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GCSE

Applications of Mathematics (Pilot)

For use in pilot centres only

Edexcel GCSE in Applications of Mathematics (2AM01)

For first teaching from September 2010

A PEARSON COMPANY

Contents

Specification at a glance

The Edexcel GCSE in Applications of Mathematics comprises two units − Units 1 and 2.

Unit 1	Applications 1	*Unit code 1F: 5AM1F *Unit code 1H: 5AM1H
• Externally assessed • Availability: June and November • First assessment: June 2011		**50% of the total GCSE**
Overview of content **1** Number **2** Financial and business applications **3** Algebra **4** Geometry **5** Measures **6** Statistics		
Overview of assessment • One written paper • Tiered papers o Foundation Tier grades C-G available o Higher Tier grades A*-D available (E allowed) o 30-40% of the Foundation Tier papers assess the functional elements of mathematics o 20-30% of the Higher Tier papers assess the functional elements of mathematics • 1 hour 45 minutes (Foundation paper) • 1 hour 45 minutes (Higher paper) • 100 marks • Calculator allowed		

| Unit 2 | Applications 2 | *Unit code 2F: 5AM2F |
| | | *Unit code 2H: 5AM2H |

• Externally assessed	
• Availability: June and November	**50% of the total GCSE**
• First assessment: June 2011	

Overview of content

1 Number

2 Algebra

3 Geometry

4 Measures

5 Probability

Overview of assessment

- One written paper

- Tiered papers

  o Foundation Tier grades C-G available

  o Higher Tier grades A*-D available (E allowed)

  o 30-40% of the Foundation Tier papers assess the functional elements of mathematics

  o 20-30% of the Higher Tier papers assess the functional elements of mathematics

- 1 hour 45 minutes (Foundation paper)

- 1 hour 45 minutes (Higher paper)

- 100 marks

- Calculator allowed

Subject content

The content of the specification has been grouped into areas:

- Number
- Financial and business applications
- 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.

An overview of the content follows, showing in which units it is assessed.

The same content descriptors may appear in each unit but concepts and skills are developed through the units, so the concepts and skills may be different.

Assessment will be based upon the concepts and skills. Questions will generally be set in a realistic context. Exemplification of the concepts and skills include some examples which are mathematical and some which are contextualised.

Content exemplification

Foundation

Overview

Content overview

This unit contains:

1 Number

- Four operations
- Factors and multiples
- Indices, squares and roots
- Fractions, decimals and percentages
- Accuracy
- Using calculators

2 Financial and business applications

- Financial mathematics
- Spreadsheets
- Flow charts

3 Algebra

- Manipulating expressions
- Equations
- Coordinates
- Straight-line graphs

4 Geometry

- Angles
- Quadrilaterals
- Symmetry
- Congruence and similarity
- Circles
- Perimeter and area

5 Measures

- Scales
- Converting between units
- Estimating measures
- Measuring and drawing

6 Statistics

- The data handling cycle

- Collecting data

- Representing data

- Analysing and interpreting data

Assessment overview

- 50% of the qualification

- One written paper

- 1 hour 45 minutes in total

- 100 marks in total

- Calculator allowed

- Grades C-G available

- Available in June and November

- 30-40% of the paper assesses the functional elements of mathematics

References

Each topic in this unit contains a specification reference (for example, **AN a, Applications Number Statement a**), 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
AN a	Understand and use number operations and the relationships between them, including inverse operations and hierarchy of operations	• Add, subtract, multiply and divide whole numbers, integers, fractions and decimals *Examples:* ○ $851 \div 37$, 27.6×23, $36.2 \div 0.2$, $-2 + -4$ ○ $365 + 45 + 1026$, $30 - 5.91$, $2.56 \div 1.6$ ○ $\frac{2}{3} - \frac{1}{4}$, $2\frac{1}{3} + 1\frac{3}{4}$, $3\frac{1}{3} \times 2\frac{2}{5}$, $\frac{5}{8} \div \frac{3}{4}$, $\frac{3}{4} \times 5$ ○ how many $\frac{3}{4}$ ounce portions in 8 ounces? ○ two rods have lengths of $1\frac{1}{2}$ inches and $2\frac{3}{4}$ inches. What is their total length? • Add, subtract, multiply and divide negative numbers *Examples:* ○ the four operations as applied to negative numbers, both abstract and in context ○ $5 + (-7)$, $13 - (-5)$, 3×-5, $-10 \div -5$ ○ temperature changes • Multiply or divide by any number between 0 and 1 *Examples:* 3.56×0.023, $3.56 \div 0.01$

Ref	Content descriptor	Concepts and skills
AN a	Understand and use number operations and the relationships between them, including inverse operations and hierarchy of operations (*continued*)	***Functional Elements:*** – use foreign exchange rates – calculate shopping bills, energy bills (eg calculations using 0.35p/unit) – 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 – work out how many child tickets are bought given total amount spent and number of adult tickets – work out the maximum number of tickets that can be bought for a given amount

Ref	Content descriptor	Concepts and skills

AN b	Numbers and their representations including powers, roots, indices (integers)	• Order integers, decimals and fractions
		
		Examples:
		
		  o find the highest temperature from a list
		
		  o place a series of positive and negative numbers in ascending or descending order
		
		  o arrange in order, smallest first
		     5, 2, –6, 0, –3
		
		• Understand and use positive numbers and negative integers, both as positions and translations on a number line
		
		Example:
		
		     3 – 5, –4 + 7, –3 – 7
		
		Functional Elements:
		
		 – Negative numbers with temperatures and heights below sea level
		
		• Order fractions
		
		Examples:
		
		  o write $\frac{3}{8}$, $\frac{1}{4}$, $\frac{3}{10}$ in descending order
		
		  o write two fractions with values between $\frac{1}{4}$ and $\frac{1}{2}$
		
		  o compare fractions using diagrams
		
		  o read information from weather maps and carry out calculations with temperatures
		
		  o select relevant information from weather maps, ignoring redundant information
		
		• Find equivalent fractions
		
		Example:
		
		     explain why $\frac{3}{4}$ is the same as $\frac{6}{8}$

Ref	Content descriptor	Concepts and skills

AN b	Numbers and their representations including powers, roots, indices (integers)
	
	(*continued*)
		• Write a fraction in its simplest form
		Examples:
		  ○ write $\dfrac{16}{24}$ as a fraction in its simplest form
		  ○ express $\dfrac{28}{35}$ in its simplest form
		
		• 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 $\dfrac{1}{2}$ and $\dfrac{3}{4}$
		
		• Convert between mixed numbers and improper fractions
		Example:
		  write $\dfrac{27}{10}$ as $2\dfrac{7}{10}$
		
		• Recall integer squares from 2×2 to 15×15 and the corresponding square 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
		  ○ know that both −3 and +3 are the square roots of 9

Ref	Content descriptor	Concepts and skills

AN b	Numbers and their representations including powers, roots, indices (integers)
	
	(*continued*)
		• Recall the cubes of 2, 3, 4, 5 and 10
		
		Example:
		
		    explain why the cube of 2 is not 6
		
		• Select a square number and a cube number from a list
		
		• Use index notation for integer powers of 10
		
		Example:
		
		    write down the value of 10^6
		
		• Use index notation for squares and cubes
		
		Examples:
		
		    ○ find the value of 2^3, 3^2, 8^1
		
		    ○ find the value of 2^4, $2^3 + 3^2$
		
		    ○ which is larger 2^3 or 3^2?
		
		• Use index laws to find the value of expressions including powers of a power
		
		Examples:
		
		    $5^7 \div 5^3$, $3^3 \times 3^4$, $(4^2)^3$

AN c	Use the concepts and vocabulary of factor (divisor), multiple, common factor, common multiple and prime number	• Recognise even and odd numbers
		
		• Identify factors, multiples and prime numbers
		
		Example:
		
		    pick multiples of 4, factors of 56, and a prime number from a list of numbers
		
		• Find the common factors and common multiples of two numbers
		
		Example:
		
		    list all the common factors of 24 and 36
		
		• Find common factors and common multiples
		
		Example:
		
		    list three common multiples of 4 and 6

Ref	Content descriptor	Concepts and skills
AN d	Approximate to specified or appropriate degrees of accuracy including a given power of ten, number of decimal places and significant figures	• Round to a given power of 10 *Examples:* o write 54 327 to the nearest thousand o round the number 23 578 to the nearest ten • Round to the nearest integer and to any number of significant figures *Examples:* o write 37 451 correct to two significant figures o write 0.000 726 9 correct to one significant figure o round practical measurements correct to 1 mm if appropriate o give answer to two decimal places, or to one significant figure, or rounded to the nearest integer • Round to a given number of decimal places *Examples:* o round an answer to a given number of decimal places o write the answer to a money problem to the nearest penny and/or pound (unprompted) o round 1.537 to 2 decimal places

Ref	Content descriptor	Concepts and skills

AN d	Approximate to specified or appropriate degrees of accuracy including a given power of ten, number of decimal places and significant figures
	
	(Continued)
		• Estimate answers to calculations, including use of rounding
		
		Examples:
		
		  o estimate $\dfrac{52.9 \times 3.1}{19.5 - 1.9}$, $\dfrac{68 \times 401}{198}$
		
		  o understand that 348 × 23 approximates to 300 × 20 (ie one significant figure)
		
		  o work out an estimate for the total cost of 113 ipods at £185 each
		
		  o write the answer to a money problem to the nearest penny and/or pound (unprompted)
		
		  o work to stated levels of accuracy
		
		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:
		
		Examples:
		
		  o how many coaches that hold 57 people are needed for 150 students on a day trip?
		
		  o how many bottles that hold 450 m*l* can be completely filled from a can containing 5000 m*l* of liquid?
		
		  o find the cost of one litre of fuel if 50 litres costs £45. Interpret the answer of 0.9 as £0.90 or 90p
		
		  o the number of articles bought must be an integer
		
		  o give an answer to two decimal places or one significant figure

Ref	Content descriptor	Concepts and skills

AN f	Understand that 'percentage' means 'number of parts per 100' and use this to compare proportions	• Convert between fractions, decimals and percentages
		
		Examples:
		
		    o be able to convert common unit fractions to decimals and percentages, $\frac{1}{2}, \frac{1}{4}, \frac{1}{5}, \frac{1}{10}, \frac{1}{100}, \frac{1}{8}$
		
		    o write $\frac{3}{8}$ as a decimal
		
		    o write 1.25 as a mixed number
		
		    o write 0.35 as a fraction in its simplest form
		
		    o 20% means 20 parts per hundred or $\frac{20}{100}$ or $\frac{1}{5}$
		
		• Use percentages, fractions and decimals to compare proportions
		
		Example:
		
		    write in order of size
		    0.7, $\frac{3}{5}$, 50%, $\frac{2}{3}$
		
		Functional Elements:
		
		  – Comparison of payment options; using +, ×, % and fractions

Ref	Content descriptor	Concepts and skills
AN g	Use multipliers for percentage change	• Use percentages in real-life situations
		o VAT
		o Simple interest
		o Find prices after a percentage increase or decrease
		o Amount of profit and loss
		• Use a multiplier to increase or decrease by a percentage in any scenario where percentages are used
		Examples:
		o find the extra paid when a credit plan with percentage interest is used rather than paying cash
		o find the sale price in a 20% sale
		o a multiplier of 1.05 corresponds to an increase of 5%
		o a multiplier of 0.95 corresponds to a decrease of 5%
		Functional Elements:
		– Salary increase using %
		– Income tax calculations
		– Comparison of interest between savings accounts and bonds using %

Ref	Content descriptor	Concepts and skills

AN h	Interpret fractions, decimals and percentages as operators	• Interpret percentage as an operator
		Example:
		
		$$15\% \text{ of } 60 \text{ means } \frac{15}{100} \times 60 \text{ or } 0.15 \times 60$$
		
		• Find percentages of quantities
		Example:
		
		find 35% of £200
		
		• Calculate a given fraction of a given quantity
		Example:
		
		find $\frac{3}{5}$ of 75 kg
		
		• 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
		• Express a given number as a percentage of another
		Example:
		
		calculate 26 as a percentage of 150
		
		• 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)
		  ○ 30% increase followed by a 20% decrease gives a total calculated using (1.3 × 0.8)
		  ○ analyse a problem and decide to use fractions, decimals or percentages as multipliers to solve it

Ref	Content descriptor	Concepts and skills

AN i	Find proportional change	• Solve word problems about ratio and proportion
		
		Examples:
		
		  o given the cost of 3 pens, work out the cost of 7 pens
		
		  o compare the value of different sizes of a product using mass and cost
		
		  o use direct proportion in context

AN m	Use calculators effectively and efficiently, including statistical functions	• Use a calculator effectively and efficiently
		
		• Know how to enter complex calculations, including those involving time and money
		
		Functional Elements:
		
		– how many coaches that hold 57 students 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?
		
		– 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)
		
		• Understand, and interpret, the calculator display, particularly when the display has been rounded by the calculator
		
		Example:
		
		  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
		
		Example:
		
		  $\frac{2}{3}$ = 0.67 is an example of premature rounding when used in the middle of a calculation

Ref	Content descriptor	Concepts and skills
AN m	Use calculators effectively and efficiently, including statistical functions (*continued*)	• Use an extended range of calculator functions, including $+$, $-$, $\times$, $\div$, x^2, $\sqrt{x}$, memory, x^y, brackets • Use a calculator to solve problems in statistics • Calculate the mean of a small dataset, using the appropriate key on a scientific calculator

2   Financial and business applications

What students need to learn:

Ref	Content descriptor	Concepts and skills
AF a	Carry out calculations relating to enterprise, saving and borrowing, appreciation and depreciation	• Work out the amount an investment is worth given the number of years and interest rate *Example:* how much will be in an account after one year if £3000 is invested at 4% per annum simple interest? • Use multipliers to work out appreciation and depreciation *Examples:* o know that to work out the value of an amount invested for 1 year at 5% interest, the calculation needed is to multiply by 1.05 o know that to work out the value of an object after 1 year's depreciation of 5% of the value at the beginning of the year, the calculation needed is to multiply by 0.95

Ref	Content descriptor	Concepts and skills

AF b	Use mathematics in the context of personal and domestic finance including loan repayments, budgeting, RPI and CPI, exchange rates and commissions	• Work out the interest due on a loan
		
		Example:
		
		how much interest is due after 1 year if £3000 is borrowed at rate of 6.5% pa?
		
		• Convert between different currencies given the exchange rate and any rates of commission
		
		Examples:
		
		  o convert between two currencies, given the exchange rate
		
		  o compare prices in different countries of the same item, using given exchange rates
		
		• Use simple index numbers
		
		Examples:
		
		  o given the cost of goods in the base year, work out the index number in the subsequent year
		
		  o given the cost of goods in the base year and the index number in the current year, work out the cost of goods in the current year
		
		• Use mathematics in the context of personal finance
		
		Examples:
		
		  o understand and use a simple bank statement
		
		  o work out amount of tax due to be paid given income and personal allowance

AF c	Use spreadsheets to model financial, statistical and other numerical situations	• Use spreadsheets to model a situation mathematically
		
		Examples:
		
		  o write a formula in a cell to find the total of the numbers in five different cells
		
		  o write a formula in a cell to calculate the amount earned in a week given the hourly wage in one cell and the number of hours worked in another
		
		  o write a formula in a cell to find the total of the numbers in a column or row

Ref	Content descriptor	Concepts and skills

AF d	Construct and use flow charts	• Construct a flow chart from a simple algorithm
		
		Examples:
		
		   o use input/output, instruction and decision boxes within a flow chart
		
		   o construct a flow chart to show the total amount of tax to be paid
		
		   o construct a flow chart to calculate the amount earned in a week, given the number of hours worked and hourly wage as well as the number of hours of overtime worked and the hourly rate for overtime.
		
		• Use a flow chart given the input value(s)
		
		Examples:
		
		   o use a flow chart that includes decision boxes
		
		   o use a flow chart to work out the total cost of using a mobile phone using the total number of minutes used as an input
		
		   o use a flow chart with different inputs and comment on the outcomes

3   Algebra

What students need to learn:

Ref	Content descriptor	Concepts and skills
AA a	Manipulate algebraic expressions by collecting like terms, by multiplying a single term over a bracket, and by taking out common factors	• Multiply a single term over a bracket *Examples:* ○ $2x(x + 4) = 2x^2 + 8x$ ○ expand and simplify $3(2x - 1) - 2(2x - 3)$ ○ understand that the transformation of algebraic expressions obey the rules of generalised arithmetic eg $a(b + c) = ab + ac$ • Manipulate algebraic expressions by collecting like terms *Examples:* simplify $x + 5 - 2x - 1 + 4 - x$ $3a + 2c - a - 3c + 2$ $a \times b \times 2 \times a$ • Use instances of index laws, for integer powers *Examples:* simplify $x^2 \times x^3 = x^5$ $x^6 \div x^4 = x^2$ $\dfrac{t^6}{t^2} = t^4$ $(x^3)^2 = x^6$ • Substitute positive and negative numbers into expressions such as $3x^2 + 4$ and $2x^3$ • Factorise algebraic expressions by taking out common factors *Examples:* factorise $x^2 + 3x = x(x + 3)$ $9x - 3 = 3(3x - 1)$ $6x^2 - 9x = 3x(2x - 3)$ $2ab^2 + 4ab = 2ab(b + 2)$

Ref	Content descriptor	Concepts and skills
AA b	Set up, and solve simple equations and inequalities	• Set up simple equations *Example:* find the size of angle a in a 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, in which the unknown appears on either side or on both sides of the equation *Examples:* $$\frac{x}{4} + 1 = 5, \ 4 + \frac{3x}{5} = x$$ • Set up and solve simple inequalities in one variable *Examples:* o when x is an integer, give all the solutions of $-2 \leq x < 4$ o solve the inequality $2x + 3 > 7$

Ref	Content descriptor	Concepts and skills
AA d	Use the conventions for coordinates in the plane and plot points in all four quadrants	• Use axes and coordinates to specify points in all four quadrants in 2-D • Identify points with given coordinates *Example:* identify the 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 the midpoint of the line segment AB, given the coordinates of A and B *Example:* if A is the point (1, 7) and B is the point (5, 3), find the midpoint of AB
AA e	Recognise and plot equations that correspond to straight-line graphs in the coordinate plane	• Plot and draw graphs of functions *Examples:* o $y = 4$, $x = 3$, $y = 2x + 3$, $x + y = 7$, $y = \dfrac{1}{2}x - 1$ o plot $x + y = 6$ with or without a table of values • Draw, label and scale axes • Recognise that equations of the form $y = mx + c$ correspond to straight line graphs in the coordinate plane • Recognise that, in a mathematical context, an equation in the form $y = mx + c$ is a straight line • Plot and draw graphs of straight lines with equations of the form $y = mx + c$

Content exemplification   Edexcel GCSE
in Applications of Mathematics

Ref	Content descriptor	Concepts and skills

AA j	Find and interpret gradients and intercepts of straight line graphs in practical contexts	• Find the gradient of lines given by equations of the form $y = mx + c$
		
		• Find the gradient of a straight line from a graph
		
		Example:
		
		    given a straight line graph, use (increase in y) ÷ (increase in x) to calculate the gradient
		
		• Use the method of finding a gradient to see how one variable increases in relation to another
		
		Examples:
		
		    o work out how price increases in relation to distance travelled on a taxi journey
		
		    o find the cost per unit of gas from a straight line graph

4 Geometry

What students need to learn:

Ref	Content descriptor	Concepts and skills

AG a	Recall and use properties of angles at a point, angles at a point on a straight line (including right angles), perpendicular lines, and vertically opposite angles	• Recall and use properties of angles:
		  ○ at a point
		  ○ angles at a point on a straight line
		  ○ vertically opposite angles
		  ○ perpendicular lines
		
		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
		  ○ work out the angle between the hands of a clock when the time is 2 o'clock
		  ○ give a time when the hands of a clock are perpendicular to one another
		  ○ in any given diagram, identify an acute angle, an obtuse angle and a right angle
		  ○ give reasons for angle calculations,
		    – 'sum of the angles on a straight line is 180°'
		    – 'sum of the angles at a point is 360°'
		  ○ 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

AG b	Understand and use the angle properties of parallel and intersecting lines, triangles and quadrilaterals	• Distinguish between scalene, isosceles, equilateral, and right-angled triangles • Understand and use the angle properties of triangles • Use the fact that the angle sum of a triangle is 180° • Understand and use the angle properties of intersecting lines • Recognise reasons for angle calculations

Ref	Content descriptor	Concepts and skills
AG c	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 • List the properties of each, or identify (name) a given shape from its properties • Use symmetry properties of quadrilaterals • 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
AG d	Recognise reflection and rotation symmetry of 2-D shapes	• Recognise reflection symmetry • Draw lines of reflection • State the line of reflective symmetry as a simple algebraic equation *Example:* use $x = 3$ as an axis of symmetry • Recognise rotational symmetry • Be able to identify the order of rotational symmetry *Examples:* o identify countries' flags, road signs, creatures (butterflies), wallpaper patterns or buildings having line and/or rotational symmetry o 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
AG e	Understand congruence and similarity, including the relationship between lengths in similar figures	• Identify shapes that are similar, including all circles or all regular polygons with equal number of sides *Example:* recognise similar shapes • Identify shapes that are congruent • Understand what makes two shapes congruent or similar • Understand the relationships between lengths, in similar figures • Recognise that all corresponding angles in similar shapes are equal in size when the lengths of corresponding sides are not • Use 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
AG h	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 *Example:* match diagrams to the mathematical names of the parts of a circle • Understand related terms of a circle, such as semicircle or quarter circle • Draw a circle given the radius or diameter

Ref	Content descriptor	Concepts and skills
AG o	Calculate perimeters and areas of shapes made from triangles and rectangles	• Measure shapes to find perimeter and areas • Find the perimeter of rectangles and triangles • Calculate perimeters of shapes made from triangles and rectangles • Find the perimeter of compound shapes • Calculate areas of shapes made from triangles and rectangles • Recall and use the formulae for the area of a triangle, rectangle and a parallelogram • Find the area of a trapezium • Find surface area using rectangles and triangles • Find the area of a parallelogram, given formulae or derived from triangles and rectangles ***Functional Elements:*** – Work out 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

5 Measures

What students need to learn:

Ref	Content descriptor	Concepts and skills

AM a	Interpret scales on a range of measuring instruments and recognise the inaccuracy of measurements	• Interpret scales on a range of measuring instruments
		
		Example:
		
		    mm, cm, m, km, m*l*, *l*, c*l*, kg, g, tonnes, °C
		
		• Indicate given values on scale
		
		• 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
		
		Examples:
		
		   o the length of a book can normally be measured to the nearest mm
		
		   o the distance of 10 km measured to the nearest km lies between 9.5 km and 10.5 km
		
		   o 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
AM b	Convert measurements from one unit to another	• Use and convert between units of time

Examples:

- o Use correct notation for time, 12- and 24-hour clock
- o Work out time intervals

• Convert between units of measure in the same system

Examples:

- o convert 2.3 m to mm
- o estimate conversions

(NB: Conversion between imperial units will be given. Metric equivalents should be known)

• Convert between imperial and metric measures

• 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

Examples:

- o estimate the number of gallons of petrol in a tank containing 50 litres of petrol
- o convert the weight of a baby in pounds to an equivalent weight in kilograms
- o given that 1 foot = 12 inches, estimate the number of inches in 1 metre

Functional Elements:

- − Use of imperial or metric measures according to which one is in common use

- − Convert between imperial and metric systems where appropriate

Ref	Content descriptor	Concepts and skills
AM c	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 (using scaled sketches) • Choose appropriate units for estimating or carrying out measurements *Examples:* o choose a sensible metric unit to measure the amount of water in a fish tank o which metric/imperial unit would you use to measure the distance from Manchester to London?
AM f	Measure and draw lines and angles	• Measure and draw lines to the nearest mm • Measure and draw angles to the nearest degree

6   Statistics

What students need to learn:

Ref	Content descriptor	Concepts and skills

AS d	Understand and use the statistical problem solving process/data handling 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

Ref	Content descriptor	Concepts and skills
AS e	Design an experiment or survey, identifying possible sources of bias	• Discuss how data relates to a problem, identify possible sources of bias and plan to minimise it *Examples:* o understand the significance of the population from which the sample is taken when avoiding bias o 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 • Understand how different sample sizes may affect the reliability of conclusions drawn • Design an experiment or survey • Consider fairness • Design a question for a questionnaire • Criticise questions for a questionnaire • Identify which primary data to collect including grouped data
AS f	Design data-collection sheets distinguishing between different types of data	• Design and use data-collection sheets for grouped, discrete and continuous data • Understand and use tallying methods • 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

Ref	Content descriptor	Concepts and skills
AS g	Extract data from publications, charts, tables and lists	• Extract data from lists and tables
AS h	Design, use and interpret 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
AS i	Look at data to find patterns and exceptions	• Look at data to find patterns and exceptions • Present findings from databases, tables and charts
AS j	Compare distributions and make inferences	• Compare distributions and make inferences, using the shapes of distributions and measures of average • 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 comparative bar charts to compare distributions • Recognise the advantages and disadvantages of different measures of average

Ref	Content descriptor	Concepts and skills

AS k	Produce and interpret charts and diagrams for categorical data including bar charts, pie charts and pictograms	• Produce or complete:
		   o pie charts
		   o bar charts
		   o multiple and dual bar charts
		   o pictograms
		   o composite bar charts
		
		• Interpret a wide range of graphs and diagrams and draw conclusions
		   o pie charts
		   o bar charts
		   o multiple and dual bar charts
		   o pictograms
		   o composite bar charts
		
		• From pie charts:
		   o find the total frequency
		   o find the frequency represented by each section

Ref	Content descriptor	Concepts and skills

AS l	Produce and interpret diagrams for ungrouped discrete numerical data, including vertical line charts and stem-and-leaf diagrams	• Produce line graphs
		
		• Produce ordered stem and leaf diagrams
		
		• Interpret a wide range of graphs and diagrams and draw conclusions
		
		• Interpret stem and leaf diagrams
		
		• Recognise simple patterns, characteristics and relationships in line graphs
		
		• From line graphs:
		  o read off frequency values
		  o calculate total population
		  o find greatest and least values
		
		• Find range and median from stem and leaf diagrams, as well as the greatest and least value
		
		• Produce and interpret histograms with equal class intervals

AS m	Produce and interpret diagrams for grouped discrete data and continuous data	• Produce
		  o frequency polygons
		  o histograms with equal class intervals
		  o frequency diagrams for grouped discrete data
		  o grouped frequency table for continuous data
		
		• Interpret a wide range of graphs and diagrams and draw conclusions
		
		• Interpret and complete
		  o frequency polygons
		  o histograms with equal class intervals
		
		• Recognise simple patterns, characteristics and relationships in line graphs and frequency polygons

Ref	Content descriptor	Concepts and skills
AS o	Work with time series, including their graphical representation	• Draw and produce time series graphs (line graphs) from given and experimental data *Example:* given the amount of average monthly rainfall each month for a year, draw a time series graph • Identify seasonality and trends in time series *Example:* interpret a graph showing number of ice creams sold each month for two years, identify if the season has an effect on the number of ice creams sold
AS p	Calculate median, mean, range, mode and modal class	• Calculate averages and range of small data sets with discrete data • Find the median and calculate the mean • Find the modal class of grouped data • Find the interval containing the median
AS q	Recognise correlation and draw and/or use lines of best fit by eye, understanding and interpreting what these represent, and appreciating that correlation does not imply causality	• Draw a scatter diagram • Complete a scatter diagram • 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' • Draw lines of best fit by eye • 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

Unit 2: Applications 2

Foundation

Overview

Content overview

This unit contains:

1 **Number**
- Four operations
- Reciprocals
- Proportion and fractions
- Ratio
- Using calculators

2 **Algebra**
- Formulae
- Inequalities
- Solving equations graphically
- Linear functions
- Trial and improvement
- Direct proportion
- Travel graphs
- Area under shapes

3 **Geometry**
- Angles and parallel lines
- Congruency and similarity
- Pythagoras' theorem
- Area and circumference
- Surface area and volume
- 2-D representations of 3-D shapes
- Constructions and loci
- Circle mensuration

4 **Measures**
- Conversions
- Speed
- Bearings

5 **Probability**

Assessment overview

- 50% of the qualification

- One written paper

- 1 hour 45 minutes in total

- 100 marks in total

- Calculator allowed

- Grades C-G available

- Available in June and November

- 30-40% of the paper assesses the functional elements of mathematics

References

Each topic in this unit contains a specification reference (for example, **AA a** is for Applications, Algebra, Statement a), the content descriptor and examples of concepts and skills associated with that content descriptor.

The content of Unit 2 subsumes the content of Unit 1. However, the content of Unit 1 will not be the direct focus of the assessment.

1   Number

What students need to learn:

Ref	Content descriptor	Concepts and skills
AN a	Understand and use number operations and the relationships between them, including inverse operations and hierarchy of operations	• Add, subtract, multiply and divide whole numbers, negative numbers, integers, fractions and decimals *Examples:* ○ $777 \div 37$, 27.6×23, $36.2 \div 0.2$, $-2 + -4$ ○ $365 + 45 + 1026$, $30 - 5.91$, $2.56 \div 1.6$ ○ 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? • Solve a problem involving division by a decimal *Example:* pens cost £0.45 each. How many pens can you buy for £18? • Understand 'reciprocal' as multiplicative inverse, knowing that any non-zero number multiplied by its reciprocal gives 1 (and that zero has no reciprocal, because division by zero is not defined) • Use inverse operations • Find reciprocals *Example:* find the reciprocal of 0.2 • Understand and use unit fractions as multiplicative inverses *Example:* 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) • Use brackets and hierarchy of operations

Ref	Content descriptor	Concepts and skills

AN a	Understand and use number operations and the relationships between them, including inverse operations and hierarchy of operations
	
	(*continued*)
		• Solve word problems
		
		***Functional Elements*:**
		
		– 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
		
		• Understand place value
		
		Examples:
		
		  o write down the value of the number that the arrow points to on a scale
		
		  o identify the value of digits in a decimal or whole number
		
		  o recognise that the 3 in 0.137 is 3 hundredths
		
		  o give the value of 6 in 3.476

AN b	Numbers and their representations	• 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:
		
		  o write $\frac{3}{8}$ as a decimal
		
		  o write 1.25 as a mixed number
		
		  o write 0.35 as a fraction in its simplest form

Ref	Content descriptor	Concepts and skills

AN k	Understand and use direct proportion	• Calculate an unknown quantity from quantities that vary in direct proportion
		
		Examples:
		
		    o given the cost of 3 pens, work out the cost of 7 pens
		
		    o given the amount earned for 37 hours' work, find the amount earned for 43 hours' work assuming pay is at the same rate
		
		• Solve word problems about ratio and proportion
		
		Examples:
		
		    o given recipe amounts for 4 people, work out the amounts for 10 people
		
		    o use foreign currency exchange rates

AN l	Divide a quantity in a given ratio	• Divide a quantity in a given ratio
		
		Examples:
		
		    o share £15 in the ratio 3:2
		
		    o 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
AN m	Use calculators effectively and efficiently	• Use a calculator effectively and efficiently
		• Know how to enter complex calculations, including those involving time and money
		• Understand, and interpret, the calculator display, particularly when the display has been rounded by the calculator
		Examples:
		o recognise that when a calculator is used to work out £5 ÷ 2, the calculator display of 2.5 should be written as £2.50
		o understand that premature rounding can cause problems when undertaking calculations with more than one step;
		o understand that $\frac{2}{3}$ = 0.67 is an example of premature rounding when used in the middle of a calculation
		• Use an extended range of calculator functions, including $+, -, \times, \div, x^2, \sqrt{x}$, memory, x^y, $x^{\frac{1}{y}}$, brackets, reciprocal functions

2 Algebra

What students need to learn:

Ref	Content descriptor	Concepts and skills

AA b	Set up, and solve simple equations and inequalities	• Set up and solve simple linear inequalities in one variable
		
		Examples:
		
		  o when x is an integer, give all the solutions of $-2 \leq x < 4$
		
		  o solve the inequality $2x + 3 > 7$

AA c	Derive a formula, substitute numbers into a formula	• Derive a formula, including those with squares, cubes and roots
		
		Examples:
		
		  o write a formula for the cost C, in pounds, of buying m magazines at £3 each and b books at £7 each
		
		  o 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
		
		• Use formulae from mathematics and other subjects expressed initially in words and then using letters and symbols
		
		Examples:
		
		  o formulae for the area of a triangle, the area enclosed by a circle
		
		  o wage earned = hours worked $\times$ rate per hour
		
		  o area of a triangle or a parallelogram volume of a prism
		
		• Substitute numbers into a formula
		
		Examples:
		
		  o find the value of $2(x + 5)$ when $x = 7$ or $x = -9$
		
		  o if $C = \dfrac{x(y+1)}{9}$, find the value of C when $x = 30$ and $y = -7$
		
		  o convert temperature between degrees Fahrenheit and degrees Celsius
		
		  o find the value of P in the formula $P = 2(l + w)$ when $l = 8$ and $w = 5$

Ref	Content descriptor	Concepts and skills
AA c	Derive a formula, substitute numbers into a formula (*continued*)	• Substitute positive and negative numbers into expressions such as $3x^2 + 4$ and $2x^3$ *Example:* find the value of $2(x + 5)$ when $x = 7$ or $x = -9$ ***Functional Elements:*** – Use of the word 'formula' – Cost = standing charge + price per unit – Hire charge = Fixed charge + mileage charge – Cooking time = 25 minutes + 20 × weight in kilograms
AA d	Use the conventions for coordinates in the plane and plot points in all four quadrants	• Calculate the length of a line segment *Example:* given the coordinates of points A and B, calculate the length of AB
AA f	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 $-2 \leq x < 4$ ○ 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

Ref	Content descriptor	Concepts and skills
AA i	Find approximate solutions of equations using graphical methods and systematic trial and improvement	• Use systematic trial and improvement to find approximate solutions of equations where there is no simple analytical method of solving them

Examples:

- o solve $x^3 + x = 900$ and give the answer to 1 decimal place

- o solve $\dfrac{1}{x} = x^2 - 5$ and give the answer to 1 decimal place

- o solve $x^2 + x^3 = 17$ and give the answer to 2 decimal places

• Generate points and plot graphs of simple quadratic functions, then more general quadratic functions

Examples:

- o $y = 3x^2 + 4$
- o $y = x^2 - 2x + 1$

• 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 $x^2 + 3x - 2 = 0$

• Use suitable mathematical techniques to draw quadratic graphs

Ref	Content descriptor	Concepts and skills

AA k	Construct linear functions from real-life problems and plot their corresponding graphs	• Draw straight line graphs for real-life situations
		
		   o ready reckoner graphs
		
		   o conversion graphs
		
		   o fuel bills
		
		   o fixed charge (standing charge) and cost per unit
		
		Examples:
		
		   o construct straight line graphs for a range of contexts in everyday life
		
		   o construct conversion graph between pounds (£) and euros (€)
		
		   o construct a line graph to show *Numbers of minutes used* and *Cost* of a mobile phone bill
		
		   o use a range of strategies to create algebraic or graphical representations of a problem and its solution
		
		   o move from one form of representation to another to get different perspectives of the problem

AA m	Recognise and use graphs that illustrate direct proportion	• Set up and use equations to solve word and other problems involving direct proportion
		
		Examples:
		
		   o $y \propto x$, $y \propto x^2$
		
		   o given that the cost of 5 kg of apples is £5.50, write down a formula for the total cost, £C, of m kg of apples
		
		   o the time (t seconds) taken to boil water is directly proportional to the mass (m kg) of the water in a large water heater. Given that $t = 600$ when $m = 250$, find an equation for t in terms of m
		
		• Relate algebraic solutions to graphical representation of the equations

Ref	Content descriptor	Concepts and skills

AA n	Discuss, plot and interpret graphs (which may be non-linear) modelling real situations, including journeys/travel graphs	• Interpret straight line graphs for real-life situations
		
		• Use travel graphs
		
		Examples:
		  o calculate speed from a distance-time graph
		  o 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:
		  o 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
		  o graphs from science; cooling curves, growth and decay of bacteria
		  o distance–time graphs for a particle moving with constant speed, the depth of water in a container as it empties
		  o graphs of water filling different shaped containers

AA o	Estimate areas of irregular shapes	• Estimate area by counting squares *Example:* estimate the area of a lake on a map by counting the number of squares that the lake covers • Estimate areas of irregular shapes by approximating area to area of known shapes

3   Geometry

What students need to learn:

Ref	Content descriptor	Concepts and skills

AG 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:
		
		   o recognise that two rails of a railway track are parallel
		
		   o give reasons for angle calculations
		
		   o 'alternate angles are equal' – Z angles are not accepted as a reason
		
		   o 'corresponding angles are equal' – F angles are not accepted as a reason
		
		• Mark parallel lines on a diagram
		
		• Use the properties of corresponding and alternate angles
		
		• Use the properties of intersecting lines and triangles
		
		• Understand and use the angle properties of quadrilaterals
		
		Examples:
		
		   o explain why the angle sum of a quadrilateral is 360°, by using two triangles
		
		   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
		
		• Give reasons for angle calculations
		
		Examples:
		
		   o 'sum of the angles in a triangle is 180°'
		
		   o 'base angles of an isosceles triangle are equal'
		
		• Explain why the angle sum of a quadrilateral is 360°
		
		• Understand a proof that the angle sum of a triangle is 180°
		
		• Understand a proof that the exterior angle of a triangle is equal to the sum of the interior angles at the other two vertices

Ref	Content descriptor	Concepts and skills
AG e	Understand congruence and similarity, including the relationship between lengths in similar figures	• Understand the effect of enlargement for perimeter • Know the relationships between linear scale factors of mathematically similar shapes

AG f	Use Pythagoras' theorem in 2-D	• Understand, recall and use Pythagoras' theorem in 2-D
		
		• Calculate the height of an isosceles triangle given the lengths of all three sides
		
		Examples:
		   o calculate the length of a side of a right-angled triangle given the lengths of the other two sides
		   o calculate the diagonal of a rectangle given the length and width of the rectangle
		   o calculate the length of a playground slide, given the vertical and horizontal dimensions
		   o 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

Ref	Content descriptor	Concepts and skills

AG i	Use 2-D representations of 3-D shapes	• Use 2-D representations of 3-D shapes
		
		• 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:
		
		   o state the number of faces, edges and vertices of a cuboid and triangular prism
		
		   o identify 3–D shapes from buildings, toys and other items in everyday use; cereal boxes, kitchen roll, dice and so on
		
		   o represent a cuboid of dimensions 2 cm by 3 cm by 4 cm on an isometric grid
		
		   o given a net of a solid, identify points that coincide in the 3-D configuration
		
		   o 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
		
		• 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)

AG j	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

Ref	Content descriptor	Concepts and skills
AG k	Draw triangles and other 2-D shapes using a ruler, pair of compasses 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

AG l	Use straight edge and a pair of compasses to do 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°, 90°, 30°, and 45°
		
		• 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 constructions to solve problems

Ref	Content descriptor	Concepts and skills

AG m	Construct loci	(NB: All loci restricted to two dimensions only)
		
		• Construct:
		   o a region bounded by a circle and an intersecting line
		   o given distance from a point and a given distance from a line
		   o equal distances from two points or two line segments
		   o regions which may be defined by 'nearer to' or 'greater than'
		
		• Find and describe regions satisfying a combination of loci
		
		Examples:
		   o find and describe regions that satisfy a combination of loci
		   o 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

Ref	Content descriptor	Concepts and skills

AG n	Find circumferences of circles and areas enclosed by circles	• Find circumferences of circles
		
		• Find 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:
		
		   o find the circumference of a bicycle wheel, given the radius or diameter
		
		   o find the area of a circular table, given the radius or diameter
		
		   o find the perimeter of a semicircular carpet, given the diameter
		
		   o find the number of revolutions of a wheel of diameter 50 cm, travelling 100 metres
		
		• Find the surface area of a cylinder

AG o	Calculate perimeters and areas of shapes made from triangles and rectangles	• Find the surface area of simple shapes (prisms) using the formulae for triangles and rectangles ***Functional Elements:*** – Work out 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
AG p	Calculate volumes of right prisms and of shapes made from cubes and cuboids	• Calculate volumes of right prisms, including the triangular prism, and shapes made from cubes and cuboids
		• Find the volume of a compound solid constructed from cubes and cuboids
		• Recall and use the formula for the volume of a cuboid
		• Find the volume of a cylinder
		• Find the volume of a compound solid
		• Find the volume of a prism, cube and cuboid
		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

AM b	Convert measurements from one unit to another	• Convert between and within metric and imperial units
		
		• Convert between units of time
		
		• Convert between metric area measures
		
		• Convert between metric volume measures
		
		• Convert between metric measures of volume and capacity, eg 1 m*l* = 1 cm³
		
		• Convert between speed measures
		
		Example:
		
		    10 km/h = 2.7777... m/s
		
		• Convert between area measures, using metric units
		
		Example:
		
		    $5 \text{ m}^2 = 5 \times 100^2 \text{ cm}^2 = 50\,000 \text{ cm}^2$
		
		• Convert between volume measures, using metric units
		
		Example:
		
		    $5 \times 100^3 \text{ cm}^3 = 5000\,000 \text{ cm}^3$
		
		Functional Elements:
		
		– Use of imperial or metric measures according to which one is in common use.
		
		– Convert between imperial and metric systems where appropriate

Ref	Content descriptor	Concepts and skills
AM d	Understand and use compound measures in familiar contexts	• Understand and use compound measures, including speed *Examples:* o how many miles has a car travelled, if it travelled at 40 mph for 3 hours? o how long does it take to travel between two cities, 200 km apart, travelling at an average speed of 60 km/h? o given a mileage chart, work out the time taken to travel from A to B when travelling at an average speed of 30 mph o calculate speed from a distance-time graph ***Functional Elements:*** − Link average speed with formulae and/or graphs

Ref	Content descriptor	Concepts and skills
AM e	Understand and use bearings	• Use bearings to specify direction • Given the bearing of a point A from point B, work out the bearing of point B from point A • Use three-figure bearings to specify direction • Use bearings to solve problems *Examples:* o the bearing of Leicester from Derby is 145°. Work out the bearing of Derby from Leicester o using a map of Yorkshire, measure the bearing of York from Bradford o find the location of a ship, given its bearing from two lighthouses • Draw and measure bearings ***Functional Elements:*** – Use bearings in map and navigation problems

5 Probability

What students need to learn:

Ref	Content descriptor	Concepts and skills
AS a	Understand and use the vocabulary of probability and the probability scale	• Distinguish between events which are impossible, unlikely, even chance, likely and certain to occur *Examples:* o state the likelihood that – the roll of a dice will show an odd number – it will snow in Scotland next year • Mark probabilities on a probability scale *Examples:* o mark with a cross (X) the probability that one roll of a dice will give an even number o 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 using fractions, percentages or decimals *Example:* $\dfrac{3}{4}$ or 75% or 0.75 (NB: Do not write probabilities as 3:4, 3 out of 4 or 3 in 4)

Ref	Content descriptor	Concepts and skills

AS b	Understand and use theoretical models for probabilities including the model of equally likely outcomes	• Understand and use measures of probability
		
		• Use theoretical models to include outcomes using dice, spinners, coins, etc
		
		Examples:
		
		  o 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
		
		  o find probabilities from a two-way table
		
		  o find the probability (x) of Dave winning the race, given that the probabilities of other athletes in the race winning are:

Andy	Bill	Chas	Dave
0.35	0.1	0.25	x

• Find the probability of successive events, such as several throws of a single dice

• Use theoretical models to estimate the number of times an event will occur for a given number of trials

Ref	Content descriptor	Concepts and skills

AS c	Understand and use estimates of probability from relative frequency	• Work out relative frequency
		
		Examples:
		
		   o spin two coins or throw two dice
		
		   o list all the outcomes of spinning a coin and throwing a dice.
		
		   o list outcomes of spinning a coin or throwing a dice are: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
		
		• Understand and use estimates of probability using relative frequency
		
		Examples:
		
		   o understand and use estimates or measures of probability from examples
		
		   o estimate the number of times an event will occur, given the probability and the number of trials
		
		• Use relative frequency to estimate the number of times an event will occur for a given number of trials

AS r	Understand that when a statistical experiment or survey is repeated there will usually be 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:
		
		   o explain whether or not a dice is fair if throwing it 600 times results in 200 sixes
		
		   o understand that:
		
		     – 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 likely to result in about $\frac{1}{6}$ th of 600 for each of 1, 2, 3, 4, 5 and 6

Ref	Content descriptor	Concepts and skills
AS s	Discuss and start to estimate risk	• Identify threats that may have an effect on the outcome of an event

Examples:

> weather, illness, technical faults relating to the cost/profit of an event

• Understand and use decision tree diagrams to estimate the effect of risk

Example:

• Estimate probabilities on the tree diagram to estimate the risk of a good/poor fayre

• Begin to use estimates of costs and probabilities

Example:

> estimate suitable premiums for insurance companies given information about risks involved

Content exemplification

Unit 1: Applications 1

Higher

Overview

Content overview

This unit contains:

1 **Number**
- Four operations
- Multiples and factors
- Indices, roots and squares
- **Standard form**
- Fractions, decimals and percentages
- **Repeated proportional change**
- Accuracy

2 **Financial and business applications**
- Financial mathematics, **AER**
- Spreadsheets
- Flow charts

3 **Algebra**
- Manipulating expressions
- Equations
- **Quadratic equations**
- Coordinates
- **Linear programming**
- **Simultaneous equations**
- Straight-line graphs
- **Gradient**

4 **Geometry**
- Angles
- Quadrilaterals
- Symmetry
- Congruence
- Circles
- Perimeter and area

5 **Measure**

- Scales and measurements
- Converting units
- Estimating measures

6 **Statistics**

- The data handling cycle
- Collecting data **and sampling**
- Representing data
- **Histograms and boxplots**
- Analysing and interpreting data
- **Moving averages**
- **Cumulative frequency**
- **Quartiles and interquartile range**

Assessment overview

- 50% of the qualification
- One written paper
- 1 hour 45 minutes
- 100 marks
- Calculator allowed
- Grades A*-D available (E allowed)
- Available June and November
- 20-30% of the paper assesses the functional elements of mathematics

References

Each topic in this unit contains a specification reference (for example, **AG a** for Application, Geometry, Statement a), 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
AN a	Understand and use number operations and the relationships between them, including inverse operations and hierarchy of operations	• Add, subtract, multiply and divide whole numbers, integers, negative numbers, fractions and decimals *Examples:* ○ $\dfrac{2}{3}-\dfrac{1}{4},\ \ 2\dfrac{1}{2}+1\dfrac{3}{4},\ \ 3\dfrac{1}{3}\times2\dfrac{2}{5},\ \ 1\dfrac{5}{8}\div\dfrac{3}{4},\ \ \dfrac{3}{4}\times36$ ○ 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 *Example:* 3 × −5, −3 × −5, 10 ÷ −5, −10 ÷ −5 • Multiply or divide by any number between 0 and 1 *Example:* 3.56 × 0.023, 3.56 ÷ 0.01 • Solve a problem involving division by a decimal *Example:* pens cost £0.45 each. How many pens can you buy for £18? • Multiply and divide numbers with no more than two decimal digits, using the commutative, associative, and distributive laws and factorisation where possible, or place value adjustments

Ref	Content descriptor	Concepts and skills
AN a	Understand and use number operations and the relationships between them, including inverse operations and hierarchy of operations (*continued*)	• Use inverse operations *Examples:* ○ check that if 354 × 78 = 27 612, then 27 612 ÷ 78 = 354 ○ if $x^3 = 8$ then $x = 8^{\frac{1}{3}}$ ○ 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 6 followed by division by 7 (or vice versa) • Use brackets and the hierarchy of operations • Use one calculation to find the answer to another ***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 method 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 ÷

Ref	Content descriptor	Concepts and skills
AN b	Numbers and their representations including powers, roots, indices (integers, **fractional and negative**), and **standard index form**	• Order integers, decimals and fractions • Understand and use positive numbers and negative integers, both as positions and translations on a number line

Example:

$$3 - 5, \ -4 + 7, \ -3 - 7$$

• Order fractions

Examples:

- o arrange in order, largest first

- o $\dfrac{1}{3}, \dfrac{3}{4}, \dfrac{1}{2}, \dfrac{1}{4}$

- o find two fractions between $\dfrac{1}{4}$ and $\dfrac{1}{2}$

- o find the level of fuel in a fuel tank if the fuel gauge shows a level between $\dfrac{1}{2}$ and $\dfrac{3}{4}$

• Find equivalent fractions

Example:

write two fractions that are equivalent to $\dfrac{2}{3}$

• Write a fraction in its simplest form

Examples:

- o write $\dfrac{16}{24}$ as a fraction in its simplest form

- o write 33 out of 55 as a fraction in its simplest form

• Convert between mixed numbers and improper fractions

• Recall integer squares from 2×2 to 15×15 and the corresponding square roots

Examples:

- o select a square number or a cube number from a list

- o find the square root of 64

Ref	Content descriptor	Concepts and skills
AN b	Numbers and their representations including powers, roots, indices (integers, **fractional and negative**), and **standard index form** (*continued*)	• Recall the cubes of 2, 3, 4, 5 and 10 *Examples:* o explain why the cube of 2 is not 6 o work out the cube root of 64 o find the length of a cube with a volume of 81 cm^3 • Use index notation for integer powers of 10, squares and cubes and roots • **Recall that** n^0 **= 1 and** $n^{-1} = \dfrac{1}{n}$ **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:* o **write down the value of 10^6, 10^0, 9^{-1}, 5^{-2},** $25^{\frac{1}{2}}$, $64^{\frac{1}{3}}$, **including** $64^{\frac{1}{3}}$, $\left(\dfrac{1}{8}\right)^{\frac{1}{3}}$ o find the number of square mm in a square cm o explain why there are 10^3 or 1000 cm^3 in 1 cm^3 o which is larger, 2^3 or 3^2, $64^{\frac{1}{2}}$, **or** $64^{\frac{1}{3}}$ **?** • Use index laws to simplify and calculate the value of numerical expressions involving multiplication and division of integer, **fractional and negative** powers, and the power of a power *Examples:* o 5^7 ÷ 5^5 = 5^2, 3^3 × 3^4 = 3^7, 5^7 ÷ 5^{-5} = 5^{12}, **3 × 3^{-4} = 3^{-1}** o $64^{\frac{2}{3}}$, $\left(\dfrac{2}{3}\right)^{-2}$, $\left(5^2\right)^3$ • **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**

Ref	Content descriptor	Concepts and skills
AN b	Numbers and their representations including powers, roots, indices (integers, **fractional and negative**), and **standard index form** (*continued*)	• **Convert between ordinary and standard form representations, converting to standard form to make sensible estimates for calculations involving multiplication and/or division** • **Interpret a calculator display using standard form** • **Calculate with standard form** ***Examples:*** ○ **$2.4 \times 10^7 \times 5 \times 10^3$** ○ **$(2.4 \times 10^7) \div (5 \times 10^3)$**
AN c	Use the concepts and vocabulary of factor (divisor), multiple, common factor, common multiple and prime number	• Identify factors, multiples and prime numbers from a list of numbers *Example:* from a list of numbers select a multiple of 7, factors of 56, a prime number • Find common factors and common multiples *Examples:* ○ list all the common factors of 24 and 36 ○ find the time lapse between synchronous flashes of two lighthouses with two different lengths of time between flashes
AN d	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 $\dfrac{52.9 \times 3.1}{19.5 - 1.9}$ ○ estimate $\dfrac{68 \times 401}{198}$ ***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

AN f	Understand that 'percentage' means 'number of parts per 100' and use this to compare proportions	• Convert between fractions, decimals and percentages
		
		Examples:
		
		  o write 0.35 as a fraction in its simplest form
		
		  o write 1.25 as a mixed number using a calculator
		
		• Use percentages, fractions and decimals to compare proportions
		
		Examples:
		
		  o 20% means 20 parts per hundred or $\dfrac{20}{100}$ or $\dfrac{1}{5}$
		
		  o which is the greater fraction; 1.5 out of 8 or 2 out of 10?
		
		Functional Elements:
		
		  – Comparison of payment options; using $+$, $\times$, % fractions

Ref	Content descriptor	Concepts and skills

AN g	Use multipliers for percentage change; **work with repeated percentage change; solve reverse percentage problems**	• Use percentages in real-life situations
		   o VAT
		   o Simple interest
		   o **Compound interest**
		   o **Depreciation**
		   o Find prices after a percentage increase or decrease
		   o Percentage profit and loss
		
		Examples:
		   o find the total price after VAT is added
		   o find the percentage profit or loss after a transaction
		   o find total interest if £400 is invested at 3% for 2 years simple interest
		   o income tax calculations
		   o annual rate of inflation
		
		• **Calculate an original amount, when given the transformed amount after a percentage change**
		
		Examples:
		   o **calculate the original price given the sale price**
		   o **find the cost before VAT is added of a restaurant meal, given the total cost is £36 with VAT at 17.5%**
		
		• **Reverse percentage calculations**
		
		Example:
		
		   Given that the sale price of a TV is £272 after a decrease of 15% then its normal price is 272 ÷ 0.85
		
		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
AN h	Interpret fractions, decimals and percentages as operators	• Interpret percentage as an operator • Find percentages of quantities • Calculate a given fraction of a given quantity • Express a given number as a fraction of another *Examples:* o write 33 out of 55 as a fraction in its simplest form o write 40 cm as a fraction of 2 m o 15% of Y means $\dfrac{15}{100} \times Y$ or $0.15 \times Y$ o calculate 26 as a percentage of 150 • Express a given number as a percentage of another *Example:* calculate 26 as a percentage of 150 • Understand the multiplicative nature of percentages as operators *Examples:* o a multiplier of 1.05 corresponds to an increase of 5% o 30% increase on £150 gives a total calculated as £(1.3×150), while 20% discount gives a total calculated as £(0.8×150) • **Understand and use compound interest and depreciation** ***Example:*** **use £100 $\times$ (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

AN i	Find proportional change and **repeated proportional change**	• **Use repeated proportional change**
		
		 Examples:
		
		  o **a bouncing ball reaching 70% of its previous height with each bounce**
		
		  o **find the total amount if £200 is invested at 5% compound interest for 3 years**
		
		  o **explore exponential growth and decay using a multiplier**
		
		 • Solve word problems about ratio and proportion, including using informal strategies and the unitary method of solution
		
		 Examples:
		
		  o given the cost of 3 pens, work out the cost of 7 pens
		
		  o compare the value of different sizes of a product using mass and cost
		
		  o use direct proportion in context
		
		 • **Represent repeated proportional change using a multiplier raised to a power**

Ref	Content descriptor	Concepts and skills

AN m	Use calculators effectively and efficiently, including **trigonometrical** and statistical functions	• Use a calculator effectively and efficiently
		
		• Know how to enter complex calculations, including those involving time and money
		
		Examples:
		  o time calculations in which parts of an hour or minute are entered as fractions or decimals
		  o 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
		  o time calculations for journey times
		  o car hire bills
		  o mobile phone tariffs
		  o given total fuel costs, find the number of units used
		  o how many coaches that hold 57 passengers are needed for 150 students on a day trip?
		
		• Understand, and interpret, the calculator display, particularly when the display has been rounded by the calculator
		
		• Use an extended range of calculator functions, including $+$, $-$, $\times$, $\div$, x^2, $\sqrt{x}$, memory, x^y, $x^{\frac{1}{y}}$, brackets
		
		• **Use standard form display and know how to enter numbers in standard form**
		
		• **Use calculators for reverse percentage calculations by doing an appropriate division**
		
		• Use a calculator to solve problems in statistics
		
		• Calculate the mean of a small dataset, using the appropriate key on a scientific calculator

2   Financial and business applications

What students need to learn:

Ref	Content descriptor	Concepts and skills
AF a	Carry out calculations relating to enterprise, saving and borrowing, appreciation and depreciation and **understand AER**	• Work out the amount an investment is worth given the number of years and interest rate *Example:* how much will be in an account after one year if £3000 is invested at 4% pa simple interest • Use multipliers to work out appreciation and depreciation *Examples:* o know that to work out the value of an amount invested for 1 year at 5% interest, the calculation needed is to multiply by 1.05 o know that to work out the value of an object after 1 year's depreciation of 5% of the value at the beginning of the year, the calculation needed is to multiply by 0.95 • **Understand and use AER** ***Examples:*** o **know that AER is 'Annual Equivalent Rate' and gives the amount of interest an account would earn if the money was left in for a full year** o **when interest is paid monthly, calculate the AER** o **given two (or more) different interest rates over the lifetime of a savings account, calculate the AER** o **work out and use AER to compare two (or more) savings options**

Ref	Content descriptor	Concepts and skills

AF b	Use mathematics in the context of personal and domestic finance including loan repayments, budgeting, RPI and CPI, exchange rates and commissions	• Work out the interest due on a loan
		
		Example:
		
		how much interest is due after 1 year if £3000 is borrowed at rate of 6.5% pa?
		
		• Convert between different currencies given the exchange rate and any rates of commission
		
		Examples:
		
		  o convert between two currencies given the exchange rate
		
		  o compare prices in different countries of the same product using given exchange rates
		
		• Use simple index numbers
		
		Examples:
		
		  o given the cost of goods in the base year, work out the index number in the subsequent year
		
		  o given the cost of goods in the base year and the index number in the current year, work out the cost of goods in the current year
		
		• Use mathematics in the context of personal finance
		
		Examples:
		
		  o understand and use a simple bank statement
		
		  o work out the amount of tax due to be paid given income and personal allowance

AF c	Use spreadsheets to model financial, statistical and other numerical situations	• Use spreadsheets to model a situation mathematically
		
		Examples:
		
		  o write a formula in a cell to find the total of the numbers in five different cells
		
		  o write a formula in a cell to calculate the amount earned in a week given the hourly wage in one cell and the number of hours worked in another
		
		  o write a formula in a cell to find the total of the numbers in a column or row

 Content exemplification Edexcel GCSE in Applications of Mathematics

Ref	Content descriptor	Concepts and skills
AF d	Construct and use flow charts	• Construct a flow chart from a simple algorithm *Examples:* o use input/output, instruction and decision boxes within a flow chart o construct a flow chart to show the total amount of tax to be paid o construct a flow chart to calculate the amount earned in a week given the number of hours worked and hourly wage as well as the number of hours of overtime worked and the hourly rate for overtime. • Use a flow chart given the input value(s) *Examples:* o use a flow chart which includes decision boxes o use a flow chart to work out the total cost of using a mobile phone using the total number of minutes used as an input o use a flow chart with different inputs and comment on the outcomes

3 Algebra

What students need to learn:

Ref	Content descriptor	Concepts and skills

AA a	Manipulate algebraic expressions by collecting like terms, by multiplying a single term over a bracket, and by taking out common factors	• Multiply a single term over a bracket
		
		• Manipulate algebraic expressions by collecting like terms
		
		Examples:
		    expand and simplify:
		    $2(x + 4) - (1 - x)$
		    $5x(3x + 4) - 2x(5 - 4x)$
		
		• Use instances of index laws, **including use of fractional, zero and negative powers**, and the power of a power
		
		Examples:
		    simplify:
		    $x^2 \times x^3$
		    $x^6 \div x^4$
		    $\dfrac{t^6}{t^2}$
		    $(x^2)^3$
		
		• Substitute positive and negative numbers into expressions such as $3x^2 + 4$ and $2x^3$
		
		• Factorise algebraic expressions by taking out common factors

Ref	Content descriptor	Concepts and skills
AA b	Set up, and solve simple equations and inequalities	• Set up simple equations

• Solve simple equations by using inverse operations or by transforming both sides in the same way

• 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 which 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, in which the unknown appears on either side or on both sides of the equation

Examples:

$$\frac{x}{4} + 1 = 5, \; \frac{2x - 3}{6} + \frac{x + 2}{3} = \frac{5}{2},$$

$$\frac{17 - x}{4} = 2 - x$$

• Set up and solve simple linear inequalities

Examples:

o when x is an integer, give all the solutions of $-2 \leq x < 4$

o solve the inequality $2x + 3 > 7$

Ref	Content descriptor	Concepts and skills
AA d	Use the conventions for coordinates in the plane and plot points in all four quadrants	• Use axes and coordinates to specify points in all four quadrants in 2-D **then 3-D** • Identify points with given coordinates (NB: Points may be in the first quadrant or all four quadrants) • Find the coordinates of the midpoint of the line segment AB, given the coordinates of A and B in 2-D
AA e	Recognise and plot equations that correspond to straight-line graphs in the coordinate plane	• 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:* o plot $x + y = 6$ with, or without a table of values o recognise that, in a mathematical context, an equation of the form $y = mx + c$ is a straight line

Ref	Content descriptor	Concepts and skills

AA g	**Set up and solve problems in linear programming, finding optimal solutions**	• **Express real life constraints in terms of linear inequalities**
		
		• **Use constraints and conditions**
		
		Examples:
		
		  ○ **given a problem with two variables and a set of constraints express these in terms of linear inequalities**
		
		  ○ **a table takes 10 hours to produce, a chair takes 15 hours to produce. There is a maximum of 120 hours of production time available in a month. Write down a linear inequality to represent this condition**
		
		  ○ **at least 4 times as many chairs as tables must be produced. Write down a linear inequality to represent this condition**
		
		• **Draw graphs of linear inequalities**
		
		Examples:
		
		  ○ **draw the graphs of** $2x + 3y \leq 24, y \geq 4x$
		
		  ○ **draw the graphs of** $y > x, 2x + 5y \geq 20$
		
		• **Write down the objective function for a real life problem**
		
		Example:
		
		  given that the profit made on selling one table is £200, and the profit made on selling one chair is £50, write down the objective function that will maximise total profit made
		
		• **Find the feasible region**
		
		Example:
		
		  draw graphs of linear inequalities that represent a problem, using shading to identify the feasible region either by shading in or shading out
		
		• **Be able to use graphs of linear inequalities to solve maximisation or minimisation problems**

Ref	Content descriptor	Concepts and skills

AA g	**Set up and solve problems in linear programming, finding optimal solutions**
	
	(*continued*)
		• **Use either the profit line or point testing to find an optimal solution**
		
		Examples:
		
		  o **use the objective function and values of x and y at the vertices of the feasible region to find the optimal solution to the problem**
		
		  o **use the objective function to draw a profit line and then use this to find the optimal solution to the problem**
		
		• **Interpret graphs of linear inequalities as a real life problem**
		
		Example:
		
		  given a graph showing a feasible region, write down the linear inequalities and then interpret these as real life constraints in context

Ref	Content descriptor	Concepts and skills
AA h	**Set up and solve linear simultaneous equations in two unknowns**	• **Find the exact solutions of two simultaneous equations in two unknowns**

Example:

> **solve for x and y**
>
> $x + y = 8$ **and** $2x + y = 1$
>
> $x - y = 3$ **and** $3x - 2y = 8$

• **Use elimination or substitution to solve simultaneous equations**

• **Interpret a pair of simultaneous equations as a pair of straight lines and their common solution as the point of intersection**

Example:

> **draw graphs and solve for x and y**
>
> $y = 3x - 4, \; y = 4 - x$

• **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
AA j	Find and interpret gradients and intercepts of straight line graphs in practical contexts	• Find the gradient of lines given by equations of the form $y = mx + c$

• 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)**

• Use the method of finding a gradient to see how one variable increases in relation to another

AA j   Find and interpret gradients and intercepts of straight line graphs in practical contexts

(*continued*)

- **Analyse problems and use gradients to interpret how one variable changes in relation to another**

Example:

> **match equations with simple sketch graphs**

4 Geometry

What students need to learn:

Ref	Content descriptor	Concepts and skills

AG a	Recall and use properties of angles at a point, angles at a point on a straight line (including right angles), perpendicular lines, and vertically opposite angles	• Recall and use properties of angles
		   o angles at a point
		   o angles at a point on a straight line
		   o perpendicular lines
		   o vertically opposite angles

AG b	Understand and use the angle properties of parallel and intersecting lines, triangles and quadrilaterals	• Draw and identify parallel lines • Distinguish between scalene, isosceles, equilateral, and right-angled triangles • Understand and use the angle properties of triangles • Understand and use the angle properties of intersecting lines • Give reasons for angle calculations • **Recall and use these basic properties of angles in more complex problems**
AG c	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 from its properties • Use symmetry properties of quadrilaterals • Classify quadrilaterals by their geometric properties
AG d	Recognise reflection and rotation symmetry of 2-D shapes	• Recognise reflection symmetry • Draw lines of reflection • Recognise rotational symmetry • Be able to identify the order of rotational symmetry • State the line of reflective symmetry as a simple algebraic equation *Functional elements:* – Use symmetry in tiling problems

Ref	Content descriptor	Concepts and skills
AG e	Understand congruence and similarity, including the relationship between lengths, **areas and volumes** in similar figures	• Identify similar shapes • Identify congruent shapes • Understand what makes two shapes congruent or similar • Understand the relationships between lengths, **areas and volumes** in similar figures *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** • **Identify similar solids** • Recognise that all corresponding angles in similar shapes are equal in size when the lengths of sides are not
AG h	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, such as semicircle or quarter circle *Example:* match diagrams to the mathematical names of the parts of the circle • Draw a circle given the radius or diameter

Ref	Content descriptor	Concepts and skills
AG o	Calculate perimeters and areas of shapes made from triangles and rectangles **and other shapes**	• Calculate perimeters of shapes made from triangles and rectangles • Find the perimeter of compound shapes • Calculate areas and perimeters of shapes made from triangles and rectangles **and other shapes** • Recall and use the formulae for the area of a triangle, and a rectangle and a parallelogram • Find the area of a trapezium • Find the area of a parallelogram • Measure sides of a rectangle to work out perimeter or area ***Functional Elements:*** – Calculate 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

5   Measures

What students need to learn:

Ref	Content descriptor	Concepts and skills
AM a	Interpret scales on a range of measuring instruments and recognise the inaccuracy of measurements	• Interpret scales on a range of measuring instruments *Examples:* m, km, mm, cm, m*l*, c*l*, *l*, kg, g, tonnes, °C • Indicate measures on a scale • 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
AM b	Convert measurements from one unit to another	• Convert between units of time • Convert between units of measure in the same system *Example*: convert 2.3 m to mm (NB: Imperial conversions: conversion between imperial units will be given.) • Metric equivalents should be known • Know rough metric equivalents of pounds, feet, miles, pints and gallons

<div style="margin-left:2em">

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

</div>

• Convert between imperial and metric measures

Functional Elements:

– Use of imperial or metric measures according to which one is in common use

– Convert between imperial and metric systems where appropriate

Ref	Content descriptor	Concepts and skills
AM c	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
AM f	Measure and draw lines and angles	• Measure and draw lines to the nearest mm • Measure and draw angles to the nearest degree

6 Statistics

What students need to learn:

Ref	Content descriptor	Concepts and skills
AS d	Understand and use the 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 sources, including experiments and surveys, and 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

Ref	Content descriptor	Concepts and skills
AS e	Design an experiment or survey, identifying 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:
		o understand the significance of the population from which the sample is taken when avoiding bias
		o 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
		• Design an experiment or survey
		• Consider fairness
		• Design a question, with response boxes, for a questionnaire by identifying key questions that can be addressed by statistical methods
		• Criticise questions for a questionnaire
		• Identify which primary data to collect and in what format, including grouped data, considering appropriate equal class intervals (and using appropriate notation)
		• **Select and justify a sampling scheme and a method to investigate a population, including random and stratified sampling**
		• **Use stratified sampling**
		Examples:
		o **use stratified sampling for opinion polls, elections, popular TV programmes etc, given information on the nature of each population to be surveyed**
		o 'how often do you visit the public library? Never…, A lot…, Sometimes….' This 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
AS f	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 • Understand and use tallying methods • Collect data using various methods, including observation, controlled experiment, data logging, questionnaires and surveys • Sort, classify and tabulate (categorical or qualitative) 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 newborn babies (discrete/continuous data)
AS g	Extract data from publications, charts, tables and lists	• Extract data from lists and tables *Examples:* o use secondary data from newspapers etc o spreadsheets containing column data o temperature, rainfall charts across the country/world

Ref	Content descriptor	Concepts and skills
AS h	Design, use and interpret 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
AS i	Look at data to find patterns and exceptions	• Look at data to find patterns and exceptions • **Explain an isolated point on a scatter graph**

Ref	Content descriptor	Concepts and skills
AS j	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
		Examples:
		o 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
		o 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
		• 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
		• Recognise the advantages and disadvantages between measures of average
		Example:
		explain why the mean shoe size of a population would not be as useful as the mode for a shoe retailer
		• **Compare the measures of spread between a pair of box plots/cumulative frequency graphs**

Ref	Content descriptor	Concepts and skills

AS k	Produce and interpret charts and diagrams for categorical data including bar charts, pie charts and pictograms	• Produce, interpret and complete:
		  o pie charts
		  o bar charts
		  o pictograms
		  o composite bar charts
		  o multiple or dual bar charts
		
		• From pie charts:
		  o find the total frequency
		  o find the frequency represented by each section

AS l	Produce and interpret diagrams for ungrouped discrete numerical data, including vertical line charts and stem-and-leaf diagrams	• Produce
		  o line graphs
		  o stem and leaf diagrams
		
		Example:
		    a stem and leaf diagram or frequency table shows the weights of fifty 16-year-old girls. Use this information to draw a box plot or a cumulative frequency diagram
		
		• Interpret a wide range of graphs and diagrams and draw conclusions
		
		• Recognise simple patterns, characteristics and relationships in line graphs
		
		• From line graphs:
		  o read off frequency values
		  o calculate total population
		  o find greatest and least values
		
		• Find range and median from stem and leaf diagrams, as well as the greatest and least value

Ref	Content descriptor	Concepts and skills

AS m	Produce and interpret diagrams for grouped discrete data and continuous data**, including histograms with unequal class intervals**	• Produce
		   ○ frequency polygons
		   ○ histograms with equal class intervals
		   ○ frequency diagrams for grouped discrete data
		   ○ frequency polygons for grouped data
		   ○ grouped frequency table for continuous data
		   ○ **histograms from class intervals with unequal width**
		• **Use and understand frequency density**
		• Interpret a wide range of graphs and diagrams, and draw conclusions
		• Interpret and complete
		   ○ frequency polygons
		   ○ **histograms, including those with unequal class intervals**
		• 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 histograms**
		   ○ **complete a grouped frequency table**
		   ○ **understand and define frequency density**

Ref	Content descriptor	Concepts and skills

AS n	**Produce and use cumulative frequency graphs and box-and-whisker plots**	• **Produce and complete:**
		
		  o **cumulative frequency tables**
		
		  o **cumulative frequency graphs**
		
		  o **box plots from raw data and when given quartiles, median, etc**
		
		• **Interpret a wide range of graphs and diagrams and draw conclusions**
		
		  o **box plots**
		
		  o **cumulative frequency diagrams**
		
		• **From cumulative frequency graphs**
		
		  o **estimate frequency greater/less than a given value**
		
		  o **find the median and quartile values and interquartile range**

AS o	Work with time series and **moving averages**, including their graphical representation	• Draw and produce time series graphs (line graphs) from given and experimental data
		
		Example:
		
		  given the amount of average monthly rainfall each month for a year, draw a time series graph
		
		• **Calculate an appropriate moving average**
		
		Example:
		
		  usually a 3 or 4 point moving average
		
		• Identify seasonality and trends in time series
		
		Example:
		
		  examine a graph showing number of ice creams sold each month for two years, identify if the season has an effect on the number of ice creams sold
		
		• **Use moving average to identify trend**
		
		Example:
		
		  use moving averages by plotting a graph to identify trend and draw in trend lines

Ref	Content descriptor	Concepts and skills
AS p	Calculate, and for **grouped data estimate**, median, mean, range, **quartiles and interquartile range**, mode and modal class	• Calculate averages and range of small data sets with discrete, then continuous, data • Find the median, **quartiles and interquartile range** for large data sets and 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** • Find the modal class of grouped data • Find the interval containing the median

Ref	Content descriptor	Concepts and skills
AS q	Recognise correlation and draw and/or use lines of best fit by eye, understanding and interpreting what these represent, and appreciating that correlation does not imply causality	• Draw and interpret a scatter diagram • 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' • Understand that correlation does not imply causality *Examples:* o positive correlation; number of ice-creams sold daily vs. daily temperature, height vs. arm-span o negative correlation; age of car vs. value of car, hours of sunshine vs. rainfall o no correlation; age of adult vs. weight ~ this true? • 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, or otherwise, to predict values of one variable given values of the other variable *Examples:* o for height against weight scatter diagram, predict the possible weight for a person with a given height o use **the trend of data** on a scatter graph to predict values of a variable given values of another

Content exemplification

Edexcel GCSE
in Applications of Mathematics

Unit 2: Applications 2

Higher

Overview

Content overview

This unit contains:

1 Number

- Four operations
- Reciprocals
- **Direct and inverse proportion**
- Ratio
- **Lower and upper bounds**
- **Exponential growth and decay**
- Using calculators

2 Algebra

- Formulae
- Inequalities
- Trial and improvement
- **Graphs of direct and indirect proportion**
- **Gradients and rates of change**
- **Areas under curves**

3 Geometry

- Angles and lines
- Congruence and similarity
- Pythagoras' Theorem
- **Trigonometry**
- 2-D representations of 3-D shapes
- Constructions and loci
- Mensuration and volume
- Circles

4 Measure

- Scale drawings

- Converting units

- Bearings

- Speed and **Density**

5 Probability

Assessment overview

- 50% of the qualification

- One written paper

- 1 hour 45 minutes

- 100 marks

- Calculator allowed

- Grades A*-D available (E allowed)

- Available June and November

- 20-30% of the paper assesses the functional elements of mathematics

References

Each topic in this unit contains a specification reference (for example, **AM a** for Applications, Measures, Statement a), 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 Unit 1 is subsumed in the content of Unit 2. However, Unit 1 content will not be the direct focus of assessment.

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
AN a	Understand and use number operations and the relationships between them, including inverse operations and hierarchy of operations	• Add, subtract, multiply and divide whole numbers, directed numbers, integers, fractions and decimals

Examples:

- $\dfrac{2}{3} - \dfrac{1}{4}$, $2\dfrac{1}{2} + 1\dfrac{3}{4}$, $3\dfrac{1}{3} \times 2\dfrac{2}{5}$, $1\dfrac{5}{8} \div \dfrac{3}{4}$, $\dfrac{3}{4} \times 36$
- 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
- 3×-5, -3×-5, $10 \div -5$, $-10 \div -5$
- 3.56×0.023, $3.56 \div 0.01$

• Solve a problem involving division by a decimal

Example:

> pens cost £0.45 each. How many pens can you buy for £18?

• 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)

• Use inverse operations

Example:

> check that if $354 \times 78 = 27\,612$, then $27\,612 \div 78 = 354$

Ref	Content descriptor	Concepts and skills

AN a	Understand and use number operations and the relationships between them, including inverse operations and hierarchy of operations
	
	(Continued)
		Functional Elements:
		
		– Use appropriate procedures for addition, subtraction, multiplication and division of integers and decimals, understanding where to position the decimal point
		
		Examples:
		
		   o break down a complex calculation by using simpler steps
		
		   o find the extra paid when a Credit Plan is used rather than paying cash
		
		   o use a multiplication rather than a division method to work out the number of full bottles that can be filled from a large container
		
		   o stock control problems
		
		   o packing problems and dealing with remainders; using $\div$
		
		• **Understand that the inverse operation of raising a positive number to a power n is raising the result of this operation to the power $\dfrac{1}{n}$**
		
		Example:
		
		   if $x^3 = 8$ then $x = 8^{\frac{1}{3}}$
		
		• Understand and use unit fractions as multiplicative inverses
		
		Examples:
		
		   understand that multiplication by $\dfrac{1}{5}$ is the same as division by 5, or multiplication by $\dfrac{6}{7}$ is the same as multiplication by 6 followed by division by 7 (or vice versa)
		
		• Find reciprocals
		
		Example:
		
		   find the reciprocal of 0.2

Ref	Content descriptor	Concepts and skills

AN b	Numbers and their representations	• 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:
		
		  o write 0.35 as a fraction in its simplest form
		
		  o write 1.25 as a mixed number using a calculator

AN e	**Understand and use 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**

AN j	**Exponential growth/decay, its relationship with repeated proportional change including financial and scientific applications**	• **Understand the meaning of exponential growth**
		
		• **Use multipliers to explore exponential growth/decay**
		
		• **Use exponential growth in real life problems**
		
		Examples:
		
		  o **the population of a country is currently 60 million and growing at a rate of 5.4% per year. Work out the likely population in 20 years**
		
		  o **given that the population of a country is currently 60 million and likely to continue growing at a rate of 5.4% per year. Work out how many years it will be before the population exceeds 70 million**

Ref	Content descriptor	Concepts and skills
AN k	Understand and use direct and **inverse** proportion	• Calculate an unknown quantity from quantities that vary in direct or **inverse** proportion
		• Solve word problems about ratio and proportion
		Examples:
		o y **varies inversely as** x**, when** $y = 4$ **and** $x = 0.5$**, find the value of** y **when** $x = 10$
		o **find the mass of 30 cm of pipe given the mass of 20 cm of the same pipe**
		o **use the inverse square law to model the volume of sound received from a loudspeaker**
		o **find the cost of 5 pens given the cost of 7 pens**
		o **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
AN l	Divide a quantity in a given ratio	• Divide a quantity in a given ratio *Examples:* o write a ratio in the form $1{:}n$ or $n{:}1$ o understand that the ratio 2: 3 is $\dfrac{2}{5}:\dfrac{3}{5}$ o write 20:12 as a ratio in its simplest form • Solve a ratio problem in a context *Examples:* o share £15 in the ratio 3:2 o share 20 metres of ribbon in the ratio 11:6:3 ***Functional Elements:*** – Solve a ratio problem in a context – Convert a recipe for 6 people to one for 8 people – Use ratios in connection with areas and tiling problems

Ref	Content descriptor	Concepts and skills

AN m	Use calculators effectively and efficiently, including **trigonometrical** and statistical functions	• Use a calculator effectively and efficiently
		
		Examples:
		   o time calculations in which parts of an hour or minute are entered as fractions or decimals
		   o 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
		   o time calculations for journey times
		   o car hire bills
		   o mobile phone tariffs
		   o given total fuel costs, find the number of units used
		   o how many coaches that hold 57 are needed for 150 students on a day trip?
		
		• Know how to enter complex calculations, including those involving time and money
		
		• Understand, and interpret, the calculator display, particularly when the display has been rounded by the calculator
		
		• Use an extended range of calculator functions, including $+, -, \times, \div, x^2, \sqrt{x}$, memory, x^y, $x^{\frac{1}{y}}$, brackets, **trigonometric** and reciprocal functions
		
		• **Calculate the upper and lower bounds of calculations, particularly when working with measurements**
		
		• **Use calculators to explore exponential growth and decay, using a multiplier and the power key**

2 Algebra

What students need to learn:

Ref	Content descriptor	Concepts and skills
AA b	Set up, and solve simple inequalities	• Set up and solve simple linear inequalities in one variable *Examples:* o when x is an integer, give all the solutions of $-2 \leq x < 4$ o solve the inequality $2x + 3 > 7$
AA c	Derive a formula, substitute numbers into a formula	• Derive a formula • Use formulae from mathematics and other subjects expressed initially in words and then using letters and symbols • Substitute numbers into a formula or expression
AA d	Use the conventions for coordinates in the plane and plot points in all four quadrants	• Given the coordinates of points A and B, in 2-D **or 3-D** calculate the length of AB

Ref	Content descriptor	Concepts and skills
AA f	Solve linear inequalities in one **or two** variables, and represent the solution set on a number line **or suitable diagram**	• Solve simple linear inequalities in one variable, **or two variables**, and represent the solution set on a number line

Examples:

    o notation $-7 \leq x < 4$ represented on a number line
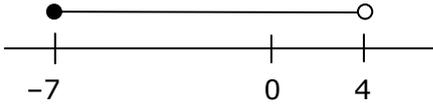
    o when x is an integer, give all the solutions of $-7 \leq x < 4$

    o show $b > 5$ on a number line

    o solve the inequality $3x + 1 > 7$

    o 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:

    o **shade the region defined by $y > 3$, $y \leq 7 - x$, $x > 0$**

    o **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
AA i	Find approximate solutions of equations using graphical methods and systematic trial and improvement	• Use systematic trial and improvement to find approximate solutions of equations where there is no simple analytical method of solving them

Example:

    $x^3 + 2x = 4$

• Find the solution of two equations by finding intersection of graphs of simple quadratic functions, then more general quadratic functions

Example:

    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

Ref	Content descriptor	Concepts and skills
AA i	Find approximate solutions of equations using graphical methods and systematic trial and improvement (*continued*)	***Examples:*** o **draw the graph of $y = 2x^2 - 3$ and find the values of x when $2x^2 - 3 = 0$** o **use $y = 2x^2 - 3$ and $y = 3 - x$ to solve the quadratic equation $2x^2 + x - 6 = 0$**

AA k	Construct linear**, quadratic and other** functions from real-life problems and plot their corresponding graphs	• Draw straight line graphs for real-life situations
		
		  o ready reckoner graphs
		
		  o conversion graphs
		
		  o fuel bills, eg gas and electric
		
		  o fixed charge (standing charge) and cost per unit
		
		  o 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

AA l	**Interpret the gradient at a point on a curve as the rate of change**	• **Know that the gradient of a curve at a point is given by the gradient of the tangent at that point**
		
		• **Draw in a tangent to a curve at a given point**
		
		• **Work out the gradient at a point on a curve by finding the gradient of the tangent**
		
		Examples:
		
		    given the graph $y = x^3 - 2x^2$ find the gradient when $x = -0.5$
		
		• **Be able to interpret the gradient as the rate of change in context of the given real life problem**
		
		Examples:
		
		    o **from a distance-time graph work out the speeds at different times**
		
		    o **from a velocity-time graph work out the acceleration at a given time**
		
		    o **from a graph showing volume of water plotted against time, work out the gradient and know that this represents the rate of change of volume at that time**

Ref	Content descriptor	Concepts and skills
AA m	Recognise and use graphs that illustrate direct and **inverse** proportion	• Set up and use equations to solve word and other problems involving direct proportion **or inverse proportion**

Examples:

- o $y \propto x$, $y \propto x^2$, $y \propto \dfrac{1}{x}$, $y \propto \dfrac{1}{x^2}$

- o the stopping distances of a car varies directly as the speed of the car increases

- o **the loudness of a loudspeaker varies inversely to 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**

- • Relate algebraic solutions to graphical representation of the equations

Ref	Content descriptor	Concepts and skills

AA n	Discuss, plot and interpret graphs (which may be non-linear **and/or periodic**) modelling real situations, including journeys/travel graphs	• Interpret straight line graphs for real-life situations:
		  o ready reckoner graphs
		  o conversion graphs
		  o fuel bills eg gas and electric
		  o fixed charge (standing charge) and cost per unit
		
		Examples:
		  o graphs from science, cooling curves, growth and decay of bacteria
		  o 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
		  o distance-time graph for a particle moving with constant speed
		  o graph showing the depth of water in a container as it empties
		  o interpret the gradient of straight line segments on a speed-time graph as acceleration
		  o graphs of water filling different shaped containers
		  o **apply the correct mathematical methods in a range of linear and non-linear graphs representing real-life situations**
		  o **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
		• Understand distance-time, speed-time and travel graphs
		• Interpret information presented in a range of linear and non-linear graphs
		• Interpret periodic graphs for real-life situations

Ref	Content descriptor	Concepts and skills
AA o	Estimate areas of irregular shapes and **areas under curves**	• Estimate areas of irregular shapes by approximating area to area of known shapes
		• **Estimate area under curves by dividing area into strips of equal width**
		Example:
		find the area under the graph of $y = x^2 + 3$ **from** $x = 0$ **to** $x = 5$
		• **Understand that if the area is divided into a greater number of strips then the effect is to increase the accuracy of the approximation**
		Example:
		obtain a better approximation for an area under a graph by increasing the number of strips

3 Geometry

What students need to learn:

Ref	Content descriptor	Concepts and skills
AG b	Understand and use the angle properties of parallel and intersecting lines, triangles and quadrilaterals	• 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 360° *Example:* investigate angles in a quadrilateral by using two triangles • Understand a proof that the angle sum of a triangle is 180° • Understand a proof that the exterior angle of a triangle is equal to the sum of the interior angles at the other two vertices
AG e	Understand congruence and similarity, including the relationship between lengths, **areas and volumes** in similar figures	• Understand the effect of enlargement for perimeter, **area and volume** of shapes and **solids** ***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** • **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**

Ref	Content descriptor	Concepts and skills
AG f	Use Pythagoras' theorem in 2-D **and 3-D**	• Understand, recall and use Pythagoras' theorem in 2-D, **then in 3-D problems** • Calculate the height (altitude) 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 a diagonal of a cuboid**

AG g	**Use the trigonometrical ratios to solve 2-D and 3-D problems**	• **Use the trigonometric ratios to solve 2-D and 3-D problems**
		
		Examples:
		
		  o **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**
		
		  o **calculate the slope of a staircase given the rise and depth of each stair**
		
		• **Understand, recall and use trigonometric relationships in right-angled triangles, and use these to solve problems in 2-D and in 3-D configurations**
		
		• **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 from the ground and the horizontal distance from the foot of the tower
		
		Functional Elements:
		
		– **Use trigonometry in navigation problems**
		
		– **Calculate heights and distances using angles of elevation and depression**
		
		– **Use loci and bearings to solve problems**

Ref	Content descriptor	Concepts and skills

AG i	Use 2-D representations of 3-D shapes	• Use 2-D representations of 3-D shapes
		
		Examples:
		
		   o represent a cuboid of dimensions 2 m by 3 m by 4 m on an isometric grid
		
		   o use isometric drawing
		
		• 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:
		
		   o draw the front and side elevation and plan of a real life structure
		
		   o given a net of a solid, identify points which coincide in the 3-D configuration
		
		   o given the front and side elevations and a plan of the solid, draw a sketch of the 3-D solid
		
		   o 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
		
		Functional Elements:
		
		– Design suitable nets for containers (not necessarily cuboids)

AG j	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
AG k	Draw triangles and other 2-D shapes using a ruler, pair of compasses 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

Ref	Content descriptor	Concepts and skills
AG l	Use straight edge and a pair of compasses to do 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°, 90°, 30°, 45°
		• 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
AG m	Construct loci	(NB: All loci restricted to two dimensions only) • Construct: o a region bounded by a circle and an intersecting line o given distance from a point and a given distance from a line o equal distances from two points or two line segments o 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

Ref	Content descriptor	Concepts and skills

AG n	Find circumferences of circles and areas enclosed by circles	• Find circumferences of circles
		
		• Find an area enclosed by a circle
		
		• Recall and use the formulae for the circumference of a circle and the area enclosed by a circle
		
		Examples:
		  o find the circumference of a bicycle wheel, given the radius of diameter
		
		  o find the perimeter of a semi-circular carpet, given the diameter
		
		  o find the area of a circular table, given the radius or diameter
		
		  o 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°
		
		• Find the surface area of a cylinder
		
		Functional Elements:
		  – Use area and perimeter to solve problems involving circular ponds, table tops, wheels

AG o	Calculate perimeters and areas of shapes made from triangles and rectangles **and other shapes**	• Find the surface area of simple shapes (prisms) using the formulae, triangles, parallelograms, rectangles **and other shapes** • Find the surface area of a cylinder

Ref	Content descriptor	Concepts and skills
AG p	Calculate volumes of right prisms and of shapes made from cubes and cuboids	• Calculate volumes of right prisms, including triangular prisms, and shapes made from cubes and cuboids • Find the volume of a compound solid • Find the volume of a cuboid *Examples:* o find the height of a cuboid that has a volume of 40 cm^3, length 5 cm and width 2 cm o 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/ 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 ***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
AG r	**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 eg**
		• **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**
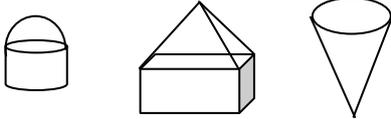
4   Measures

What students need to learn:

Ref	Content descriptor	Concepts and skills
AM b	Convert measurements from one unit to another	• Convert between and within imperial and metric measurements • Convert between units of time • Convert between metric area measures • Convert between metric volume measures • Convert between metric measures of volume and capacity, eg 1 ml = 1 cm^3 ***Functional Elements:*** – Use of imperial or metric measures according to which one is in common use – Convert between imperial and metric systems where appropriate

AM d	Understand and use compound measures in familiar and **unfamiliar** contexts	• Understand and use compound measures, including speed **and density**
		
		Examples:
		
		  o how many miles has a car travelled at 40 mph for 3 hours?
		
		  o how long does it take to travel between two cities, 200 km apart, travelling at an average speed of 60 km/h?
		
		  o find the average speed for a journey of 100 miles travelled in $2\frac{1}{2}$ hours
		
		  o given a mileage chart, work out the time taken to travel from A to B when travelling at an average speed of 30 mph
		
		  o 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

Ref	Content descriptor	Concepts and skills
AM e	Understand and use bearings	• Use three-figure bearings to specify direction *Example*: 072°, 314° • Draw and measure bearings • Use bearings to solve loci problems ***Functional Elements:*** Use bearings in map and navigation problems

5   Probability

What students need to learn:

Ref	Content descriptor	Concepts and skills
AS a	Understand and use the vocabulary of probability and the probability scale	• Write probabilities using fractions, percentages or decimals *Example:* $\frac{3}{4}$ 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
AS b	Understand and use theoretical models for probabilities including the model of equally likely outcomes	• Use theoretical models to include outcomes using dice, spinners, coins, etc *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 • Understand and use measures of probability *Examples:* o find probabilities from a two-way table o find the probability (x) of Dave winning the race, given that the probabilities of other athletes in the race winning are <table><tr><td>Andy</td><td>Bill</td><td>Chas</td><td>Dave</td></tr><tr><td>0.35</td><td>0.1</td><td>0.25</td><td>x</td></tr></table> • Find the probability of successive events, such as several throws of a single dice • Use theoretical models to find an estimate for the number of times an event occurs, given the number of trials

Ref	Content descriptor	Concepts and skills

AS c	Understand and use estimates of probability from relative frequency	• Calculate relative frequency
		
		Examples:
		
		  o spinning two coins or throwing two dice
		
		  o list all the outcomes of spinning a coin and throwing a dice
		
		  o List the outcomes of flipping a coin and throwing a dice as H1, _H2_, H3, _H4_, H5, _H6_, T1, T2, T3, T4, T5, T6, and then find the probability of spinning a head and throwing and even number on the dice
		
		• Understand and use estimates of probability
		
		Examples:
		
		  o understand and use estimates or measures of probability from examples
		
		  o estimate the number of times an event will occur, given the probability and the number of trials
		
		• Find the probability of successive events, such as several throws of a single dice
		
		• Use relative frequency to find an estimate for the number of times an event occurs, given the number of trials

AS r	Understand that when a statistical experiment or survey is repeated there will usually be 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:
		
		  o explain whether or not a dice is fair if throwing it 600 times results in 200 sixes
		
		  o understand that:
		
		    – 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

Ref	Content descriptor	Concepts and skills
AS s	Discuss and start to estimate risk	• Identify threats that may have an effect on the outcome of an event

Examples:

> weather, illness, technical faults relating to the cost/profit of an event

• Understand and use decision tree diagrams to estimate the effect of risk

Example:

• Estimate probabilities on the tree diagram to estimate the risk of a good/poor fayre

• **Quantify risk using Risk = probability of event $\times$ cost (desired outcome)**

Examples:

o **for above situation:**
P(good) =
$0.3 \times 0.1 + 0.5 \times 0.7 + 0.2 \times 0.9$
= 0.54 risk of a good fayre

o **estimate the likely amount that an insurance company will have to pay out based on the probability of an event occurring and the likely pay out**

o estimate suitable premiums for insurance companies given information about risks involved

Formulae sheets

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

Volume of prism = area of cross section × length
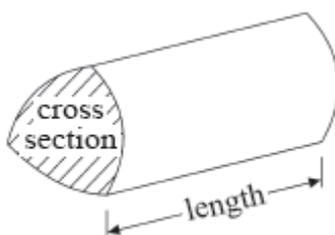
Formulae: Higher Tier

You must not write on this formulae page.
Anything you write on this formulae page will gain NO credit.

Volume of a prism = area of cross section × length
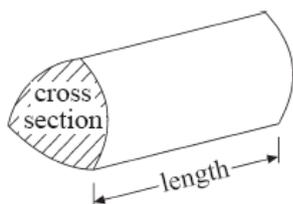
Volume of sphere $= \frac{4}{3}\pi r^3$

Surface area of sphere $= 4\pi r^2$
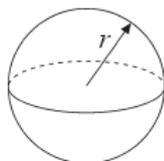
Volume of cone $= \frac{1}{3}\pi r^2 h$

Curved surface area of cone $= \pi r l$
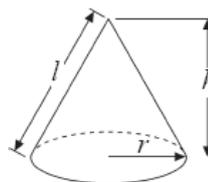
Area of trapezium $= \frac{1}{2}(a \quad b)h$
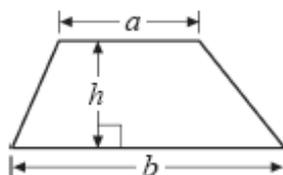
In any triangle ABC
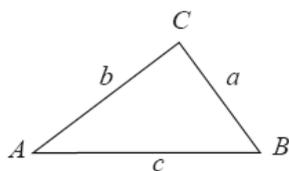
The Quadratic Equation

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

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

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

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

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