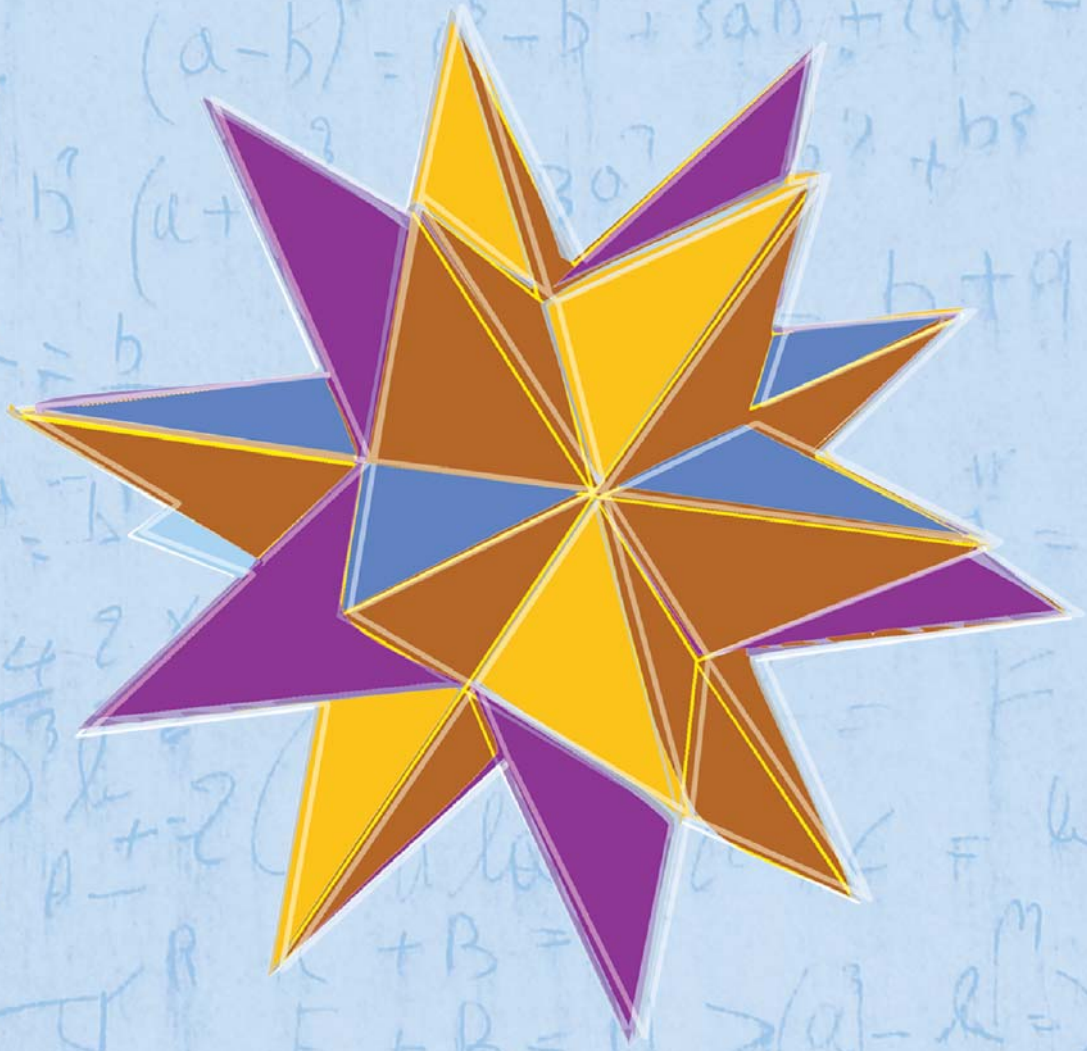


Content Exemplification

Edexcel GCSE in Mathematics A – Linear (1MA0)

A PEARSON COMPANY

Contents

Specification at a glance

The Edexcel GCSE in Mathematics A is a linear qualification:

Mathematics	*Paper code 1F/2F *Paper code 1H/2H
• Externally assessed • Availability: March, June and November • First assessment: June 2012	**100% of the total GCSE**
Overview of content **1.** Number **2.** Algebra **3.** Geometry **4.** Measures **5.** Statistics **6.** Probability	

Overview of assessment
• Two written papers: each contributes 50% of the final grade
• Tiered papers
  ○ Foundation Tier grades C-G available
  ○ Higher Tier grades A*-D available (E allowed)
• 1 hour 45 minutes (Foundation papers)
• 1 hour 45 minutes (Higher papers)
• 100 marks on each paper
• Paper 1F and 1H: Non-calculator
• Paper 2F and 2H: Calculator
• The functional elements of mathematics are assessed on each paper:
  ○ 30-40% of the Foundation Tier papers
  ○ 20-30% of the Higher Tier papers.	

Subject content

The content of the specification has been grouped into topic areas:

- Number
- Algebra
- Geometry
- Measures
- Statistics
- Probability.

The specification content consists of a reference (ref), a content descriptor and examples of concepts and skills.

Content that is Higher Tier only is indicated in **bold type**.

The content of Higher Tier subsumes the content of Foundation Tier.

Foundation

Overview

Content overview

This qualification contains:

1. Number

2. Algebra

3. Geometry

4. Measures

5. Statistics

6. Probability

Assessment overview

- Each paper contributes 50% of the qualification
- Two written papers
- Each paper lasts 1 hour 45 minutes in total
- Each paper contains 100 marks in total
- Paper 1 Non-calculator, Paper 2 Calculator
- Grades C-G available
- Available in March, June and November
- 30-40% of each paper assesses the Functional elements of mathematics

References

Each topic in this qualification contains a specification reference (for example, **SP a** for Statement a, Statistics and Probability), the content descriptor and examples of concepts and skills associated with that content descriptor.

1 Number

What students need to learn:

Ref	Content descriptor	Concepts and skills
N a	Add, subtract, multiply and divide any number	• Add, subtract, multiply and divide whole numbers, integers, negative numbers, decimals, fractions and numbers in index form *Examples:* ○ 851 ÷ 37, 777 ÷ 37, 27.6 × 23, 36.2 ÷ 0.2, −2 + −4 ○ 365 + 45 + 1026, 30 − 5.91, 2.56 ÷ 1.6 ○ non-calculator methods such as 365 × 54, 753 ÷ 36 ○ use foreign exchange rates ○ calculate shopping bills, energy bills (eg calculations using 0.35p/unit) ○ $\frac{2}{3}-\frac{1}{4}$, $2\frac{1}{3}+1\frac{3}{4}$, $3\frac{1}{3}\times 2\frac{2}{5}$, $\frac{5}{8}\div\frac{3}{4}$, $\frac{3}{4}\times 5$ ○ How many $\frac{3}{4}$ ounce portions in 8 ounces? ○ the four rules as applied to negative numbers, both abstract and in context ○ 5 + (− 7), 13 − (− 5), 3 × −5, −10 ÷ −5 ○ 3 × − 5, − 3 × − 5, 10 ÷ − 5, −10 ÷ − 5 ○ temperature changes • Recall all multiplication facts to 10 × 10, and use them to derive quickly the corresponding division facts *Example:* Know that 8 × 7 = 56, 56 ÷ 7 = 8 and 56 ÷ 8 = 7 • Multiply or divide any number by powers of 10 *Examples:* 356 × 100, 356 ÷ 100, 3 × 0.4, 0.7 ÷ 1000, 8.8 × 10 • Multiply or divide by any number between 0 and 1 *Examples:* 3.56 × 0.023, 3.56 ÷ 0.01

Ref	Content descriptor	Concepts and skills
N a	(*Continued*)	• Solve a problem involving division by a decimal (up to two decimal places) *Example:* Pens cost £0.45 each. How many pens can you buy for £18? • Write numbers in words • Write numbers from words *Examples:* ○ write 50 million in figures ○ write fifty-five thousand two hundred and six in figures ○ write 675 543 in words • Recall the fraction-to-decimal conversion of familiar fractions ***Functional Elements:*** • Stock control problems; using +−×÷ • Seats available on a bus; using +− • Invoices; using +× • Packing problems and dealing with remainders; using ÷ • Use appropriate procedures for addition, subtraction, multiplication and division of integers and decimals, understanding where to position the decimal point *Examples:* ○ using a price list in a café ○ calculate a simple bill and find change ○ breakdown a complex calculation into simpler steps; eg find the extra paid when a credit plan is used rather than paying cash ○ choose relevant information from a table or chart when some is redundant ○ select information from timetables, shopping lists, TV programmes, Holiday brochures and advertisements ○ use a multiplication method rather than a division method to work out the number of full bottles that can be filled from a large container

Ref	Content descriptor	Concepts and skills
N b	Order rational numbers	• Order integers, decimals and fractions *Examples:* ○ write $\frac{3}{8}$, $\frac{1}{4}$, $\frac{3}{10}$ in descending order ○ order fractions in a list including percentages and decimals ○ write two fractions with values between $\frac{1}{4}$ and $\frac{1}{2}$ ○ explain why $\frac{3}{4}$ is the same as $\frac{6}{8}$ ○ compare fractions using diagrams ○ read information from weather maps and carry out calculations with temperatures ○ select relevant information from weather maps and ignore redundant information • Understand and use positive numbers and negative integers, both as positions and translations on a number line *Examples:* ○ 3 – 5, –4 + 7, –3 – 7 ○ find the highest temperature from a list ○ place a series of positive and negative numbers in ascending or descending order ○ arrange in order, smallest first 5, 2, –6, 0, –3 ***Functional Elements:*** • Negative numbers with temperatures and heights below sea level

Ref	Content descriptor	Concepts and skills
N c	Use the concepts and vocabulary of factor (divisor), multiple, common factor, Highest Common Factor (HCF), Least Common Multiple (LCM), prime number and prime factor decomposition	• Recognise even and odd numbers • Identify factors, multiples and prime numbers *Example:* Pick multiples of 4, factors of 56, a prime number from a list of numbers • Find the prime factor decomposition of positive integers *Examples:* ○ write 18 as the product of its prime factors ○ write 252 as $2^2 \times 3^3 \times 7$ ○ express the answer either as the product of prime factors, or the product of powers of prime factors • Find the common factors and common multiples of two numbers *Example:* List all the common factors of 24 and 36 • Find the Lowest common multiple (LCM) and Highest common factor (HCF) of two numbers *Examples:* ○ find the HCF of 24 and 36 ○ find the LCM of 15 and 20

Ref	Content descriptor	Concepts and skills
N d	Use the terms square, positive and negative square root, cube and cube root	• Recall integer squares up to 15 × 15 and the corresponding square roots • Recall the cubes of 2, 3, 4, 5 and 10 • Find squares and cubes • Find square roots and cube roots *Examples:* ○ find a value for the square root of 100 ○ find the value of $\sqrt{64}$ ○ find the length of a square with an area of 81 cm^2 ○ explain why the cube of 2 is not 6 ○ know that both –3 and +3 are the square roots of 9
N e	Use index notation for squares, cubes and powers of 10	• Use index notation for squares and cubes *Examples:* ○ find the value of 2^3, 3^2, 7^0, 8^1 ○ find the value of 2^4, $2^3 + 3^2$ ○ which is larger 2^3 or 3^2? • Use index notation for powers of 10 *Example:* Write down the value of 10^6 • Find the value of calculations using indices *Examples:* ○ write 252 as $2^2 \times 3^2 \times 7$ ○ express an answer either as the product of prime factors, or the product of powers of prime numbers
N f	Use index laws for multiplication and division of integer powers	• Use index laws to simplify and calculate the value of numerical expressions involving multiplication and division of integer powers, and of powers of a power *Example:* $5^7 \div 5^3 = 5^2$, $3^3 \times 3^4 = 3^7$, $(4^2)^3 = 4^6$ (NB: Fractional, zero and negative powers are only assessed on Higher tier)

Ref	Content descriptor	Concepts and skills
N h	Understand equivalent fractions, simplifying a fraction by cancelling all common factors	• Find equivalent fractions • Write a fraction in its simplest form *Examples:* ○ write $\frac{16}{24}$ as a fraction in its simplest form ○ express $\frac{28}{35}$ in its simplest form • Convert between mixed numbers and improper fractions *Examples:* ○ write improper fractions as mixed numbers and vice versa ○ write $\frac{27}{10}$ as $2\frac{7}{10}$ • Compare fractions *Examples:* ○ compare shaded fractions of shapes, giving answers in simplified forms ○ find the fraction of fuel in a fuel tank if the fuel gauge shows a level between $\frac{1}{2}$ and $\frac{3}{4}$ ○ select appropriate operations, methods and strategies to solve number problems, including trial and improvement where a more efficient method of solution is not obvious
N i	Add and subtract fractions	• Add and subtract fractions *Examples:* ○ two rods have lengths of $1\frac{1}{2}$ inches and $2\frac{3}{4}$ inches. What is their total length when placed end to end? ○ $\frac{2}{3}-\frac{1}{4}$, $2\frac{1}{3}+1\frac{3}{4}$

Ref	Content descriptor	Concepts and skills
N j	Use decimal notation and recognise that each terminating decimal is a fraction	• Understand place value *Examples:* ○ write down the value of the number that the arrow points to on a scale ○ recognise that the 3 in 0.137 is 3 hundredths • Identify the value of digits in a decimal or whole number *Example:* Give the value of 6 in 3.476 • Write terminating decimals as fractions *Example:* 0.137 = $\frac{137}{1000}$ • Recall the fraction-to-decimal conversion of familiar simple fractions *Examples:* $\frac{1}{2}, \frac{1}{4}, \frac{1}{5}, \frac{1}{10}, \frac{1}{100}, \frac{1}{8}$ • Convert between fractions and decimals *Examples:* ○ write $\frac{3}{8}$ as a decimal ○ write 1.25 as a mixed number ○ write 0.35 as a fraction in its simplest form
N k	Recognise that recurring decimals are exact fractions, and that some exact fractions are recurring decimals	• Recognise that recurring decimals are exact fractions, and that some exact fractions are recurring decimals *Examples:* ○ $\frac{1}{7}$ = 0.142857142857… ○ $\frac{1}{3} = 0.\dot{3}$ ○ explain why $\frac{1}{3}$ is not 0.3 • Convert between recurring fractions and decimals

Ref	Content descriptor	Concepts and skills
N l	Understand that 'percentage' means 'number of parts per 100' and use this to compare proportions	• Order fractions, decimals and percentages • Convert between fractions, decimals and percentages *Examples:* ○ 20% means 20 parts per hundred or $\frac{20}{100}$ or $\frac{1}{5}$ ○ write in order of size 0.7, $\frac{3}{5}$, 50%, $\frac{2}{3}$ ***Functional Elements:*** • Comparison of payment options; using +×% fractions
N m	Use percentage	• Use percentages to solve problems *Examples:* ○ 15% of 60 means $\frac{15}{100} \times 60$ or 0.15 × 60 ○ calculate 26 as a percentage of 150 • Find a percentage of a quantity in order to increase or decrease • Use percentages in real-life situations – VAT – Value of profit or loss – Simple interest – Income tax calculations (NB: Repeated proportional change is only assessed at Higher tier) *Examples:* ○ find the extra paid when a Credit Plan with percentage interest is used rather than paying cash ○ find the sale price in a 20% sale ***Functional Elements:*** • Salary increase; using % • Comparison of interest between savings accounts and bonds; using %

Ref	Content descriptor	Concepts and skills
N o	Interpret fractions, decimals and percentages as operators	• Find a fraction of a quantity • Express a given number as a fraction of another *Examples:* ○ write 33 out of 55 as a fraction in its simplest form ○ write 40 cm as a fraction of 2 m • Find a percentage of a quantity *Example*: Calculate 26 as a percentage of 150 • Express a given number as a percentage of another number • Use decimals to find quantities • Understand the multiplicative nature of percentages as operators *Examples:* ○ 30% increase on £150 gives a total calculated as £(1.3×150) ○ 20% discount on £150 gives a total calculated as £(0.8×150) ○ analyse a problem and decide to use fractions, decimals or percentages as multipliers to solve it • Use a multiplier to increase or decrease by a percentage in any scenario where percentages are used *Example:* A multiplier of 1.05 corresponds to an increase of 5% ***Functional Elements:*** • Salary increase, using % • Comparison of interest between savings accounts and bonds, using %
N p	Use ratio notation, including reduction to its simplest form and its various links to fraction notation	• Use ratios *Examples:* ○ write a ratio in the form $1 : n$ or $n : 1$ ○ understand that the ratio $2 : 3$ is $\frac{2}{5} : \frac{3}{5}$ • Write ratios in their simplest form *Example:* Write $20 : 12$ as a ratio in its simplest form

Ref	Content descriptor	Concepts and skills
N q	Understand and use number operations and the relationships between them, including inverse operations and hierarchy of operations	• Multiply and divide numbers using the commutative, associative, and distributive laws and factorisation where possible, or place value adjustments *Example:* 56.7 ÷ 0.28, 14.3 × 4.6 • Use inverse operations *Example:* ○ Calculate 354 × 78 = 27612, then check by calculating 27612 ÷ 78 ○ When 354 × 78 = 27012, then 27012 ÷ 78 = 354 • Use brackets and the hierarchy of operations *Examples:* ○ insert brackets so that 20 – 3 × 2 = 34 ○ BIDMAS: work out 5 × (2 + 3) and 5 × 2 + 3 ○ find the value of $3(2 + 5^2)$ • Use one calculation to find the answer to another *Example:* Estimate $\sqrt{85}$ by using square numbers • Understand 'reciprocal' as multiplicative inverse, knowing that any non-zero number multiplied by its reciprocal is 1 (and that zero has no reciprocal, because division by zero is not defined) • Find reciprocals *Example:* Find the reciprocal of 0.2 • Understand and use unit fractions as multiplicative inverses *Examples:* ○ by thinking of multiplication by $\frac{1}{5}$ as division by 5, or multiplication by $\frac{6}{7}$ as multiplication by 6 followed by division by 7 (or vice versa) • Solve word problems

Ref	Content descriptor	Concepts and skills
N q	(*Continued*)	***Functional Elements:*** • Find the cost of 5 pens given the cost of 7 pens • Solve word problems about ratio and proportion, including using informal strategies and the unitary method of solution • Select trial and improvement methods where a standard procedure is inappropriate • Use a multiplication method to work out the number of full bottles rather than a division method to work out the number of full bottles that can be filled from a large container • Set out a solution to a multi-step problem in a logical progression • Solve reverse rate problems; given total fuel costs, find the number units used
N t	Divide a quantity in a given ratio	• Divide a quantity in a given ratio *Examples:* ○ share £15 in the ratio 3 : 2 ○ share 20 metres of ribbon in the ratio 11:6:3 • Solve a ratio problem in context *Example:* ○ Bill and Mary share a sum of money in the ratio 3:5. Bill receives £12, how much does Mary receive? ***Functional Elements:*** • Adapt a recipe for 6 people to serve 8 people

Ref	Content descriptor	Concepts and skills
N u	Approximate to specified or appropriate degrees of accuracy including a given power of ten, number of decimal places and significant figures	• Round numbers to a given power of 10 *Examples:* ○ write 54 327 to the nearest thousand ○ round the number 23 578 to the nearest ten • Round to the nearest integer and to any given number of significant figures *Examples:* ○ write 37 451 correct to two significant figures ○ write 0 000 726 9 correct to one significant figure • Round to a given number of decimal places *Examples:* ○ round an answer to a given number of decimal places ○ write the answer to a money problem to the nearest penny and/or pound (unprompted) • Estimate answers to calculations, including use of rounding *Examples:* ○ estimate $\frac{52.9\times3.1}{19.5-1.9}$, $\frac{68\times401}{198}$ ○ 348 × 23 approximates to 300 × 20 (ie one significant figure) ○ work out an estimate for the total cost of 113 ipods at £185 each ○ rounding to a given number of decimal places ○ write the answer to a money problem to the nearest penny and/or pound (unprompted) ○ round 1.537 to 2 decimal places ○ work to stated levels of accuracy ○ round practical measurements correct to 1 mm if appropriate ○ give answer to two decimal places, or to one significant figure, or rounded to the nearest integer

Ref	Content descriptor	Concepts and skills

N u	(*Continued*)	***Functional Elements:***
		• *Approximation* and *rounding* is appropriate in functional questions. Students should make clear what approximating they are doing and why
		• Deal with remainders in context
		  ○ how many coaches that hold 57 people are needed for 150 students on a day trip?
		  ○ how many bottles that hold 450 m/ can be completely filled from a can containing 5000 m/ of liquid?
		  ○ find the cost of one litre of fuel if 50 litres cost £45. Interpret the answer of 0.9 as £0.90 or 90p
		  ○ the number of articles bought must be an integer
		  ○ give an answer to two decimal places or one significant figure

Ref	Content descriptor	Concepts and skills
N v	Use calculators effectively and efficiently, including statistical functions	• Know how to enter complex calculations • Enter a range of calculations including those involving time and money • Understand and interpret the calculator display, knowing when the display has been rounded by the calculator, and know not to round during the intermediate steps of a calculation *Examples:* ○ recognise that when a calculator is used to work out £5 ÷ 2, the calculator display of 2.5 should be written as £2.50 ○ understand that premature rounding can cause problems when undertaking calculations with more than one step ○ $\frac{2}{3}$ = 0.67 is an example of premature rounding • Use a range of calculator functions including +, −, ×, ÷, x^2, $\sqrt{x}$, memory, x^y, $x^{1/y}$ and brackets ***Functional Elements:*** *Examples:* ○ how many coaches that hold 57 students are needed for 150 students on a day trip? ○ how many bottles that hold 450 m*l* can be completely filled from a can containing 5000 m*l* of liquid? ○ calculate an energy bill with some information in £s and the rate given in pence ○ find the greatest number of stamps bought for £10 (must be a whole number and rounding up is not appropriate)

2 Algebra

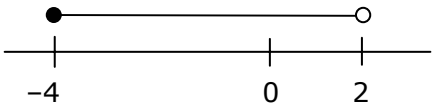
What students need to learn:

Ref	Content descriptor	Concepts and skills
A a	Distinguish the different roles played by letter symbols in algebra, using the correct notation	• Use notation and symbols correctly *Examples:* ○ know that letter symbols can be used to denote variables in expressions and formulae ○ understand that if you have x small boxes of 6 eggs and y large boxes of 12 eggs, then the total number of eggs is $6x + 12y$ ○ if n is an even number, what type of number is $n - 1$? ○ know that $2a$ is $a + a$ or $2 \times a$
A b	Distinguish in meaning between the words 'equation', 'formula' and 'expression'	• Write an expression *Examples:* ○ know that $5x$, $2a + b$ are expressions ○ know that $5x + 2 = 12$ is an equation ○ know that $V = Ir$ is a formula ○ a class has x boys and y girls. Write an expression, in terms of x and y, for the total number of students in the class ○ select an expression from a list of equations, formulae and expressions ○ use notation and symbols correctly ○ understand that if a rectangle has one side of length $a + 1$ and one side of length 4, the area of the rectangle is $4(a + 1) = 4a + 4$ • Select an expression/equation/formula from a list

Ref	Content descriptor	Concepts and skills
A c	Manipulate algebraic expressions by collecting like terms, by multiplying a single term over a bracket, and by taking out common factors	• Manipulate algebraic expressions by collecting like terms *Examples:* Simplify: $x + 5 - 2x - 1 + 4 - x$ $3a + 2c - a - 3c + 2$ $a \times b \times 2$ • Multiply a single algebraic term over a bracket *Example:* ○ $2x(x + 4) = 2x^2 + 8x$ ○ expand and simplify $3(2x - 1) - 2(2x - 3)$ ○ understand that the transformation of algebraic expressions obey the rules of generalised arithmetic eg $a(b + c) = ab + ac$ • Write expressions using squares and cubes • Use simple instances of index laws *Examples:* Simplify: $x^2 \times x^3 = x^5$ $x^6 \div x^4 = x^2$ $\frac{t^6}{t^2} = t^4$ $(x^3)^2 = x^6$ • Factorise algebraic expressions by taking out common factors *Examples:* Factorise: $x^2 + 3x = x(x + 3)$ $9x - 3 = 3(3x - 1)$ $6x^2 - 9x = 3x(2x - 3)$ $2ab^2 + 4ab = 2ab(b + 2)$ • Write expressions to solve problems *Example:* Find an expression for the total length of $(x + 3)$ and $(2x + 5)$ • Use algebraic manipulation to solve problems

Ref	Content descriptor	Concepts and skills
A d	Set up and solve simple equations	• Set up simple equations *Example:* Find the angle a in an triangle with angles a, $a + 10$, $a + 20$ • Rearrange simple equations • Solve simple equations *Examples:* $3x^2 = 48$, $3 = \frac{12}{x}$ • Solve linear equations, with integer coefficients, in which the unknown appears on either side or on both sides of the equation *Examples:* $11 - 4x = 2$, $4x + 7 = 3$, $3x = 2x + 1$, $2a + 4 = a + 7$ • Solve linear equations which include brackets, those that have negative signs occurring anywhere in the equation, and those with a negative solution *Examples:* $2(1 - x) = 6\ (2 + x)$, $2a - 4 = a - 7$ • Solve linear equations in one unknown, with integer or fractional coefficients *Examples:* $\frac{x}{4} + 1 = 5$, $4 + \frac{3x}{5} = x$

Ref	Content descriptor	Concepts and skills
A f	Derive a formula, substitute numbers into a formula and change the subject of a formula	• Derive a simple formula, including those with squares, cubes and roots *Example:* Write a formula for the cost C, in pounds, of buying m magazines at £3 each and b books at £7 each • Use formulae from mathematics and other subjects expressed initially in words and then using letters and symbols *Examples:* ○ formulae for the area of a triangle, the area enclosed by a circle ○ wage earned = hours worked × rate per hour ○ area of a triangle or a parallelogram volume of a prism • Substitute numbers into a formula *Examples:* ○ find the value of $2(x + 5)$ when $x = 7$ or $x = -9$ ○ if $C = \frac{x(y - 1)}{9}$, find the value of C when $x = 30$ and $y = -7$ ○ convert temperature between degrees Fahrenheit and degrees Celsius ○ find the value of P in the formula $P = 2(l + w)$ when $l = 8$ and $w = 5$ • Substitute positive and negative numbers into expressions such as $3x^2 + 4$ and $2x^3$ *Example:* Write a formula for T, the total number of eggs, when you have x small boxes of 6 eggs and y large boxes of 12 eggs • Change the subject of a formula (NB: Rearranging of formula using square roots or squares is Higher Tier only) *Examples:* ○ find the perimeter of a rectangle given its area A and the length l of one side ○ find r given that $C = 2\pi r$ ○ find x given that $y = mx + c$

Ref	Content descriptor	Concepts and skills
A f	(*Continued*)	***Functional Elements:*** • Use of the word 'formula' • Cost = standing charge + price per unit • Hire charge = fixed charge + mileage charge • Cooking time = 45 minutes + 40 × weight in kilograms
A g	Solve linear inequalities in one variable, and represent the solution set on a number line	• Solve simple linear inequalities in one variable, and represent the solution set on a number line *Examples:* ○ notation $-4 \leq x < 2$ represented on a number line  ○ when x is an integer, give all the solutions of $-2 \leqslant x < 4$ ○ show $b > 2$ on a number line ○ solve the inequality $2x + 3 > 7$ ○ write down an inequality shown on a number line • Use the correct notation to show inclusive and exclusive inequalities
A h	Use systematic trial and improvement to find approximate solutions of equations where there is no simple analytical method of solving them	• Use systematic trial and improvement to find approximate solutions of equations where there is no simple analytical method of solving them *Examples:* ○ solve $x^3 + x = 900$ and give answer to 1 decimal place ○ solve $\frac{1}{x} = x^2 - 5$ and give answer to 1 decimal place ○ solve $x^2 + x^3 = 14$ and give answer to 2 decimal places

Ref	Content descriptor	Concepts and skills
A i	Generate terms of a sequence using term-to-term and position-to-term definitions of the sequence	• Recognise sequences of odd and even numbers • Generate arithmetic sequences of numbers, squared integers and sequences derived from diagrams *Examples:* ○ find the next (or the 10^{th}) term in 1, 2, 4, 8,… ○ find the next (or the 6^{th}) term in 1, 3, 6, 10,… ○ find the next (or the 10^{th}) term in 1, 4, 5, 8,… ○ draw the next diagram in a sequence of diagrams • Write the term-to-term definition of a sequence in words *Example:* Explain how to generate the next term of the sequence 5, 12, 19, 26,… • Find a specific term in a sequence using position-to-term or term-to-term rules *Example:* A sequence has an n^{th} term, given by n^{th} term = $3n + 7$. What is the 20^{th} term? • Identify which terms cannot be in a sequence

Ref	Content descriptor	Concepts and skills
A j	Use linear expressions to describe the n^{th} term of an arithmetic sequence	• Find the n^{th} term of an arithmetic sequence *Examples:* ○ what is the n^{th} term of this arithmetic sequence 2, 7, 12, 17, 22? ○ interpret numerical and algebraic information based upon number patterns and sequences of diagrams ○ present and interpret solutions in the context of the original problem • Use the n^{th} term of an arithmetic sequence *Example:* Relate solutions back to the original number sequence or sequence of drawings
A k	Use the conventions for coordinates in the plane and plot points in all four quadrants, including using geometric information	• Use axes and coordinates to specify points in all four quadrants in 2-D • Identify points with given coordinates *Example:* Identify points given the following coordinates (3, 4), (0, 6), (−2, 4) • Identify coordinates of given points (NB: Points may be in the first quadrant or all four quadrants) • Find the coordinates of points identified by geometrical information in 2-D *Examples:* ○ find the coordinates of the fourth vertex of a parallelogram with vertices at (2, 1), (−7, 3) and (5, 6) ○ identify if enough information is available to solve a problem when using a coordinate grid • Find the coordinates of the midpoint of a line segment *Example:* If A is the point (1, 7) and B is the point (5, 3), find the midpoint of AB • Calculate the length of a line segment *Example:* Given the coordinates of points A and B calculate the length of AB

Ref	Content descriptor	Concepts and skills
A I	Recognise and plot equations that correspond to straight-line graphs in the coordinate plane, including finding gradients	• Draw, label and scale axes • Recognise that equations of the form $y = mx + c$ correspond to straight-line graphs in the coordinate plane • Plot and draw graphs of functions *Examples:* ○ $y = 4$, $x = 3$, $y = 2x + 3$, $x + y = 7$, $y = \frac{1}{2}x - 1$ • Plot and draw graphs of straight lines of the form $y = mx + c$ *Example:* Plot $x + y = 6$ with or without a table of values • Find the gradient of a straight line from a graph

Ref	Content descriptor	Concepts and skills
A r	Construct linear functions from real-life problems and plot their corresponding graphs	• Draw straight line graphs for real-life situations – ready reckoner graphs – conversion graphs – fuel bills – fixed charge (standing charge) and cost per unit • Draw distance-time graphs *Examples:* ○ construct straight line graphs for a range of contexts in everyday life ○ conversion graph between pounds (£) and euros (€) ○ a line graph to show *Numbers of minutes used* and *Cost* of a mobile phone bill ○ use a range of strategies to create algebraic or graphical representations of a problem and its solution ○ move from one form of representation to another to get different perspectives of the problem (NB: Quadratic functions from real life problems are at Higher Tier only)

Ref	Content descriptor	Concepts and skills
A s	Discuss, plot and interpret graphs (which may be non-linear) modelling real situations	• Plot a linear graph • Interpret straight-line graphs for real-life situations – ready reckoner graphs – conversion graphs – fuel bills – fixed charge (standing charge) and cost per unit • Interpret distance-time graphs *Examples:* ○ calculate speed from a distance-time graph ○ interpret the gradient of straight line segments on a distance – time graph (as speed) • Interpret information presented in a range of linear and non-linear graphs *Examples:* ○ graphs describing trends, conversion graphs, distance – time graphs, graphs of height or weight against age, graphs of quantities that vary against time, such as employment ○ distance – time graphs for a particle moving with constant speed, the depth of water in a container as it empties ○ graphs of water filling different shaped containers ***Functional Elements:*** • The information in the first bullet point should not be regarded as an exhaustive list of possibilities for functional graphs

Ref	Content descriptor	Concepts and skills
A t	Generate points and plot graphs of simple quadratic functions, and use these to find approximate solutions	• Generate points and plot graphs of simple quadratic functions, then more general quadratic functions *Examples:* ○ $y = 3x^2 + 4$ ○ $y = x^2 - 2x + 1$ • Find approximate solutions of a quadratic equation from the graph of the corresponding quadratic function *Example:* Draw the graph of $y = x^2 + 3x - 2$, and use the graph to find the solutions to $x^2 + 3x - 2 = 0$

3 Geometry

What students need to learn:

Ref	Content descriptor	Concepts and skills
GM a	Recall and use properties of angles at a point, angles on a straight line (including right angles), perpendicular lines, and opposite angles at a vertex	• Recall and use properties of: ○ angles at a point ○ angles at a point on a straight line, including right angles ○ perpendicular lines ○ vertically opposite angles *Examples:* ○ use the sum of three angles on a straight line to find a missing angle ○ use the sum of four angles at a point to find a missing angle ○ Use the sum of three angles on a straight line and/or the sum of four angles at a point, of which one may be 90°, to find a missing angle, giving reasons • Find the size of missing angles at a point or at a point on a straight line *Example:* Work out the angle between the hands of a clock when the time is 2 o'clock • Distinguish between acute, obtuse, reflex and right angles *Example:* In any given diagram, identify an acute, an obtuse and a right angle • Name angles • Estimate sizes of angles • Give reasons for calculations *Examples:* ○ 'sum of the angles on a straight line is 180°' ○ 'sum of the angles at a point is 360°' • Use geometric language appropriately • Use letters to identify points, lines and angles • Use two letter notation for a line and three letter notation for an angle

Ref	Content descriptor	Concepts and skills
GM a	(*Continued*)	• Mark perpendicular lines on a diagram • Identify a line perpendicular to a given line *Example:* Give a time when the hands of a clock are perpendicular to one another
GM b	Understand and use the angle properties of parallel and intersecting lines, triangles and quadrilaterals	• Understand and use the angle properties of parallel lines *Examples:* ○ recognise that two rails of a railway track are parallel ○ give reasons for angle calculations ○ 'alternate angles are equal' – Z angles are not accepted as a reason ○ 'corresponding angles are equal' – F angles are not accepted as a reason ○ explain why the angle sum of a quadrilateral is 360º, by using two triangles ○ understand a proof that the exterior angle of a triangle is equal to the sum of the interior angles at the other two vertices • Mark parallel lines on a diagram • Find missing angles using properties of corresponding and alternate angles • Understand and use the angle properties of quadrilaterals • Give reasons for angle calculations *Examples:* ○ 'sum of the angles in a triangle is 180°' ○ 'base angles of an isosceles triangle are equal'

Ref	Content descriptor	Concepts and skills
GM b	(*Continued*)	• Use the fact that angle sum of a quadrilateral is 360^{o} • Understand the proof that the angle sum of a triangle is 180° • Find a missing angle in a triangle, using the angle sum of a triangle is 180^{o} • Understand a proof that the exterior angle of a triangle is equal to the sum of the interior angles at the other two vertices • Distinguish between scalene, equilateral, isosceles and right-angled triangles • Understand and use the angle properties of triangles • Understand and use the angle properties of interesting lines • Use the side/angle properties of isosceles and equilateral triangles

Ref	Content descriptor	Concepts and skills
GM c	Calculate and use the sums of the interior and exterior angles of polygons	• Calculate and use the sums of the interior angles of polygons • Use geometrical language appropriately and recognise and name pentagons, hexagons, heptagons, octagons and decagons • Use the sum of angles in irregular polygons • Calculate and use the angles of regular polygons • Use the sum of the interior angles of an n-sided polygon *Example:* Find the size of each interior angle or the size of each exterior angle or the number of sides of a regular polygon given one of the three pieces of information • Use the sum of the exterior angles of any polygon is 360^{o} *Example:* Given the size of each exterior angle of a regular polygon, find the number of sides • Use the fact that the sum of the interior angle and exterior angle is 180^{o} • Understand tessellations of regular and irregular polygons *Example:* Tessellate at least 6 kites • Tessellate combinations of polygons *Example:* Tessellate tiles • Explain why some shapes tessellate and why other shapes do not ***Functional Elements:*** • Use tessellations in tiling problems and in wall paper patterns

Ref	Content descriptor	Concepts and skills
GM d	Recall the properties and definitions of special types of quadrilateral, including square, rectangle, parallelogram, trapezium, kite and rhombus	• Recall the properties and definitions of special types of quadrilaterals, including symmetry properties • List the properties of each, or identify (name) a given shape • Draw sketches of shapes • Name all quadrilaterals that have a specific property • Identify quadrilaterals from everyday usage • Classify quadrilaterals by their geometric properties *Example:* Name all the quadrilaterals that have a pair of opposite sides that are parallel or that have diagonals which intersect at right angles
GM e	Recognise reflection and rotation symmetry of 2-D shapes	• Recognise reflection symmetry of 2-D shapes • Identify and draw lines of symmetry on a shape • Recognise rotation symmetry of 2-D shapes • Identify the order of rotational symmetry of a 2-D shape • Draw or complete diagrams with a given number of lines of symmetry • State the line of symmetry as a simple algebraic equation *Example:* Use $x = 3$ as an axis of symmetry • Draw or complete diagrams with a given order of rotational symmetry *Examples:* ○ identify countries' flags, road signs, creatures (butterflies), wallpaper patterns or buildings having line and/or rotational symmetry ○ on a grid, shade additional squares in order that a pattern has line or rotational symmetry ***Functional Elements:*** • Use of symmetry in tiling problems

Ref	Content descriptor	Concepts and skills
GM f	Understand congruence and similarity	• Understand congruence • Identify shapes which are congruent • Understand similarity • Identify shapes which are similar, including all circles or all regular polygons with equal number of sides • Recognise that all corresponding angles in similar shapes are equal in size when the corresponding lengths of sides are not equal in size *Example:* Recognise similar shapes
GM g	Use Pythagoras' theorem in 2-D	• Understand, recall and use Pythagoras' theorem in 2-D *Examples:* ○ calculate the length of a side of a right-angled triangle given the lengths of the other two sides ○ calculate the diagonal of a rectangle given the length and width of the rectangle calculate the length of a playground slide, given the vertical and horizontal dimensions ○ calculate the length of a diagonal of a rectangular garage base given the length and width of the base ***Functional Elements:*** • Use Pythagoras' Theorem in problems relating to perimeter and length
GM i	Distinguish between centre, radius, chord, diameter, circumference, tangent, arc, sector and segment	• Recall the definition of a circle and identify (name) and draw parts of a circle • Understand related terms of a circle • Draw a circle given the radius or diameter *Example:* Match diagrams to the mathematical names of the parts of a circle

Ref	Content descriptor	Concepts and skills
GM k	Use 2-D representations of 3-D shapes	• Identify and name common solids: cube, cuboid, cylinder, prism, pyramid, sphere and cone • Know the terms face, edge and vertex *Example:* State the number of faces, edges and vertices of a cuboid and triangular prism • Use 2-D representations of 3-D shapes *Example:* Identify 3–D shapes from buildings, toys and other items in everyday use; cereal boxes, kitchen roll, dice and so on • Use isometric grids *Example:* Represent a cuboid of dimensions 2 cm by 3 cm by 4 cm on an isometric grid • Draw nets and show how they fold to make a 3-D solid *Examples:* ○ given a net of a solid, identify points which coincide in the 3-D configuration ○ work out the greatest number of nets of a cube of 2 cm that can be made from a square sheet of card measuring 12 cm by 12 cm • Understand and draw front and side elevations and plans of shapes made from simple solids • Given the front and side elevations and the plan of a solid, draw a sketch of the 3-D solid ***Functional Elements:*** • Design suitable nets for containers (not necessarily cuboids)

Ref	Content descriptor	Concepts and skills
GM I	Describe and transform 2-D shapes using single or combined rotations, reflections, translations, or enlargements by a positive scale factor and distinguish properties that are preserved under particular transformations	• Describe and transform 2-D shapes using single rotations • Understand that rotations are specified by a centre and an (anticlockwise) angle • Find the centre of rotation • Rotate a shape about the origin, or any other point *Example:* Give the angle of rotation as a fraction of a turn or in degrees • Describe and transform 2-D shapes using single reflections • Understand that reflections are specified by a mirror line *Example:* Reflect a triangle in the x-axis or the y-axis or $y = \pm x$ • Identify the equation of a line of symmetry • Describe and transform 2-D shapes using single translations • Understand that translations are specified by a distance and direction, (using a vector) • Translate a given shape by the vector $\begin{pmatrix} 2 \\ -3 \end{pmatrix}$ • Describe and transform 2-D shapes using enlargements by a positive scale factor • Understand that an enlargement is specified by a centre and a scale factor *Example:* Use photography to illustrate enlargements • Scale a shape on a grid (without a centre specified) • Draw an enlargement • Enlarge a given shape using (0, 0) as the centre of enlargement *Example:* Enlarge a given shape by scale factor 3, centre (0,0) • Enlarge shapes with a centre other than (0, 0) • Find the centre of enlargement

Ref	Content descriptor	Concepts and skills
GM I	(*Continued*)	• Describe and transform 2-D shapes using combined rotations, reflections, translations, or enlargements *Example:* Describe the single transformation that describes the result of a combination of the rotation of a triangle by 180^{o}, centre (0, 0), followed by a reflection in the x-axis • Distinguish properties that are preserved under particular transformations • Recognise that enlargements preserve angle but not length • Identify the scale factor of an enlargement of a shape as the ratio of the lengths of two corresponding sides • Understand that distances and angles are preserved under rotations, reflections and translations, so that any figure is congruent under any of these transformations • Describe a transformation ***Functional Elements:*** • Use enlargements and scale factors relating to map

Ref	Content descriptor	Concepts and skills
GM v	Use straight edge and a pair of compasses to carry out constructions	• Use straight edge and a pair of compasses to do standard constructions • Construct a triangle *Example:* Construct a triangle of sides 5 cm, 7 cm and 9 cm • Construct an equilateral triangle *Example:* Construct an equilateral triangle of side 6 cm • Understand, from the experience of constructing them, that triangles satisfying SSS, SAS, ASA and RHS are unique, but SSA triangles are not • Construct the perpendicular bisector of a given line • Construct the perpendicular from a point to a line • Construct the bisector of a given angle • Construct angles of 60^o, 90^o, 30^o, 45^o • Draw parallel lines • Draw circles and arcs to a given radius • Construct a regular hexagon inside a circle • Construct diagrams of everyday 2-D situations involving rectangles, triangles, perpendicular and parallel lines • Draw and construct diagrams from given instructions ***Functional Elements:*** • Use scale drawing with loci to solve problems

Ref	Content descriptor	Concepts and skills
GM w	Construct loci	• Construct: – a region bounded by a circle and an intersecting line – a given distance from a point and a given distance from a line – equal distances from two points or two line segments – regions which may be defined by 'nearer to' or 'greater than' • Find and describe regions satisfying a combination of loci *Examples:* ○ find and describe regions that satisfy a combination of loci ○ locate the region where treasure on a map may be found given that it is within 3 km of a point A and nearer to A than another point B (NB: All loci restricted to two dimensions only)

Ref	Content descriptor	Concepts and skills
GM x	Calculate perimeters and areas of shapes made from triangles and rectangles	• Measure shapes to find perimeters and areas • Find the perimeter of rectangles and triangles • Find the perimeter of compound shapes • Find the area of a rectangle and triangle • Recall and use the formulae for the area of a triangle, rectangle and a parallelogram • Calculate areas of compound shapes made from triangles and rectangles • Find the area of a trapezium • Find the area of a parallelogram • Find the surface area using rectangles and triangles • Find the surface area of a prism ***Functional Elements:*** • Cover areas of floors or walls (using tiles, carpets etc), work out the number of tiles needed to tile a wall • Work out ratios and costs involved when buying tiles singly or in packs • Plant seeds, fertilise fields (hectares could be used) • Perimeters and surface areas could be a feature of the problem to be solved

Ref	Content descriptor	Concepts and skills
GM z	Find circumferences and areas of circles	• Find circumferences of circles and areas enclosed by circles • Recall and use the formulae for the circumference of a circle and the area enclosed by a circle • Use $\pi \approx 3.142$ or use the π button on a calculator • Find the perimeters and areas of semicircles and quarter circles *Examples:* ○ find the circumference of a bicycle wheel, given the radius or diameter ○ find the area of a circular table, given the radius or diameter ○ find the perimeter of a semi-circular carpet, given the diameter ○ find the number of revolutions of a wheel of diameter 50 cm, travelling 100 metres • Find the surface area of a cylinder
GM aa	Calculate volumes of right prisms and shapes made from cubes and cuboids	• Find the volume of a prism, including a triangular prism, cube and cuboid • Calculate volumes of right prisms and shapes made from cubes and cuboids • Recall and use the formula for the volume of a cuboid • Find the volume of a cylinder ***Functional Elements:*** • Use volumes with formulae and compound units • Use volumes to solve problems

4 Measures

What students need to learn:

Ref	Content descriptor	Concepts and skills
GM m	Use and interpret maps and scale drawings	• Use and interpret maps and scale drawings • Read and construct scale drawings • Draw lines and shapes to scale • Estimate length using a scale diagram *Examples:* ○ interpret the dimensions of the floor space of a building given a scaled plan diagram ○ draw a scaled diagram of a tower in the shape of an isosceles triangle with given dimensions ○ distances between points on an Ordinance Survey map ○ work out the real distance that 6 cm represents if the scale of the diagram is 1:50 000
GM n	Understand the effect of enlargement for perimeter, area and volume of shapes and solids	• Understand the effect of enlargement for perimeter, area and volume of shapes and solids *Example:* The perimeter of a square of side 2 cm when the side length is enlarged by a scale factor of 3, is also enlarged by a scale factor of 3 • Understand that enlargement does not have the same effect on area and volume • Use simple examples of the relationship between enlargement and areas and volumes of simple shapes and solids *Examples:* ○ area of 2 cm square = 4 cm^2 ○ area of enlarged square of side 6 cm = 36 cm^2; not a scale factor of 3 ○ find the perimeter of a car park given a scaled drawing

Ref	Content descriptor	Concepts and skills
GM o	Interpret scales on a range of measuring instruments and recognise the inaccuracy of measurements	• Indicate given values on a scale • Interpret scales on a range of measuring instruments – seconds, minutes, hours, days, weeks, months and years – mm, cm, m, km, m*l*, c*l*, *l*, mg, g, kg, tonnes, °C • Use correct notation for time, 12- and 24-hour clock • Work out time intervals *Examples:* ○ work out the duration of journeys from a train/bus timetable ○ use a calendar to work out the number of days between two dates ○ identify which train, from a timetable, will be the latest in order to arrive at a destination at a given time • Know that measurements using real numbers depend upon the choice of unit • Recognise that measurements given to the nearest whole unit may be inaccurate by up to one half in either direction *Examples:* ○ the length of a book can normally be measured to the nearest mm ○ the distance of 10 km measured to the nearest km lies between 9.5 km and 10.5 km ○ what volume, when measured to the nearest cm^3 will lie between 23.5 cm^3 and 24.5 cm^3? ***Functional Elements:*** • Use information from scales and dials in order to solve a problem

Ref	Content descriptor	Concepts and skills
GM p	Convert measurements from one unit to another	• Convert between units of measure within one system • Convert metric units to metric units *Example:* Change 2.3 m to mm (Metric equivalents should be known) • Convert imperial units to imperial units (NB: Conversion between imperial units will be given) • Know rough metric equivalents of pounds, feet, miles, pints and gallons **Metric** **Imperial** 1 kg 2.2 pounds 1 *l* $1\frac{3}{4}$ pints 4.5 *l* 1 gallon 8 km 5 miles 30 cm 1 foot • Convert between metric and imperial measures • Estimate conversions *Examples:* ○ estimate the number of gallons of petrol in a tank containing 50 litres of petrol ○ convert the weight of a baby in pounds to an equivalent weight in kilograms ○ given that 1 foot = 12 inches, estimate the number of inches in 1 metre • Convert between area measures *Example:* $5\ m^2 = 5 \times 100^2\ cm^2 = 50\ 000\ cm^2$ • Convert between volume measures *Example:* $5 \times 100^3\ cm^3 = 5000\ 000\ cm^3$ • Convert between speed measures • Convert between metric measures of volume and capacity eg $1\ cm^3 = 1\ ml$ *Example:* 10 km/h = 2.7777 m/s

Ref	Content descriptor	Concepts and skills
GM p	(*Continued*)	***Functional Elements:*** • Use of imperial or metric measures according to which one is in common use • Convert between imperial and metric systems where appropriate
GM q	Make sensible estimates of a range of measures	• Make sensible estimates of a range of measures in everyday settings *Example:* Given the height of a woman, estimate the height of a tree (this could be illustrated by scaled sketches) • Choose appropriate units for estimating or carrying out measurement *Examples:* ○ choose a sensible metric unit to measure the amount of water in a fish tank ○ which metric/imperial unit would you use to measure the distance from Manchester to London?
GM r	Understand and use bearings	• Use three figure-bearings to specify direction • Mark on a diagram the position of point B given its bearing from the point A • Give a bearing between the points on a map or scaled plan • Given the bearing of point A from point B, work out the bearing of B from A *Examples:* ○ the bearing of Leicester from Derby is 145°. Work out the bearing of Derby from Leicester ○ using a map of Yorkshire, measure the bearing of York from Bradford ○ find the location of a ship, given its bearing from two lighthouses ***Functional Elements:*** • Use bearings in map and navigation problems (combine with GM u/v)

Ref	Content descriptor	Concepts and skills
GM s	Understand and use compound measures	• Understand and use compound measures including speed *Examples:* ○ how many miles has a car travelled at 40 mph for 3 hours? ○ how long does it take to travel between two cities, 200 km apart, travelling at an average speed of 60 km/h? ○ given a mileage chart, work out the time taken to travel from A to B when travelling at an average speed of 30 mph ○ calculate speed from a distance-time graph ***Functional Elements:*** • Link average speed with formulae and/or graphs (A f/A s)
GM t	Measure and draw lines and angles	• Measure and draw lines, to the nearest mm • Measure and draw angles, to the nearest degree
GM u	Draw triangles and other 2-D shapes using ruler and protractor	• Make accurate drawing of triangles and other 2-D shapes using a ruler and a protractor • Make an accurate scale drawing from a diagram *Example:* Make an accurate drawing of triangle ABC given that BC = 7.3 cm, AC = 8 cm and angle C = 38° • Use accurate drawing to solve bearings problems

5 Statistics

What students need to learn:

Ref	Content descriptor	Concepts and skills
SP a	Understand and use statistical problem solving process/handling data cycle	• Specify the problem and plan • Decide what data to collect and what statistical analysis is needed *Example:* Formulate a plan for a statistical investigation, including using a hypothesis • Collect data from a variety of suitable primary and secondary sources • Use suitable data collection techniques *Example:* Undertake mini projects, demonstrating the data handling cycle; eg height vs. weight, reaction times • Process and represent the data • Interpret and discuss the data *Example:* Provide a conclusion or evaluation in the context of the statistical project
SP b	Identify possible sources of bias	• Understand how sources of data may be biased *Examples:* ○ understand how different sample sizes may affect the reliability of conclusions drawn ○ discuss how data relate to a problem, identify possible sources of bias and plan to minimise it ○ understand the significance of he population from which the sample is taken when avoiding bias ○ in a survey on the usage of a Sports Centre, discuss the shortcomings of a sample selected from people attending the Centre on a Monday morning
SP c	Design an experiment or survey	• Identify which primary data they need to collect and in what format, including grouped data • Consider fairness • Understand sample and population • Design a question for a questionnaire • Criticise questions for a questionnaire

Ref	Content descriptor	Concepts and skills
SP d	Design data-collection sheets distinguishing between different types of data	• Design and use data-collection sheets for grouped, discrete and continuous data • Collect data using various methods • Sort, classify and tabulate data and discrete or continuous quantitative data • Group discrete and continuous data into class intervals of equal width
SP e	Extract data from printed tables and lists	• Extract data from lists and tables
SP f	Design and use two-way tables for discrete and grouped data	• Design and use two-way tables for discrete and grouped data • Use information provided to complete a two-way table
SP g	Produce charts and diagrams for various data types	• Produce: – Pictograms – Composite bar charts – Comparative and dual bar charts – Pie charts – Histograms with equal class intervals – Frequency diagrams for grouped discrete data – Line graphs – Scatter graphs – Frequency polygons for grouped data – Ordered stem and leaf diagrams
SP h	Calculate median, mean, range, mode and modal class	• Calculate: – mean – mode – median – range – modal class – interval containing the median

Ref	Content descriptor	Concepts and skills
SP h	*(Continued)*	• Estimate the mean of grouped data using the mid-interval value • Find the median for large data sets with grouped data • Estimate the mean for large data sets with grouped data • Understand that the expression 'estimate' will be used where appropriate, when finding the mean of grouped data using mid-interval values (NB: Quartiles and interquartile range are Higher Tier only)
SP i	Interpret a wide range of graphs and diagrams and draw conclusions	• Interpret: – composite bar charts – comparative and dual bar charts – pie charts – stem and leaf diagrams – scatter graphs – frequency polygons • Recognise simple patterns, characteristics and relationships in bar charts, line graphs and frequency polygons • From pictograms, bar charts, line graphs, frequency polygons, frequency diagrams and histograms with equal class intervals: – read off frequency values – calculate total population – find greatest and least values • From pie charts – find the total frequency – find the size of each category • Find the range, mode, median and greatest and least values from stem and leaf diagrams

Ref	Content descriptor	Concepts and skills
SP j	Look at data to find patterns and exceptions	• Present findings from databases, tables and charts • Look at data to find patterns and exceptions
SP k	Recognise correlation and draw and/or use lines of best fit by eye, understanding what these represent	• Draw lines of best fit by eye, understanding what these represent • Distinguish between positive, negative and zero correlation using lines of best fit • Use a line of best fit to predict values of one variable given values of the other variable • Interpret scatter graphs in terms of the relationship between two variables • Interpret correlation in terms of the problem • Understand that correlation does not imply causality
SP l	Compare distributions and make inferences	• Compare the mean and range of two distributions • Understand that the frequency represented by corresponding sectors in two pie charts is dependent upon the total populations represented by each of the pie charts • Use dual or comparative bar charts to compare distributions • Recognise the advantages and disadvantages between measures of average
SP u	Use calculators efficiently and effectively, including statistical functions	• Calculate the mean of a small data set, using the appropriate key on a scientific calculator

6 Probability

What students need to learn:

Ref	Content descriptor	Concepts and skills
SP m	Understand and use the vocabulary of probability and probability scale	• Distinguish between events which are; impossible, unlikely, even chance, likely, and certain to occur • Mark events and/or probabilities on a probability scale of 0 to 1 *Example:* ○ mark with a cross (X) the probability that one roll of a dice will give a number less than 5 ○ know that an event with probability of 0.68 is more likely to happen than an event with the probability of 0.65 • Write probabilities in words, fractions, decimals and percentages *Example:* $\frac{3}{4}$ (oe) or 0.75 or 75% (NB: Do not write probabilities using 3:4, 3 out of 4 or 3 in 4) *Examples:* State the likelihood that ○ the roll of a dice will show an odd number ○ it will snow in Scotland next year
SP n	Understand and use estimates or measures of probability from theoretical models (including equally likely outcomes), or from relative frequency	• Find the probability of an event happening using theoretical probability *Example:* Theoretical models of finding the probability of an event happening to include outcomes using dice, spinners, coins etc • Find the probability of an event happening using relative frequency *Examples:* ○ understand and use estimates or measures of probability from examples ○ estimate the number of times an event will occur, given the probability and the number of trials • Estimate the number of times an event will occur, given the probability and the number of trials • Use theoretical models to include outcomes using dice, spinners, coins

Ref	Content descriptor	Concepts and skills
SP o	List all outcomes for single events, and for two successive events, in a systematic way and derive relative probabilities	• List all outcomes for single events systematically *Examples:* ○ spinning two coins or throwing two dice ○ list all the outcomes of spinning a coin and throwing a dice H1, *H2*, H3, *H4*, H5, *H6*, T1, T2, T3, T4, T5, T6, and then finding the probability of spinning a head and throwing and even number on the dice • List all outcomes for two successive events systematically • Use and draw sample space diagrams
SP p	Identify different mutually exclusive outcomes and know that the sum of the probabilities of all these outcomes is 1	• Add simple probabilities *Example:* If the probability of picking a red counter is 0.2, and a blue counter 0.3, then the probability of picking a red or blue counter is 0.5 • Identify different mutually exclusive outcomes and know that the sum of the probabilities of all these outcomes is 1 • Use $1-p$ as the probability of an event not occurring where p is the probability of the event occurring • Find a missing probability from a list or table *Examples:* ○ find probabilities from a two-way table ○ find the probability (x) of Dave winning the race given that the probabilities of other athletes in the race winning are shown in the table Andy: 0.35 | Bill: 0.1 | Chaz: 0.25 | Dave: x

Ref	Content descriptor	Concepts and skills
SP s	Compare experimental data and theoretical probabilities	• Compare experimental data and theoretical probabilities *Examples:* ○ understand that rolling a dice 60 times should give about 10 occurrences each of 1, 2, 3, 4, 5 and 6 ○ explain whether or not a dice is fair if throwing it 600 times results in 200 sixes
SP t	Understand that if they repeat an experiment, they may – and usually will – get different outcomes, and that increasing sample size generally leads to better estimates of probability and population characteristics	• Compare relative frequencies from samples of different sizes *Examples:* ○ rolling a fair dice 6 times is not likely to result in one each of 1, 2, 3, 4, 5 and 6 ○ rolling a dice 60 times is likely to result in about 10 each of 1, 2, 3, 4, 5 and 6 ○ rolling a dice 600 times is more likely to result in about $\frac{1}{6}$th of 600 for each of 1, 2, 3, 4, 5 and 6

Higher

Overview

Content overview

This qualification contains:

1. Number

2. Algebra

3. Geometry

4. Measure

5. Statistics

6. Probability

Assessment overview

- Each paper contributes 50% of the qualification
- Two written papers
- Each paper lasts 1 hour 45 minutes
- Each paper contains 100 marks
- Paper 1 Non-calculator, Paper 2 Calculator
- Grades A*-D available (E allowed)
- Available March, June and November
- 20-30% of each paper assesses the Functional elements of Mathematics

References

Each topic in this qualification contains a specification reference (for example, **SP a** for Statement a, Statistics and Probability), the content descriptor and examples of concepts and skills associated with that content descriptor.

Content that is Higher Tier only is indicated in **Bold type**.

The content of Foundation Tier is subsumed in the content for Higher Tier.

1 Number

What students need to learn:

Ref	Content descriptor	Concepts and skills
N a	Add, subtract, multiply and divide any number	• Add, subtract, multiply and divide whole numbers, integers, fractions, decimals and numbers in index form *Examples:* ○ $\frac{2}{3}-\frac{1}{4}$, $2\frac{1}{2}+1\frac{3}{4}$, $3\frac{1}{3}\times 2\frac{2}{5}$, $1\frac{5}{8}\div\frac{3}{4}$, $\frac{3}{4}\times 36$ ○ use time calculations for journey lengths ○ work out energy bills from meter readings ○ work out car hire bills using relevant tariffs ○ work out mobile phone bills from given tariffs ○ use foreign exchange rates ○ find the 'best buy' when comparing a range of tariffs • Add, subtract, multiply and divide negative numbers *Example*: 3×-5, -3×-5, $10\div -5$, $-10\div -5$ • Multiply or divide by any number between 0 and 1 *Example:* 3.56×0.023, $3.56\div 0.01$ • Solve a problem involving division by a decimal (up to 2 decimal places) *Example:* Pens cost £0.45 each. How many pens can you buy for £18?

Ref	Content descriptor	Concepts and skills
N a	(*Continued*)	***Functional Elements:*** • Use appropriate procedures for addition, subtraction, multiplication and division of integers and decimals, understanding where to position the decimal point *Examples:* ○ break down a complex calculation by using simpler steps ○ find the extra paid when a Credit Plan is used rather than paying cash ○ use a multiplication rather than a division method to work out the number of full bottles that can be filled from a large container • Stock control problems • Packing problems and dealing with remainders; using ÷
N b	Order rational numbers	• Order integers, decimals and fractions *Examples:* ○ arrange in order, largest first ○ $\frac{1}{3}, \frac{3}{4}, \frac{1}{2}, \frac{1}{4}$ ○ find the fractions between $\frac{1}{4}$ and $\frac{1}{2}$ • Understand and use positive numbers and negative integers, both as positions and translations on a number line *Example:* 3 – 5, –4 + 7, –3 – 7

Ref	Content descriptor	Concepts and skills
N c	Use the concepts and vocabulary of factor (divisor), multiple, common factor, Highest Common Factor, Least Common Multiple, prime number and prime factor decomposition	• Identify factors, multiples and prime numbers *Example*: From a list of numbers select a multiple of 7, factors of 56, a prime number • Find the prime factor decomposition of positive integers *Example:* Write 48 as a product of its prime factors • Find the common factors and common multiples of two numbers *Example:* List all the common factors of 24 and 36 • Find the Highest Common Factor (HCF) and the Lowest Common Multiple (LCM) of two numbers *Examples:* ○ find the LCM and HCF of 24 and 60 ○ find the time lapse between synchronous flashes of two lighthouses with two different lengths of time between flashes
N d	Use the terms square, positive and negative square root, cube and cube root	• Recall integer squares from 2×2 to 15×15 and the corresponding square roots *Examples:* ○ select a square number or a cube number from a list ○ find the square root of 64 ○ work out the cube root of 64 ○ find the length of a square with a volume of 81 cm^3 ○ explain why the cube of 2 is not 6 • Recall the cubes of 2, 3, 4, 5 and 10

Ref	Content descriptor	Concepts and skills
N e	Use index notation for squares, cubes and powers of 10	• Use index notation for squares and cubes • Use index notation for integer powers of 10 • Find the value of calculations using indices
N f	Use index laws for multiplication and division of integer, **fractional and negative** powers	• Use index laws to simplify and calculate the value of numerical expressions involving multiplication and division of integer, **fractional and negative** powers, and powers of a power *Examples:* $5^7 \div 5^5 = 5^2$, $3^3 \times 3^4 = 3^7$, **$5^7 \div 5^{-5} = 5^{12}$, $3 \times 3^{-4} = 3^{-1}$** *Examples:* $64^{\frac{2}{3}}$, $\left(\frac{2}{3}\right)^{-2}$, $\left(5^2\right)^3$ • **Recall that $n^0 = 1$ and $n^{-1} = \frac{1}{n}$ for positive integers n as well as $n^{\frac{1}{2}} = \sqrt{n}$ and $n^{\frac{1}{3}} = \sqrt[3]{n}$ for any positive number n** ***Examples:*** ○ **write down the value of 10^6, 10^0, 9^{-1}, 5^{-2}, $25^{\frac{1}{2}}$, $64^{\frac{1}{3}}$, including $\left(\frac{1}{8}\right)^{\frac{1}{3}}$** ○ **find the number of square mm in a square cm** ○ **explain why there are 10^3 or 1000 mm^3 in 1 cm^3** ○ **which is larger, 2^3 or 3^2, $64^{\frac{1}{2}}$ or $64^{\frac{1}{3}}$?**

Ref	Content descriptor	Concepts and skills
N g	**Interpret, order and calculate with numbers written in standard index form**	• **Use standard form, expressed in conventional notation** ***Examples:*** ○ **35000 = 3.5 × 10^4, 0.00643 × 10^{-3}** • **Be able to write very large and very small numbers presented in a context in standard form** • **Convert between ordinary and standard form representations** • **Interpret a calculator display using standard form** • **Calculate with standard form** ***Examples:*** ○ **2.4 × 10^7 × 5 × 10^3** ○ **(2.4 × 10^7) ÷ (5 × 10^3)**
N h	Understand equivalent fractions, simplifying a fraction by cancelling all common factors	• Find equivalent fractions *Example:* Write two fractions that are equivalent to $\frac{2}{3}$ • Write a fraction in its simplest form *Examples:* ○ write $\frac{16}{24}$ as a fraction in its simplest form ○ write 33 out of 55 as a fraction in its simplest form • Convert between mixed numbers and improper fractions *Example:* ○ find the level of fuel in a fuel tank if the fuel gauge shows a level between $\frac{1}{2}$ and $\frac{3}{4}$
N i	Add and subtract fractions	• Add and subtract fractions *Examples*: $\frac{2}{3}-\frac{1}{4}$, $2\frac{1}{3}+1\frac{3}{4}$

Ref	Content descriptor	Concepts and skills
N j	Use decimal notation and recognise that each terminating decimal is a fraction	• Recall the fraction-to-decimal conversion of familiar simple fractions *Examples:* $\frac{1}{2}, \frac{1}{4}, \frac{1}{5}, \frac{1}{10}, \frac{1}{100}, \frac{1}{3}, \frac{2}{3}, \frac{1}{8}$ • Convert between fractions and decimals *Examples:* ○ write 0.35 as a fraction in its simplest form ○ write 1.25 as a mixed number
N k	Recognise that recurring decimals are exact fractions, and that some exact fractions are recurring decimals	• Recognise that recurring decimals are exact fractions, and that some exact fractions are recurring decimals *Examples:* ○ $\frac{1}{7}$ = 0.142857142857… ○ change $0.3\dot{7}$ into a fraction ○ know that $\frac{1}{3} = 0.\dot{3}$ and $0.3\dot{7}$ = 0.37777… ○ which of the following can be written as terminating fractions, $\frac{3}{4}, \frac{1}{6}, \frac{7}{10}, \frac{3}{15}$? ○ distinguish between fractions with denominators that have only prime factors of 2 and 5 (which are represented by terminating decimals), and other fractions (which are represented by recurring decimals) ○ explain why $\frac{1}{3}$ is not 0.3 • Convert between recurring decimals and fractions • **Understand a recurring decimal to fraction proof** ***Examples:*** ○ **change $0.3\ddot{7}$, $2.3\dot{4}$ to fractions** ○ **show 0.142857142857… = $\frac{1}{7}$**

Ref	Content descriptor	Concepts and skills
N 1	Understand that 'percentage' means 'number of parts per 100' and use this to compare proportions	• Convert between fractions, decimals and percentages *Examples:* ○ 20% means 20 parts per hundred or $\frac{20}{100}$ or $\frac{1}{5}$ ○ which is the greater fraction; 1.5 out of 8 or 2 out of 10? ***Functional Elements:*** • Comparison of payment options; using +×% fractions

Ref	Content descriptor	Concepts and skills
N m	Use percentage, **repeated proportional change**	• Use percentages to solve problems • Use percentages in real-life situations – VAT – Simple interest – Income tax calculations – **Compound interest** – **Depreciation** – Find prices after a percentage increase or decrease – **Percentage profit and loss** *Examples:* ○ find the total price after VAT is added ○ find the percentage profit or loss after a transaction ○ find total interest if £400 is invested at 3% for 2 years simple interest ○ annual rate of inflation • **Calculate an original amount when given the transformed amount after a percentage change** ***Examples:*** ○ **calculate the original price given the sale price** ○ **find the cost before VAT is added of a restaurant meal given the total cost is £36 with VAT at 17.5%** • **Calculate repeated proportional change** ***Examples:*** ○ **a bouncing ball reaching 70% of its previous height with each bounce** ○ **find the total amount if £200 is invested at 5% compound interest for 3 years** ○ **explore exponential growth and decay using a multiplier** ***Functional Elements:*** • **Use compound interest, depreciation and reverse percentages to compare interest return on different savings accounts or bonds**

Ref	Content descriptor	Concepts and skills
N n	**Understand and use direct and indirect proportion**	• **Calculate an unknown quantity from quantities that vary in direct or inverse proportion** ***Examples:*** ○ **y varies inversely as x, when $y = 4$ and $x = 0.5$, find the value of y when $x = 10$** ○ **find the mass of 30 cm of pipe given the mass of 20 cm of the same pipe** ○ **use the inverse square law to model the volume of sound received from a loudspeaker** ○ **find the cost of 5 pens given the cost of 7 pens** ○ **interpret a graph to help decide on a rule that connects two variables using direct and inverse proportion** ***Functional Elements:*** • **Solve direct proportion problems** • **Solve indirect proportion problems that involve either the square law or the inverse square law**

Ref	Content descriptor	Concepts and skills
N o	Interpret fractions, decimals and percentages as operators	• Find a fraction of a quantity • Express a given number as a fraction of another number *Examples:* ○ write 33 out of 55 as a fraction in its simplest form ○ write 40 cm as a fraction of 2 m • Find a percentage of a quantity *Example:* 15% of Y means $\frac{15}{100} \times Y$ or $0.15 \times Y$ • Use decimals to find quantities • Express a given number as a percentage of another number *Example:* ○ calculate 26 as a percentage of 150 • Understand the multiplicative nature of percentages as operators *Examples:* ○ a multiplier of 1.05 corresponds to an increase of 5% ○ 30% increase on £150 gives a total calculated as £(1.3 × 150) while 20% discount gives a total calculated as £(0.8 × 150) • **Represent repeated proportional change using a multiplier raised to a power** • **Use compound interest** ***Example:*** **Use £100 × $(1.05)^3$ to find the amount after £100 is invested for 3 years at 5% compound interest** • Use a multiplier to increase or decrease by a percentage in any scenario where percentages are used

Ref	Content descriptor	Concepts and skills
N p	Use ratio notation, including reduction to its simplest form and its various links to fraction notation	• Use ratios *Examples:* ○ write a ratio in the form $1 : n$ or $n : 1$ ○ understand that the ratio 2 : 3 is $\frac{2}{5} : \frac{3}{5}$ • Write ratios in their simplest form *Example:* Write 20 : 12 as a ratio in its simplest form

Ref	Content descriptor	Concepts and skills
N q	Understand and use number operations and the relationships between them, including inverse operations and hierarchy of operations	• Multiply and divide numbers, using the commutative, associative, and distributive laws and factorisation where possible, or place value adjustments • Use brackets and the hierarchy of operations • Use one calculation to find the answer to another • Understand 'reciprocal' as multiplicative inverse, knowing that any non-zero number multiplied by its reciprocal is 1 (and that zero has no reciprocal, because division by zero is not defined) • Find reciprocals *Example:* Find the reciprocal of 0.2 • Use inverse operations *Example:* Check that if 354 × 78 = 27 612, then 27 612 ÷ 78 = 354 • **Understand that the inverse operation of raising a positive number to a power *n* is raising the result of this operation to the power $\frac{1}{n}$** *Example:* If $x^3 = 8$ then $x = 8^{\frac{1}{3}}$ • Understand and use unit fractions as multiplicative inverses *Examples:* ○ understand that multiplication by $\frac{1}{5}$ is the same as division by 5, or multiplication by $\frac{6}{7}$ is the same as multiplication by 5 followed by division by 7 (or vice versa) • Solve word problems • **Use reverse percentage calculations** ***Example:* Given the sale price of a TV is £272 after a decrease of 15% then its normal price is 272 ÷ 0.85**

Ref	Content descriptor	Concepts and skills
N r	**Use surds and π in exact calculations**	• **Use surds and π in exact calculations, without a calculator** • **Give an answer to a question involving the area of a circle as 25π** • **Give an answer to use of Pythagoras' theorem as $\sqrt{13}$** • **Write $(3-\sqrt{3})^2$ in the form $a+b\sqrt{3}$** • **Rationalise a denominator** ***Examples:*** ○ **rationalise $\frac{1}{\sqrt{3}}$** ○ **simplify $(3-\sqrt{2})^2$** ○ **rationalise a denominator in a mathematical context**
N s	**Calculate upper and lower bounds**	• **Calculate the upper and lower bounds of calculations, particularly when working with measurements** • **Find the upper and lower bounds of calculations involving perimeter, areas and volumes of 2-D and 3-D shapes** • **Find the upper and lower bounds in real life situations using measurements given to appropriate degrees of accuracy** • **Give the final answer to an appropriate degree of accuracy following an analysis of the upper and lower bounds of a calculation**

Ref	Content descriptor	Concepts and skills
N t	Divide a quantity in a given ratio	• Divide a quantity in a given ratio *Examples:* ○ share £15 in the ratio 3:2 ○ share 20 metres of ribbon in the ratio 11:6:3 ***Functional Elements:*** • Solve a ratio problem in a context *Example:* Change a recipe for 6 people to one for 8 people • Use ratios in connection with areas and tiling problems
N u	Approximate to specified or appropriate degrees of accuracy including a given power of ten, number of decimal places and significant figures	• Round numbers to a given power of 10 • Round to the nearest integer and to any number of significant figures • Round to a given number of decimal places • Estimate answers to calculations, including use of rounding *Examples:* ○ estimate $\frac{52.9 \times 3.1}{19.5 - 1.9}$ ○ estimate $\frac{68 \times 401}{198}$ ***Functional Elements:*** • *Approximation* and *rounding* is appropriate in functional questions. Students should make clear what approximating they are doing and why. • Deal with remainders in context

Ref	Content descriptor	Concepts and skills
N v	Use calculators effectively and efficiently, including **trigonometrical** functions	• Enter a range of calculations, including those involving time and money *Examples:* ○ time calculations in which parts of an hour or minute are entered as fractions or a decimals ○ realise that 2 hours 36 minutes can be entered into a calculator as $2\frac{36}{60}$ or $2\frac{3}{5}$ or 2.6 hours ○ time calculations for journey times ○ car hire bills ○ mobile phone tariffs ○ given total fuel costs, find the number of units used ○ how many coaches that hold 57 are needed for 150 students on a day trip? • Know how to enter complex calculations • Use an extended range of calculator functions, including +, −, ×, ÷, x^2, $\sqrt{x}$, memory, xy, $\frac{1}{y}$, brackets and **trigonometric functions** • Understand, and interpret, the calculator display • Understand that premature rounding can cause problems when undertaking calculations with more than one step • **Calculate the upper and lower bounds of calculations, particularly when working with measurements** • **Use standard form display and know how to enter numbers in standard form** • **Calculate using standard form** • **Use calculators for reverse percentage calculations by doing an appropriate division** • **Use calculators to explore exponential growth and decay**

2 Algebra

What students need to learn:

Ref	Content descriptor	Concepts and skills
A a	Distinguish the different roles played by letter symbols in algebra, using the correct notation	• Use notation and symbols correctly *Example:* Understand that if you have x small boxes of 6 eggs and y large boxes of 12 eggs, then the total number of eggs is $6x + 12y$
A b	Distinguish in meaning between the words 'equation', 'formula', **'identity'** and 'expression'	• Write an expression • Select an expression/**identity**/equation/ formulae from a list

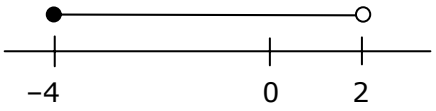
Ref	Content descriptor	Concepts and skills
A c	Manipulate algebraic expressions by collecting like terms, by multiplying a single term over a bracket, and by taking out common factors, **multiplying two linear expressions, factorise quadratic expressions including the difference of two squares and simplify rational expressions**	• Manipulate algebraic expressions by collecting like terms *Examples:* Expand and simplify ○ $2(x+4)-(1-x)$ ○ $5x(3x+4)-2x(5-4x)$ • Multiply a single term over a bracket • Use instances of index laws, including use of **fractional, zero and negative powers**, and powers raised to a power *Examples:* Simplify: ○ $x^2 \times x^3$ ○ $x^6 \div x^4$ ○ $\frac{t^6}{t^2} = t^4$ ○ $(x^2)^3 = x^6$ • Factorise algebraic expressions by taking out common factors • Write expressions to solve problems • Use algebraic manipulation to solve problems *Examples:* ○ apply algebraic manipulation techniques in an algebraic context ○ interpret algebraic information by factorising using index laws and substituting numbers into an algebraic expression • **Expand the product of two linear expressions** ***Examples:*** ○ $(x+2)(x-5) = x^2 - 3x - 10$ ○ $(3x+2)(2x-5) = 6x^2 - 11x - 10$ • **Factorise quadratic expressions**

Ref	Content descriptor	Concepts and skills
A c	(*Continued*)	***Examples:*** ○ $6x^2 + x - 2 = (3x + 2)(2x - 1)$ ○ **factorise by grouping like terms** $6(x + y)^2 - 4(x + y)$, $3a - 6b + ax - 2bx$ • **Factorise quadratic expressions using the difference of two squares** **Examples: Factorise:** ○ $x^2 - 9$ ○ $81p^2 - 16q^2$ • **Simplify rational expressions by cancelling, adding, subtracting, and multiplying** ***Examples:*** **Simplify completely:** ○ $\frac{1}{x} + \frac{3}{2 - x}$ ○ $\frac{2(x+1)^2}{(x+1)}$ ○ $\frac{2x^2 + 3x + 1}{x^2 + 2x + 1}$

Ref	Content descriptor	Concepts and skills
A d	Set up and solve simple equations **including simultaneous equations in two unknowns**	• Set up simple equations • Rearrange simple equations • Solve simple equations • Solve linear equations, with integer coefficients, in which the unknown appears on either side or on both sides of the equation *Examples:* Solve: ○ $11 - 4x = 2$ ○ $4x + 7 = 3$ ○ $2x + 3 = 5x - 6$ • Solve linear equations that include brackets, those that have negative signs occurring anywhere in the equation, and those with a negative solution *Examples:* $3(2x + 1) = 8,\ 2(1 - x) = 6(2 + x)$ • Solve linear equations in one unknown, with integer or fractional coefficients *Examples:* ○ $\frac{x}{4} + 1 = 5,\ \frac{2x - 3}{6} + \frac{x + 2}{3} = \frac{5}{2},$ ○ $\frac{17 - x}{4} = 2 - x$ • **Find the exact solutions of two simultaneous equations in two unknowns** • **Use elimination or substitution to solve simultaneous equations** ***Examples:* Solve for x and y** ○ $x + y = 8$ **and** $2x + y = 1$ ○ $x - y = 3$ **and** $3x - 2y = 8$ • **Interpret a pair of simultaneous equations as a pair of straight lines and their solution as the point of intersection** ***Example:* Draw graphs and solve for x and y** ○ $y = 3x - 4, y = 4 - x$

Ref	Content descriptor	Concepts and skills
Ad	(*Continued*)	• **Set up and solve a pair of simultaneous equations in two variables** ***Example:*** **Find the cost of a pen and a pencil given the following:** ○ **2 pens and 3 pencils cost 35p** ○ **3 pens and 2 pencils cost 40p** ***Functional Elements:*** • **Set up simultaneous equations to solve problems in context**

Ref	Content descriptor	Concepts and skills
A e	**Solve quadratic equations**	• **Solve simple quadratic equations by using the quadratic formula** ***Example:*** **Solve $3x^2 + 2x - 1 = 0$, giving your answer to 2 decimal places** • **Solve simple quadratic equations by factorisation and completing the square** ***Examples:*** ○ **solve $x^2 + 5x - 6 = 0$, $2x^2 - 7x + 3 = 0$** ○ **write $x^2 + 4x - 5 = 0$ in the form $(x + a)^2 + b = 0$. Hence solve the equation** ***Functional Elements:*** • **Solve problems using quadratic equations**
A f	Derive a formula, substitute numbers into a formula and change the subject of a formula	• Derive a formula • Use formulae from mathematics and other subjects • Substitute numbers into a formula *Example:* Write a formula for T, when you have x small boxes of 6 eggs and y large boxes of 12 eggs • Substitute positive and negative numbers into expressions such as $3x^2 + 4$ and $2x^3$ *Examples:* Substitute $a = -3.5$, substitute $b = \frac{4}{5}$ into $5b^2 - 4a$ • Change the subject of a formula **including cases where the subject is on both sides of the original formula, or where a power of the subject appears** ***Functional Elements:*** • Use formulae with compound measures (speed, density, miles per gallon etc)

Ref	Content descriptor	Concepts and skills
A g	Solve linear inequalities in one or **two** variables, and represent the solution set on a number line **or coordinate grid**	• Solve simple linear inequalities in one variable, and represent the solution set on a number line *Examples:* ○ notation $-4 \leq x < 2$ represented on a number line  ○ when x is an integer, give all the solutions of $-2 \leq x < 4$ ○ show $b > 2$ on a number line ○ solve the inequality $2x + 3 > 7$ ○ write down an inequality shown on a number line • Use the correct notation to show inclusive and exclusive inequalities • **Show the solution set of several inequalities in two variables on a graph** ***Examples:*** ○ **shade the region defined by $y > 3$, $y \leqslant 7 - x$, $x > 0$** ○ **mark with a cross, points with integer coordinates that are in the region defined by $x + y \leq 4$, $x \geq 0$ and $y \geq 0$**

Ref	Content descriptor	Concepts and skills
A h	Use systematic trial and improvement to find approximate solutions of equations where there is no simple analytical method of solving them	• Use systematic trial and improvement to find approximate solutions of equations where there is no simple analytical method of solving them *Example:* $x^3 + 2x = 4$ • Understand the connections between changes of sign and location of roots
A i	Generate terms of a sequence using term-to-term and position-to-term definitions of the sequence	• Recognise sequences of odd and even numbers • Generate simple sequences of numbers, squared integers and sequences derived from diagrams • Describe the term-to-term definition of a sequence in words • Find a specific term in a sequence using the position-to-term and term-to-term rules • Identify which terms cannot be in a sequence
A j	Use linear expressions to describe the n^{th} term of an arithmetic sequence	• Find the n^{th} term of an arithmetic sequence *Example:* What is the n^{th} term of the arithmetic sequence 2, 7, 12, 17, 22? • Use the n^{th} term of an arithmetic sequence *Example:* Relate solutions back to the original sequence
A k	Use the conventions for coordinates in the plane and plot points in all four quadrants, including using geometric information	• Use axes and coordinates to specify points in all four quadrants in 2-D **and 3-D** • Identify points with given coordinates • Identify coordinates of given points (NB: Points may be in the first quadrant or all four quadrants) • Find the coordinates of points identified by geometrical information in 2-D **and 3-D** • Find the coordinates of the midpoint of a line segment • Calculate the length of a line segment *Example:* Given the coordinates of the points A and B, in 2-D calculate the length of AB

Ref	Content descriptor	Concepts and skills
A l	Recognise and plot equations that correspond to straight-line graphs in the coordinate plane, including finding gradients	• Draw, label and scale axes • Recognise that equations of the form $y = mx + c$ correspond to straight-line graphs in the coordinate plane • Plot and draw graphs of functions *Examples:* ○ $y = 4$, $x = 3$ ○ $y = 2x + 3$, $x + y = 7$ ○ $y = \frac{1}{2}x + 1$ • Plot and draw graphs of straight lines with equations of the form $y = mx + c$ *Examples:* ○ plot $x + y = 6$ with, or without a table of values ○ recognise that, in a mathematical context, an equation of the form $y = mx + c$ is a straight line • Find the gradient of a straight line from a graph ***Examples:*** ○ **write down the gradient of the graph $y = 3x + 2$** ○ **find the gradient of a straight line drawn on a coordinate grid** ○ **find the gradient of the line joining (–2, –3) and (3, 5)** • **Find the gradient of lines given by equations of the form $y = mx + c$** • **Analyse problems and use gradients to interpret how one variable changes in relation to another**
A m	**Understand that the form $y = mx + c$ represents a straight line and that m is the gradient of the line and c is the value of the y- intercept**	• **Interpret and analyse a straight line graph** • **Understand that the form $y = mx + c$ represents a straight line and that m is the gradient of the line and c is the value of the y- intercept** ***Example:*** **Match equations with simple sketch graphs** • **Find the gradient of a straight line from its equation**

Ref	Content descriptor	Concepts and skills
A n	**Understand the gradients of parallel lines**	• **Explore the gradients of parallel lines and lines perpendicular to each other** • **Write down the equation of a line parallel or perpendicular to a given line** ***Example:*** **Find an equation of the line perpendicular to $y = 4x - 7$ which passes through (8, 6)** • **Select and use the fact that when $y = mx + c$ is the equation of a straight line then the gradient of a line parallel to it will have a gradient of m and a line perpendicular to this line will have a gradient of $-\frac{1}{m}$** • **Interpret and analyse a straight line graph and generate equations of lines parallel and perpendicular to the given line**

Ref	Content descriptor	Concepts and skills
A o	**Find the intersection points of the graphs of a linear and quadratic function, knowing that these are the approximate solutions of the corresponding simultaneous equations representing the linear and quadratic functions**	• **Solve exactly, by elimination of an unknown, two simultaneous equations in two unknowns, one of which is linear in each unknown, and the other is linear in one unknown and quadratic in the other, or where the second equation is of the form $x^2 + y^2 = r^2$** ***Example:*** **Solve the following for x and y** ○ $y = 11x - 2$ ○ $y = 5x^2$ • **Find approximate solutions to simultaneous equations formed from one linear function and one quadratic function using a graphical approach** ***Examples:*** ○ **draw the graphs of $y = 2x + 3$ and $x^2 + y^2 = 15$** ○ **find an approximate solution to the pair of simultaneous equations $y = 2x + 3$ and $x^2 + y^2 = 15$, giving your answer to one decimal place** • **Select and apply algebraic and graphical techniques to solve simultaneous equations where one is linear and one quadratic** ***Example:*** **Solve the simultaneous equations $4x - 3y = 24$ and $x^2 + y^2 = 25$**

Ref	Content descriptor	Concepts and skills
A p	**Draw, sketch, recognise graphs of simple cubic functions, the reciprocal function $y = \frac{1}{x}$ with $x \neq 0$, the function $y = k^x$ for integer values of x and simple positive values of k, the trigonometric functions $y = \sin x$ and $y = \cos x$**	• **Plot graphs of simple cubic functions, the reciprocal function $y = \frac{1}{x}$ with $x \neq 0$, the exponential function $y = k^x$ for integer values of x and simple positive values of k, the circular functions $y = \sin x$ and $y = \cos x$, within the range -360° to +360°** ***Examples:*** **Plot the graphs of the following;** ○ $y = x^3 + 2x^2$ ○ $y = 2\sin(3x + 90°)$ ○ $y = (\frac{1}{2})^2$ • **Recognise the characteristic shapes of all these functions** • **Draw and plot a range of mathematical functions** • **Interpret and analyse a range of mathematical functions and be able to draw them, recognising that they were of the correct shape**
A q	**Construct the graphs of simple loci**	• **Construct the graphs of simple loci including the circle $x^2 + y^2 = r^2$ for a circle of radius r centred at the origin of the coordinate plane** ***Example:*** **Draw the graph of $x^2 + y^2 = 9$** • **Find graphically the intersection points of a given straight line with this circle** • **Select and apply construction techniques and understanding of loci to draw graphs based on circles and perpendiculars of lines**

Ref	Content descriptor	Concepts and skills
A r	Construct linear, **quadratic and other** functions from real-life problems and plot their corresponding graphs	• Draw straight line graphs for real-life situations – ready reckoner graphs – conversion graphs – fuel bills – fixed charge (standing charge) and cost per unit • Draw distance time graphs • **Generate points and plot graphs of simple quadratic functions, then more general quadratic functions** ***Examples:*** **Plot the graphs of $y = x^2$, $y = 3x^2 + 4$, $y = x^2 - 2x + 1$** • **Find approximate solutions of a quadratic equation from the graph of the corresponding quadratic function** ***Example:*** **Draw the graph of $y = 2x^2 - 3$ and find the values of x when $2x^2 - 3 = 0$** • **Find the intersection points of the graphs of a linear and quadratic function, knowing that these are the approximate solutions of the corresponding simultaneous equations representing the linear and quadratic functions** ***Example:*** **Use $y = 2x^2 - 3$ and $y = 3 - x$ to solve the quadratic equation $2x^2 + x - 6 = 0$**

Ref	Content descriptor	Concepts and skills
A s	Discuss, plot and interpret graphs (which may be non-linear) modelling real situations	• Plot a linear graph • Interpret straight line graphs for real-life situations – ready reckoner graphs – conversion graphs – fuel bills – fixed charge (standing charge) and cost per unit • Interpret distance-time graphs • Interpret information presented in a range of linear and non-linear graphs *Examples:* ○ graphs from science, cooling curves, growth and decay of bacteria ○ graphs describing trends, conversion graphs, distance-time graphs, graphs of height or weight against age, graphs of quantities that vary against time, such as employment ○ distance-time graph for a particle moving with constant speed, the depth of water in a container as it empties ○ interpret the gradient of straight line segments on a speed-time graph as acceleration ○ graphs of water filling different shaped containers ○ **apply the correct mathematical methods in a range of linear and non-linear graphs representing real-life situations** ○ **interpret and analyse graphs that model real life situation** ***Functional Elements:*** • The information in the first bullet point should not be regarded as an exhaustive list of possibilities for functional graphs

Ref	Content descriptor	Concepts and skills
A t	Generate points and plot graphs of simple quadratic functions, and use these to find approximate solutions	• Generate points and plot graphs of simple quadratic functions, then more general quadratic functions *Examples*: Plot the graphs of $y = 3x^2 + 4$, $y = x^2 + 1$ • Find approximate solutions of a quadratic equation from the graph of the corresponding quadratic function *Example:* Draw the graph of $y = x^2 + 3x - 2$ and use the graph to find the solutions to $x^2 + 3x - 2 = 0$ • **Select and use the correct mathematical techniques to draw quadratic graphs**
A u	**Direct and indirect proportion**	• **Set up and use equations to solve word and other problems involving direct proportion or inverse proportion and relate algebraic solutions to graphical representation of the equations** ***Examples:*** ○ $y \propto x$, $y \propto x^2$, $y \propto \frac{1}{x}$, $y \propto \frac{1}{x^2}$ ○ **the stopping distances of a car varies directly as the speed of the car increases** ○ **the loudness of a loudspeaker varies inversely as the distance from the loudspeaker** ***Functional Elements:*** • **Solve direct and indirect proportion problems** • **Solve proportion problems that involve either the square law or the inverse square law**

Ref	Content descriptor	Concepts and skills
A v	**Transformation of functions**	• **Apply to the graph of $y = f(x)$ the transformations $y = f(x) + a$, $y = f(ax)$, $y = f(x + a)$, $y = af(x)$ for linear, quadratic, sine and cosine functions $f(x)$** • **Select and apply the transformations of reflection, rotation, enlargement and translation of functions expressed algebraically** • **Interpret and analyse transformations of functions and write the functions algebraically**

3 Geometry

What students need to learn:

Ref	Content descriptor	Concepts and skills
GM a	Recall and use properties of angles at a point, angles on a straight line (including right angles), perpendicular lines, and opposite angles at a vertex	• Recall and use properties of angles – angles at a point – angles at a point on a straight line, including right angles – perpendicular lines – vertically opposite angles
GM b	Understand and use the angle properties of parallel lines, triangles and quadrilaterals	• Distinguish between scalene, isosceles, equilateral, and right-angled triangles • Understand and use the angle properties of triangles • Use the angle sum of a triangle is 180º • Understand and use the angle properties of intersecting lines • Understand and use the angle properties of parallel lines • Mark parallel lines on a diagram • Use the properties of corresponding and alternate angles • Understand and use the angle properties of quadrilaterals • Give reasons for angle calculations • Explain why the angle sum of a quadrilateral is 360º *Examples*: Investigate angles in a quadrilateral by using two triangles • Understand the proof that the angle sum of a triangle is 180º • Understand a proof that the exterior angle of a triangle is equal to the sum of the interior angles at the other two vertices • Use the side/angle properties of isosceles and equilateral triangles • **Recall and use these properties of angles in more complex problems**

Ref	Content descriptor	Concepts and skills
GM c	Calculate and use the sums of the interior and exterior angles of polygons	• Calculate and use the sums of the interior angles of polygons • Use geometric language appropriately and recognise and name pentagons, hexagons, heptagons, octagons and decagons • Use the angle sums of irregular polygons • Calculate and use the angles of regular polygons • Use the sum of the interior angles of an n-sided polygon • Use the sum of the exterior angles of any polygon is 360° • Use the sum of the interior angle and the exterior angle is 180° • Find the size of each interior angle or the size of each exterior angle or the number of sides of a regular polygon • Understand tessellations of regular and irregular polygons *Example:* Tessellate at least six kites • Tessellate combinations of polygons *Example:* Tessellate tiles • Explain why some shapes tessellate when other shapes do not ***Functional Elements:*** • Use tessellations together with area and tiling problems • Relate tessellations to real life situations
GM d	Recall the properties and definitions of special types of quadrilateral, including square, rectangle, parallelogram, trapezium, kite and rhombus	• Recall the properties and definitions of special types of quadrilateral, including symmetry properties • List the properties of each, or identify (name) a given shape • Classify quadrilaterals by their geometric properties

Ref	Content descriptor	Concepts and skills
GM e	Recognise reflection and rotation symmetry of 2-D shapes	• Recognise reflection symmetry of 2-D shapes • Identify and draw lines of symmetry on a shape • Recognise rotation symmetry of 2-D shapes • Identify the order of rotational symmetry of a 2-D shape • Draw or complete diagrams with a given number of lines of symmetry • State the line of symmetry as a simple algebraic equation *Example:* Use $x = 3$ as an axis of symmetry • Draw or complete diagrams with a given order of rotational symmetry *Examples:* ○ identify countries' flags, road signs, creatures (butterflies), wallpaper patterns or buildings having line and/or rotational symmetry ○ on a grid, shade additional squares in order that a pattern has line or rotational symmetry ***Functional Elements:*** • Use of symmetry in tiling problems
GM f	Understand congruence and similarity	• Recognise that all corresponding angles in similar figures are equal in size when the lengths of sides are not • **Understand and use SSS, SAS, ASA and RHS conditions to prove the congruence of triangles using formal arguments, and to verify standard ruler and a pair of compasses constructions** • **Understand similarity of triangles and of other plane figures, and use this to make geometric inferences** ***Example:*** **Use the scale factors to find the length of a missing side in each of two similar triangles, given the lengths of a pair of corresponding sides** • **Formal geometric proof of similarity of two given triangles**

Ref	Content descriptor	Concepts and skills
GM g	Use Pythagoras' theorem in 2-D **and 3-D**	• Understand, recall and use Pythagoras' theorem in 2-D, **then in 3-D problems** • **Understand the language of planes, and recognise the diagonals of a cuboid** • **Calculate the length of a diagonal of a cuboid** *Examples:* ○ calculate the length of a diagonal of a rectangle given the length and width of the rectangle ○ calculate the height of an isosceles triangle given the lengths of all three sides • **Understand the language of planes, and recognise the diagonals of a cuboid** • **Calculate the length of the diagonal of a cuboid** ***Functional Elements:*** • Solve problems involving Pythagoras' Theorem

Ref	Content descriptor	Concepts and skills
GM h	**Use the trigonometric ratios and the sine and cosine rules to solve 2-D and 3-D problems**	• **Use the trigonometric ratios to solve 2-D and 3-D problems** • **Understand, recall and use trigonometric relationships in right-angled triangles, and use these to solve problems in 2-D and in 3-D configurations** ***Examples:*** ○ **calculate the length of a side or the size of an angle of a right angled triangle given the lengths of one side and an angle or lengths of two sides** ○ **calculate the slope of a staircase given the rise and depth of each stair** • **Find the angle between a line and a plane (but not the angle between two planes or between two skew lines)** • **Find angles of elevation and angles of depression** ***Example:*** **Calculate the height of a tower given the angle of elevation of the top of the tower and the horizontal distance from the foot of the tower** • **Use the sine and cosine rules to solve 2-D and 3-D problems** ***Examples:*** ○ **find the three angles of a scalene triangle given the length of each side** ○ **find the lengths of a side of a scalene triangle given the lengths of two sides and the size of the included angle, or the size of two angles and the length of one side (noting the ambiguous case)** ○ **find the bearing and distance from the original location having travelled 1.3 km on a bearing of 054º and then 2.5 km on a bearing of 125º**

Ref	Content descriptor	Concepts and skills
Gm h	(*Continued*)	***Functional Elements:*** • **Use trigonometry in navigation problems** • **Calculate heights and distances using angles of elevation and depression** • **Use loci and bearings to solve problems**
GM i	Distinguish between centre, radius, chord, diameter, circumference, tangent, arc, sector and segment	• Recall the definition of a circle and identify (name) and draw the parts of a circle • Understand related terms of a circle *Examples:* o semi-circle and quarter circle o match diagrams to the mathematical names of the parts of the circle • Draw a circle given the radius or diameter
GM j	**Understand and construct geometrical proofs using circle theorems**	• **Understand and use the fact that the tangent at any point on a circle is perpendicular to the radius at that point** • **Understand and use the fact that tangents from an external point are equal in length** • **Find missing angles on diagrams** • **Give reasons for angle calculations involving the use of tangent theorems** • **Prove and use the facts that:** – **the angle subtended by an arc at the centre of a circle is twice the angle subtended at any point on the circumference** – **the angle in a semicircle is a right angle** – **angles in the same segment are equal** – **opposite angles of a cyclic quadrilateral sum to 180°** – **alternate segment theorem** – **the perpendicular from the centre of a circle to a chord bisect the chord**

Ref	Content descriptor	Concepts and skills
GM k	Use 2-D representations of 3-D shapes	• Use 2-D representations of 3-D shapes • Use isometric grids *Example:* Represent a cuboid of dimensions 2 m by 3 m by 4 m on an isometric grid • Draw nets and show how they fold to make a 3-D solid • Understand and draw front and side elevations and plans of shapes made from simple solids *Examples:* ○ draw the front and side elevation and plan of a real life structure ○ given a net of a solid, identify points which coincide in the 3-D configuration ○ given the front and side elevations and a plan of the solid, draw a sketch of the 3-D solid ○ work out the greatest number of nets of a cube of side 2 cm that can be made from a square sheet measuring 12 cm by 12 cm • Given the front and side elevations and the plan of a solid, draw a sketch of the 3-D solid ***Functional Elements:*** • Design suitable nets for containers (not necessarily cuboids)

Ref	Content descriptor	Concepts and skills
GM I	Describe and transform 2-D shapes using single or combined rotations, reflections, translations, or enlargements by a positive, **fractional or negative** scale factor and distinguish properties that are preserved under particular transformations	• Describe and transform 2-D shapes using single rotations • Understand that rotations are specified by a centre and an (anticlockwise) angle • Find the centre of rotation • Rotate a shape about the origin, or any other point *Examples:* Rotate a triangle by 90º (a quarter of a whole turn) clockwise about the point (1, 2) to give another triangle • Describe and transform 2-D shapes using single reflections • Understand that reflections are specified by a mirror line *Example:* Reflect a triangle in the x-axis (or the y-axis or $y = \pm x$ • Identify the equation of a line of symmetry *Examples:* ○ $x = a, y = b, \ y = \pm x$ ○ describe translations fully using a column vector • Describe and transform 2-D shapes using single translations • Understand that translations are specified by a distance and direction (using a vector) • Translate a given shape by the vector $\begin{pmatrix} 2 \\ -3 \end{pmatrix}$ • Describe and transform 2-D shapes using enlargements by a positive and a **negative or fractional** scale factor • Understand that an enlargement is specified by a centre and a scale factor

Ref	Content descriptor	Concepts and skills
GM I	(*Continued*)	• Enlarge shapes using (0, 0) as the centre of enlargement *Examples:* ○ enlarge a given shape by scale factor 3, centre (0, 0) ○ **enlarge a shape scale factor** $-1\frac{1}{2}$ **centre (0, 0)** • Enlarge shapes using centre other than (0, 0) • Find the centre of enlargement • Describe and transform 2-D shapes using combined rotations, reflections, translations, or enlargements *Examples:* ○ describe the single transformation that describes the result of a combination of, for example, the rotation of a triangle by 180º, centre (0, 0) followed by a reflection in the x-axis ○ scale a shape on a grid (centre not specified) • Distinguish properties that are preserved under particular transformations • Use congruence to show that translations, rotations and reflections preserve length and angle, so that any figure is congruent to its image under any of these transformations • Understand that distances and angles are preserved under rotations, reflections and translations so that any shape is congruent to its image *Example:* Identify the scale factor of an enlargement of a shape as the ratio of the lengths of two corresponding sides • Recognise that enlargements preserve angle but not length • Describe a transformation

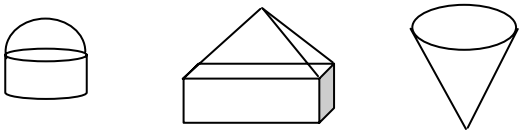
Ref	Content descriptor	Concepts and skills
GM v	Use straight edge and a pair of compasses to carry out constructions	• Use straight edge and a pair of compasses to do standard constructions • Construct a triangle *Example:* Construct a triangle of sides 5 cm, 7 cm and 9 cm • Construct an equilateral triangle *Example:* Construct an equilateral triangle of side 6 cm • Understand, from the experience of constructing them, that triangles satisfying SSS, SAS, ASA and RHS are unique, but SSA triangles are not • Construct the perpendicular bisector of a given line • Construct the perpendicular from a point to a line • Construct the perpendicular from a point on a line • Construct the bisector of a given angle • Construct angles of 60^o, 90^o, 30^o, 45^o • Draw parallel lines • Draw circles and arcs to a given radius • Construct a regular hexagon inside a circle • Construct diagrams of everyday 2-D situations involving rectangles, triangles, perpendicular and parallel lines. • Draw and construct diagrams from given information ***Functional Elements:*** • Use scale drawings to solve trigonometric problems

Ref	Content descriptor	Concepts and skills
GM w	Construct loci	• Construct: – a region bounded by a circle and an intersecting line – given distance from a point and a given distance from a line – equal distances from two points or two line segments – regions which may be defined by 'nearer to' or 'greater than' • Find and describe regions satisfying a combination of loci *Example:* Locate the region where treasure on a map may be found given that it is within 3 km of a point A and nearer to point A than to another point B (NB: All loci restricted to two dimensions only)

Ref	Content descriptor	Concepts and skills
GM x	Calculate perimeters and areas of shapes made from triangles and rectangles **or other shapes**	• Measure shapes to find perimeter or area • Find the perimeter of rectangles and triangles • Calculate perimeter and area of compound shapes made from triangles, rectangles **and other shapes** • Recall and use the formulae for the area of a triangle, rectangle and a parallelogram • Calculate areas of shapes made from triangles and rectangles • Calculate perimeters of compound shapes made from triangles and rectangles • Find the area of a trapezium • Find the area of a parallelogram • Find the surface area of simple shapes (prisms) using the formulae for triangles and rectangles, **and other shapes** ***Functional Elements:*** • Cover areas of floors or walls (using tiles, carpets etc) • Work out ratios and costs involved when buying tiles singly or in packs • Plant seeds, fertilise fields (hectares could be used) • Perimeters and surface areas could be a feature of the problem to be solved
GM y	**Calculate the area of a triangle using** $\frac{1}{2}ab\sin C$	• **Calculate the area of a triangle given the length of two sides and the included angle** ***Examples:*** ○ **calculate the area of a triangular field given the lengths of two sides and the included angle** ○ **calculate the area of a parallelogram**

Ref	Content descriptor	Concepts and skills
GM z	Find circumferences and areas of circles	• Find circumferences of circles and areas enclosed by circles • Recall and use the formulae for the circumference of a circle and the area enclosed by a circle *Examples:* ○ find the circumference of a bicycle wheel, given the radius of diameter ○ find the perimeter of a semi-circular carpet, given the diameter ○ find the area of a circular table, given the radius or diameter ○ find the number of revolutions of a wheel of diameter 50 cm can travel in a 100 m • Use $\pi \approx 3.142$ or use the π button on a calculator • Find the perimeters and areas of semicircles and quarter circles *Example:* Find the distance moved by the tip of the hand of a clock, of radius 5 cm, in 10 minutes • **Calculate the lengths of arcs and the areas of sectors of circles** ***Example:*** **Find the area of a biscuit, in the shape of a sector of radius 9 cm and with an angle of 20°** • **Answers in terms of π may be required** • Find the surface area of a cylinder ***Functional Elements:*** • Use area and perimeter to solve problems involving circular ponds, table tops, wheels etc

Ref	Content descriptor	Concepts and skills
GM aa	Calculate volumes of right prisms and shapes made from cubes and cuboids	• Calculate volumes of right prisms, including the triangular prism, and shapes made from cubes and cuboids • Recall and use the formula for the volume of a cuboid *Examples:* ○ find the height of a cuboid that has a volume of 40 cm^3, length 5 cm and width 2 cm ○ find the greatest number of small boxes that can fit in a larger box, given all the dimensions? How does the orientation of the larger box affect this greatest number? • Find the volume of a cylinder *Example:* A cup holds 30 m*l* of liquid. 20 cupfuls are poured into a cylindrical container of base radius 8 cm. Work out the height of the liquid in the container • Use volume to solve problems ***Functional Elements:*** • Use volumes and density to solve problems • Use capacity to solve problems which involve liquid levels and filling containers • Use volumes of cylinders to solve problems

Ref	Content descriptor	Concepts and skills
GM bb	**Solve mensuration problems involving more complex shapes and solids**	• **Solve problems involving more complex shapes and solids, including segments of circles and frustums of cones** • **Find the surface area and volumes of compound solids constructed from cubes, cuboids, cones, pyramids, spheres, hemispheres, cylinder** ***Examples:***  • **Solve problems including examples of solids in everyday use** • **Find the area of a segment of a circle given the radius and length of the chord** ***Functional Elements:*** • **Solve problems including examples of solids in everyday use** • **Find the area of a segment of a circle given the radius and the length of chord**
GM cc	**Use vectors to solve problems**	• **Understand and use vector notation** ***Example:*** **The notation $\overrightarrow{AB}$ or a in bold type will be used. The form $\begin{pmatrix} p \\ q \end{pmatrix}$ is also required** ***Example:*** $\overrightarrow{AB} = \begin{pmatrix} -1 \\ 3 \end{pmatrix}$ • **Calculate, and represent graphically, the sum of two vectors, the difference of two vectors and a scalar multiple of a vector** • **Calculate the resultant of two vectors** • **Solve geometrical problems in 2-D using vector methods** ***Example:*** **The joining of the midpoints of the sides of any quadrilateral form a parallelogram** • **Apply vector methods for simple geometrical proofs**

4 Measures

What students need to learn:

Ref	Content descriptor	Concepts and skills
GM m	Use and interpret maps and scale drawings	• Use and interpret maps and scale drawings • Read and construct scale drawings • Draw lines and shapes to scale • Estimate lengths using a scale diagram
GM n	Understand **and use** the effect of enlargement for perimeter, area and volume of shapes and solids	• Understand the effect of enlargement for perimeter, area and volume of shapes and solids • Understand that enlargement does not have the same effect on area and volume • Use simple examples of the relationship between enlargement and areas and volumes of simple shapes and solids • **Use the effect of enlargement on areas and volumes of shapes and solids** • **Know the relationships between linear, area and volume scale factors of mathematically similar shapes and solids**
GM o	Interpret scales on a range of measuring instruments and recognise the inaccuracy of measurements	• Know that measurements using real numbers depend upon the choice of unit • Recognise that measurements given to the nearest whole unit may be inaccurate by up to one half in either direction *Example:* A distance of 10 km lies between 9.5 km and 10.5 km

Ref	Content descriptor	Concepts and skills
GM p	Convert measurements from one unit to another	• Convert between units of measure in the same system *Example:* Change 2.3 m to mm (NB: Conversion between imperial units will be given. Metric equivalents should be known) • Know rough metric equivalents of pounds, feet, miles, pints and gallons: **Metric** — **Imperial** 1 kg — 2.2 pounds 1 *l* — $1\frac{3}{4}$ pints 4.5 *l* — 1 gallon 8 km — 5 miles 30 cm — 1 foot • Convert between imperial and metric measures • Convert between metric area measures • Convert between metric volume measures • Convert between speed measures (Using metric units) • Convert between metric units of volume and units of capacity measures, eg 1 m*l* = 1 cm³ ***Functional Elements:*** • Use of imperial or metric measures according to which one is in common use • Convert between imperial and metric systems where appropriate
GM q	Make sensible estimates of a range of measures	• Make sensible estimates of a range of measures in everyday settings • Choose appropriate units for estimating or carrying out measurements

Ref	Content descriptor	Concepts and skills
GM r	Understand and use bearings	• Use three-figure bearings to specify direction • Mark on a diagram the position of the point B given its bearing from point A • Measure or draw a bearing between the points on a map or scaled plan • Given the bearing of a point A from point B, work out the bearing of B from A ***Functional Elements:*** • Use bearings in map and navigation problems (combine with GM h/u/v)
GM s	Understand and use compound measures	• Understand and use compound measures, including speed and **density** *Examples:* ○ how many miles has a car travelled at 40 mph for 3 hours? ○ how long does it take to travel between two cities, 200 km apart, travelling at an average speed of 60 km/h? ○ find the average speed for a journey of 100 miles travelled in $2\frac{1}{2}$ hours ○ given a mileage chart, work out the time taken to travel from A to B when travelling at an average speed of 30 mph ○ calculate speed from a distance-time graph ***Functional Elements:*** • Use of imperial or metric measures according to which one is in common use • Convert between imperial and metric systems where appropriate • Link compound units of speed, **density,** miles per gallon etc with formulae (from A f)
GM t	Measure and draw lines and angles	• Measure and draw lines, to the nearest mm • Measure and draw angles, to the nearest degree

Ref	Content descriptor	Concepts and skills
GM u	Draw triangles and other 2-D shapes using ruler and protractor	• Make accurate drawing of triangles and other 2-D shapes using a ruler and a protractor • Make an accurate scale drawing from a diagram • Use accurate drawing to solve a bearings problem

5 Statistics

What students need to learn:

Ref	Content descriptor	Concepts and skills
SP a	Understand and use statistical problem solving process/handling data cycle	• Specify the problem and plan • Decide what data to and what statistical analysis is needed *Example:* Formulate a plan for a statistical investigation, including using a hypothesis • Collect data from a variety of suitable primary and secondary sources • Use suitable data collection techniques *Example:* Undertake mini-projects, demonstrating the data handling cycle; height vs. weight, reaction times • Process and represent the data • Interpret and discuss the data *Example:* Provide a conclusion or evaluation in the context of a statistical project
SP b	Identify possible sources of bias	• **Discuss how data relates to a problem, identify possible sources of bias and plan to minimise it** • **Understand how different sample sizes may affect the reliability of conclusions drawn** *Examples:* ○ understand the significance of the population from which the sample is taken when avoiding bias ○ in a survey about the usage of a Sports Centre, discuss the shortcomings of a sample selected from people attending the Centre on a Monday morning

Ref	Content descriptor	Concepts and skills
SP c	Design an experiment or survey	• Identify which primary data they need to collect and in what format, including grouped data • Consider fairness • Understand sample and population • Design a question for a questionnaire • Criticise questions for a questionnaire • **Design an experiment or survey** • **Select and justify a sampling scheme and a method to investigate a population, including random and stratified sampling** • **Use stratified sampling** ***Examples:*** ○ **use stratified sampling for opinion polls; elections, popular TV programmes etc, given information on the nature of each population to be surveyed** ○ 'how often do you visit the public library? Never…, A lot…, Sometimes….' Could be used to survey the usage of a public library. Describe what is wrong with this question and design a better question that could be used

Ref	Content descriptor	Concepts and skills
SP d	Design data-collection sheets distinguishing between different types of data	• Design and use data-collection sheets for grouped, discrete and continuous data *Example:* Design a data collection sheet that could be used to collect information about the ways in which students travel to school • Collect data using various methods • Sort, classify and tabulate data and discrete or continuous quantitative data *Example:* Design and use a frequency table or tally chart • Group discrete and continuous data into class intervals of equal width *Examples:* Design a data collection sheet that could be used to collect information about: ○ the way that people intend to vote in an election or how people spend their leisure time (qualitative data) ○ annual earnings/weights of new born babies (discrete/continuous data)

Ref	Content descriptor	Concepts and skills
SP e	Extract data from printed tables and lists	• Extract data from lists and tables *Examples:* ○ use secondary data from newspapers etc ○ spreadsheets containing column data ○ temperature, rainfall charts across the country/world
SP f	Design and use two-way tables for discrete and grouped data	• Design and use two-way tables for discrete and grouped data *Example:* Given the number of gold, silver and bronze medals won by Team GB in each of Swimming, Athletics and Cycling in the 2008 Olympic Games, design a two-way table to show this information • Use information provided to complete a two-way table *Example:* Complete the two-way table showing information about road accidents in Manchester in 2004 and 2005

Year	Slight	Serious	Fatal	Total
2004	2180			2149
2005		241	20	
Total		461		4755

Ref	Content descriptor	Concepts and skills
SP g	Produce charts and diagrams for various data types	• Produce: – Composite bar charts – Comparative and dual bar charts – Pie charts – Histograms with equal class intervals – Frequency diagrams for grouped discrete data – Scatter graphs – Line graphs – Frequency polygons for grouped data – **Grouped frequency tables for continuous data** – Ordered stem and leaf diagrams – **Cumulative frequency tables** – **Cumulative frequency graphs** – **Box plots from raw data and when given quartiles, median** – **Histograms from class intervals with unequal width** *Example:* A stem and leaf diagram or frequency table shows the weights of 50 16 year old girls. Use this information to draw a box plot or a cumulative frequency diagram • **Use and understand frequency density**

Ref	Content descriptor	Concepts and skills
SP h	Calculate median, mean, range, **quartiles and interquartile range,** mode and modal class	• Calculate: – mean, – mode, – median, – range, – modal class, – the interval which contains the median • Estimate the mean of grouped data using the mid-interval value • Find the median, **quartiles and interquartile range** for large data sets with grouped data • Estimate the mean for large data sets with grouped data • Understand that the expression 'estimate' will be used where appropriate, when finding the mean of grouped data using mid-interval values • **Use cumulative frequency graphs to find median, quartiles and interquartile range** • **Interpret box plots to find median, quartiles, range and interquartile range** *Examples:* ○ given the mean score (45.6) of a cricket batsman in 10 innings, work out the number of runs required, in the eleventh innings to make the mean score 50.0 ○ decide which is the best average to use when trying to find the average wage in a small company with one worker earning £100 a week, ten earning £200 a week and the owner earning £1000 a week

Ref	Content descriptor	Concepts and skills
SP i	Interpret a wide range of graphs and diagrams and draw conclusions	• Interpret: – composite bar charts – comparative and dual bar charts – pie charts – stem and leaf diagrams – scatter graphs – frequency polygons – **box plots** – **cumulative frequency diagrams** – **histograms** • Recognise simple patterns, characteristics and relationships in line graphs and frequency polygons • **Find the median from a histogram or any other information from a histogram, such as the number of people in a given interval** • From line graphs, frequency polygons and frequency diagrams – read off frequency values – calculate total population – find greatest and least values • From pie charts: – find the total frequency – find the size of each category • Find the mode, median, range and **interquartile range**, **as well as the greatest and least values from stem and leaf diagrams** • **From cumulative frequency graphs:** – **estimate frequency greater/less than a given value** – **find the median and quartile values and interquartile range** • **From histograms:** – **complete a grouped frequency table** – **understand and define frequency density** (NB: No pictograms or bar charts at higher)

Ref	Content descriptor	Concepts and skills
SP j	Look at data to find patterns and exceptions	• Present findings from databases, tables and charts • Look at data to find patterns and exceptions • **Explain an isolated point on a scatter graph**
SP k	Recognise correlation and draw and/or use lines of best fit by eye, understanding what these represent	• Draw lines of best fit by eye, understanding what these represent • Distinguish between positive, negative and zero correlation using lines of best fit *Examples:* ○ positive correlation; number of ice-creams sold daily vs. daily temperature, height vs. arm-span ○ negative correlation; age of car vs. value of car, hours of sunshine vs. rainfall ○ no correlation; age of adult vs. weight ~ this true? • Understand that correlation does not imply causality • Use a line of best fit, **or otherwise**, to predict values of one variable given values of the other variable *Examples:* ○ for height against weight scatter diagram predict the possible weight for a person for a given height ○ use **the trend of data** on a scatter graph to predict values of a variable given values of another • **Appreciate that correlation is a measure of the strength of the association between two variables and that zero correlation does not necessarily imply 'no relationship' but merely 'no linear relationship'**

Ref	Content descriptor	Concepts and skills
SP l	Compare distributions and make inferences	• **Compare distributions and make inferences, using the shapes of distributions and measures of average and spread, including median and quartiles** • Compare the mean and range of two distributions, **or median and interquartile range**, as appropriate *Example:* Explain why the mean shoe size of a population would not be as useful as the mode for a shoe retailer • Understand that the frequency represented by corresponding sectors in two pie charts is dependent upon the total populations represented by each of the pie charts • Use dual or comparative bar charts to compare distributions • Recognise the advantages and disadvantages between measures of average • **Compare the measures of spread between a pair of box plots/cumulative frequency graphs**
SP u	Use calculators efficiently and effectively, including statistical functions	• Calculate the mean of a small data set, using the appropriate key or a scientific calculator • **Use $\sum x$ and $\sum fx$ or the calculation of the line of best fit**

6 Probability

What students need to learn:

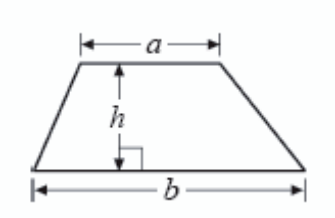
Ref	Content descriptor	Concepts and skills
SP m	Understand and use the vocabulary of probability and probability scale	• Distinguish between events which are; impossible, unlikely, even chance, likely, and certain to occur • Mark events and/or probabilities on a probability scale of 0 to 1 • Write probabilities in words or fractions, percentages or decimals
SP n	Understand and use estimates or measures of probability from theoretical models (including equally likely outcomes), or from relative frequency	• Understand and use estimates or measures of probability, including relative frequency • Use theoretical models to include outcomes using dice, spinners, coins • Find the probability of successive events, such as several throws of a single dice • Estimate the number of times an event will occur, given the probability and the number of trials
SP o	List all outcomes for single events, and for two successive events, in a systematic way and derive relative probabilities	• List all outcomes for single events, and for two successive events, systematically • Use and draw sample space diagrams
SP p	Identify different mutually exclusive outcomes and know that the sum of the probabilities of all these outcomes is 1	• Add simple probabilities • Identify different mutually exclusive outcomes and know that the sum of the probabilities of all these outcomes is 1 • Use $1-p$ as the probability of an event not occurring where p is the probability of the event occurring • Find a missing probability from a list or table
SP q	**Know when to add or multiply two probabilities: when A and B are mutually exclusive, then the probability of A or B occurring is $\mathrm{P}(A) + \mathrm{P}(B)$, whereas when A and B are independent events, the probability of A and B occurring is $\mathrm{P}(A) \times \mathrm{P}(B)$**	• **Understand conditional probabilities** • **Understand selection with or without replacement**

Ref	Content descriptor	Concepts and skills
SP r	**Use tree diagrams to represent outcomes of compound events, recognising when events are independent**	• **Draw a probability tree diagram based on given information (no more than 3 branches per event)** • **Use a tree diagram to calculate conditional probability**
SP s	Compare experimental data and theoretical probabilities	• Compare experimental data and theoretical probabilities
SP t	Understand that if they repeat an experiment, they may – and usually will – get different outcomes, and that increasing sample size generally leads to better estimates of probability and population characteristics	• Compare relative frequencies from samples of different sizes

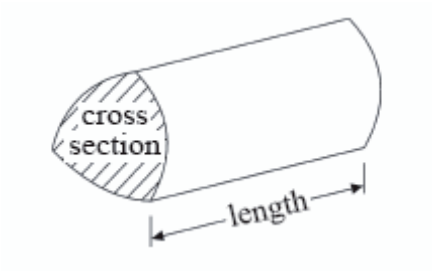
Formulae sheets

Foundation Tier

Area of trapezium = $\frac{1}{2}(a+b)h$



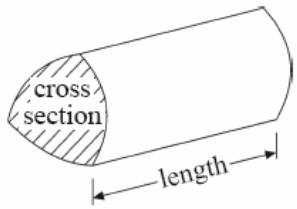
Volume of prism = area of cross section × length



GCSE Mathematics

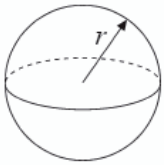
Formulae: Higher Tier

Volume of a prism = area of cross section × length



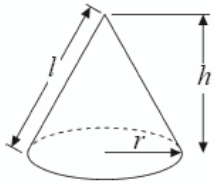
Volume of sphere $= \frac{4}{3}\pi r^3$

Surface area of sphere $= 4\pi r^2$

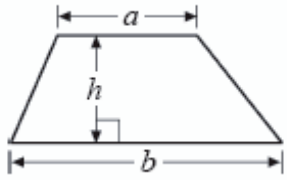


Volume of cone $= \frac{1}{3}\pi r^2 h$

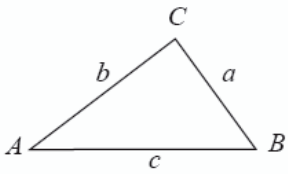
Curved surface area of cone $= \pi r l$



Area of trapezium $= \frac{1}{2}(a+b)h$



In any triangle ABC



Sine Rule $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

Cosine Rule $a^2 = b^2 + c^2 - 2bc\cos A$

Area of triangle $= \frac{1}{2}ab\sin C$

The Quadratic Equation

The solutions of $ax^2 + bx + c = 0$ where $a \neq 0$, are given by

$$x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$$

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