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GCSE Maths

GCSE

Edexcel GCSE in Mathematics (Linear) (1380)

First examination June 2009 First certification June 2009

QCA
Qualifications and Curriculum Authority

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Introduction

This specification offers a traditional linear route to GCSE Mathematics comprising two terminal examination papers. Centres preferring a modular route should refer to Edexcel's GCSE in Mathematics (2381, Modular).

Key features

- Accessible assessment for all students
- Advice from subject specialists
- Professional development support days
- Support booklets on all aspects of the examination, including ICT guide, schemes of work and content exemplification
- Endorsed textbooks and online resources

Summary of scheme of assessment

	Two parallel examination papers **AO1–AO4**	
Weighting	50%	50%
Foundation tier (G to C)	Paper 1 Non-calculator 1 hour 30 minutes	Paper 2 With-calculator 1 hour 30 minutes
Higher tier (D to A*)	Paper 3 Non-calculator 1 hour 45 minutes	Paper 4 With-calculator 1 hour 45 minutes

Summary of the specification content

This GCSE specification has been written against the Key Stage 4 Programme of Study for England. Candidates entering for this GCSE in Northern Ireland and Wales must be taught all the material required by the National Curriculum in those countries.

Availability of external assessment

- First assessment of this specification will be in June 2009.
- Examinations will be available twice a year, in June and November.

Tiers of entry and papers available in each examination session are shown below:

Examination session	**Tier of entry and papers**	
	Foundation tier Papers 1, 2	Higher tier Papers 3, 4
June 2009 and all June sessions thereafter	✓	✓
November 2009 and all November sessions thereafter	✓	✓

Progression and prior learning

This specification builds on the content, knowledge and skills developed in the Key Stage 3 Programme of Study for Mathematics as defined by the National Curriculum Orders for England. This course is designed to meet the requirements for Key Stage 4. Grade C in GCSE Mathematics at the Higher tier forms a foundation for further study of the subject at Level 3 of the National Qualifications Framework.

Forbidden combinations and links with other subjects

Every specification is assigned to a national classification code indicating the subject area to which it belongs.

Centres should be aware that students who enter for more than one GCSE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the school and college performance tables.

The classification code for this specification is 2210.

Candidates entering for this specification may not, in the same series of examinations, enter for any other specification with the title 'Mathematics'.

National Qualifications Framework (NQF) criteria

The specification is based on the common criteria and the GCSE criteria, which are prescribed by the regulatory authorities, including QCA, and are mandatory for all awarding bodies. It is also derived from the prescribed subject criteria for Mathematics.

Specification content

Examination papers 1–4

The subject content for the examination papers is presented in two tiers: Foundation and Higher.

The subject content for the GCSE Foundation tier is drawn from the Foundation tier of the 'The Mathematics National Curriculum for England'.

The subject content for the GCSE Higher tier is drawn from the Higher tier of the 'The Mathematics National Curriculum for England'.

The content references in this specification match those given in 'The Mathematics National Curriculum for England'. When shown in italics in the specification for the Foundation tier, it means that the reference can also be found in the Higher tier in the Key Stage 4 Programme of Study within the National Curriculum document. When shown in italics in the specification for the Higher tier, it means that the reference can also be found in the Foundation tier in the Key Stage 4 Programme of Study within the National Curriculum document.

In both tiers the content is in the right-hand column. The first text in a column is the programme of study as defined in 'The Mathematics National Curriculum for England' and the shaded text gives further guidance in the form of examples, also taken from 'The Mathematics National Curriculum for England'.

Material introduced in the Higher tier which is not included in the Foundation tier is shown in bold. The examples, in conjunction with the specimen papers, are intended to provide guidance in interpreting the subject content.

Foundation tier

Students should be taught the knowledge, skills and understanding contained in this specification through:

a extending mental and written calculation strategies and using efficient procedures confidently to calculate with integers, fractions, decimals, percentages, ratio and proportion

b solving a range of familiar and unfamiliar problems, including those drawn from real-life contexts and other areas of the curriculum

c activities that provide frequent opportunities to discuss their work, to develop reasoning and understanding and to explain their reasoning and strategies

d activities focused on developing short chains of deductive reasoning and correct use of the '=' sign

e activities in which they carry out practical work with geometrical objects, visualise them and work with them mentally

f practical work in which they draw inferences from data, consider how statistics are used in real life to make informed decisions, and recognise the difference between meaningful and misleading representations of data

g activities focused on the major ideas of statistics, including using appropriate populations and representative samples, using different measurement scales, using probability as a measure of uncertainty, using randomness and variability, reducing bias in sampling and measuring, and using inference to make decisions

h substantial use of tasks focused on using appropriate ICT (for example spreadsheets, databases, geometry or graphic packages), using calculators correctly and efficiently, and knowing when not to use a calculator.

Foundation tier

Ma2 Number and algebra

1 Using and Applying Number and Algebra

Students should be taught to:

Problem solving

a select and use suitable problem-solving strategies and efficient techniques to solve numerical and algebraic problems

Example: includes choosing relevant information when some is redundant

identify what further information may be required in order to pursue a particular line of enquiry and give reasons for following or rejecting particular approaches

b break down a complex calculation into simpler steps before attempting to solve it and justify their choice of methods

c use algebra to formulate and solve a simple problem — identifying the variable, setting up an equation, solving the equation and interpreting the solution in the context of the problem

d make mental estimates of the answers to calculations

use checking procedures, including use of inverse operations

work to stated levels of accuracy

Communicating

e interpret and discuss numerical and algebraic information presented in a variety of forms

f use notation and symbols correctly and consistently within a given problem

g use a range of strategies to create numerical, algebraic or graphical representations of a problem and its solution

move from one form of representation to another to get different perspectives on the problem

h present and interpret solutions in the context of the original problem

i review and justify their choice of mathematical presentation

Reasoning

j explore, identify, and use pattern and symmetry in algebraic contexts, investigating whether particular cases can be generalised further, and understanding the importance of a counter-example

Example: using simple codes that substitute numbers for letters

identify exceptional cases when solving problems

k show step-by-step deduction in solving a problem

understand the difference between a practical demonstration and a proof

m recognise the importance of assumptions when deducing results

recognise the limitations of any assumptions that are made and the effect that varying the assumptions may have on the solution to a problem

2 Numbers and the Number System

Students should be taught to:

Integers

a use their previous understanding of integers and place value to deal with arbitrarily large positive numbers and round them to a given power of 10

understand and use positive numbers and negative integers, both as positions and translations on a number line

order integers

a use the concepts and vocabulary of factor (divisor), multiple, common factor, highest common factor, least common multiple, prime number and prime factor decomposition

Example: identification of prime numbers

Powers and roots

b use the terms square, positive and negative square root, cube and cube root

use index notation for squares, cubes and powers of 10

Example: simple integer powers (such as 2^4)

use index laws for multiplication and division of integer powers

express standard index form both in conventional notation and on a calculator display

Example: interpretation of calculator displays

Fractions

c understand equivalent fractions, simplifying a fraction by cancelling all common factors

order fractions by rewriting them with a common denominator

Decimals

d use decimal notation and recognise that each terminating decimal is a fraction

Example: $0.137 = \frac{137}{1000}$

order decimals

d recognise that recurring decimals are exact fractions, and that some exact fractions are recurring decimals

Example: $\frac{1}{7} = 0.142857142857...$

Percentages

e understand that 'percentage' means 'number of parts per 100' and use this to compare proportions

Example: 10% means 10 parts per 100

interpret percentage as the operator 'so many hundredths of'

Example: 15% of Y means $\frac{15}{100} \times Y$

use percentage in real-life situations

Example: commerce and business, including rate of inflation, VAT and interest rates

Ratio

f use ratio notation, including reduction to its simplest form and its various links to fraction notation

Example: in maps and scale drawings, paper sizes and gears

3 Calculations

Students should be taught to:

Number operations and the relationships between them

a add, subtract, multiply and divide integers and then any number

Example: including negative integers

multiply or divide any number by powers of 10, and any positive number by a number between 0 and 1

a find the prime factor decomposition of positive integers

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)

multiply and divide by a negative number

use index laws to simplify and calculate the value of numerical expressions involving multiplication and division of integer powers

use inverse operations

b use brackets and the hierarchy of operations

c calculate a given fraction of a given quantity, expressing the answer as a fraction

Example: scale drawings and construction of models, down payments, discounts

express a given number as a fraction of another

add and subtract fractions by writing them with a common denominator

perform short division to convert a simple fraction to a decimal

d 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);
addition and subtraction of mixed numbers

d multiply and divide a fraction by an integer, by a unit fraction and by a general fraction

e convert simple fractions of a whole to percentages of the whole and vice versa

Example: analysing diets, budgets or the costs of running, maintaining and owning a car

understand the multiplicative nature of percentages as operators

Example: 30% increase on £150 gives a total calculated as £(1.3 × 150) while a 20% discount gives a total calculated as £(0.8 × 150)

f divide a quantity in a given ratio

Example: share £15 in the ratio of 1:2

Mental methods

g recall all positive integer complements to 100

Example: 37 + 63 = 100

recall all multiplication facts to 10 × 10, and use them to derive quickly the corresponding division facts

recall integer squares from 11 × 11 to 15 × 15 and the corresponding square roots, recall the cubes of 2, 3, 4, 5 and 10, and the fraction-to-decimal conversion of familiar simple fractions

Example: $\frac{1}{2}, \frac{1}{4}, \frac{1}{5}, \frac{1}{10}, \frac{1}{100}, \frac{1}{3}, \frac{2}{3}, \frac{1}{8}$

h round to the nearest integer and to one significant figure

Example: rounding to a given number of decimal places

estimate answers to problems involving decimals

i develop a range of strategies for mental calculation

derive unknown facts from those they know

Example: estimate $\sqrt{85}$

add and subtract mentally numbers with up to two decimal places

Example: $13.76 - 5.21$, $20.8 + 12.4$

multiply and divide numbers with no more than one decimal digit, using the commutative, associative, and distributive laws and factorisation where possible, or place value adjustments

Example: 14.3×4, $56.7 \div 7$

Written methods

j use standard column procedures for addition and subtraction of integers and decimals

k use standard column procedures for multiplication of integers and decimals, understanding where to position the decimal point by considering what happens if they multiply equivalent fractions

solve a problem involving division by a decimal (up to 2 decimal places) by transforming it to a problem involving division by an integer

l use efficient methods to calculate with fractions, including cancelling common factors before carrying out the calculation, recognising that, in many cases, only a fraction can express the exact answer

m solve simple percentage problems, including increase and decrease

Example: simple interest, VAT, annual rate of inflation, income tax, discounts

n solve word problems about ratio and proportion, including using informal strategies and the unitary method of solution

Example: given that m identical items cost £y, then one item costs £$^{y}/_{m}$ and n items cost £$(n \times {}^{y}/_{m})$, the number of items that can be bought for £z is $z \times {}^{m}/_{y}$

n use π in exact calculations, without a calculator

Calculator methods

o use calculators effectively and efficiently: know how to enter complex calculations and use function keys for reciprocals, squares and powers

p enter a range of calculations, including those involving standard index form and measures

Example: time calculations in which fractions of an hour must be entered as fractions or as decimals

q understand the calculator display, knowing when to interpret the display, when the display has been rounded by the calculator, and not to round during the intermediate steps of a calculation

Example: in money calculations, or when the display has been rounded by the calculator

4 Solving Numerical Problems

Students should be taught to:

a draw on their knowledge of operations, inverse operations and the relationships between them, and of simple integer powers and their corresponding roots, and of methods of

a simplification (including factorisation and the use of the commutative, associative and distributive laws of addition, multiplication and factorisation) in order to select and use suitable strategies and techniques to solve problems and word problems, including those involving ratio and proportion, a range of measures and compound measures, metric units, and conversion between metric and common imperial units, set in a variety of contexts

b select appropriate operations, methods and strategies to solve number problems, including trial and improvement where a more efficient method to find the solution is not obvious

b estimate answers to problems

use a variety of checking procedures, including working the problem backwards, and considering whether a result is of the right order of magnitude

d give solutions in the context of the problem to an appropriate degree of accuracy, interpreting the solution shown on a calculator display, and recognising limitations on the accuracy of data and measurements

5 Equations, Formulae and Identities

Students should be taught to:

Use of symbols

a distinguish the different roles played by letter symbols in algebra, using the correct notational conventions for multiplying or dividing by a given number, and knowing that letter symbols represent definite unknown numbers in equations, defined quantities or variables in formulae, general, unspecified and independent numbers in identities, and in functions they define new expressions or quantities by referring to known quantities

Examples: $5x + 1 = 16$
$V = IR$
$3x + 2x = 5x$ for all values of x
$y = 2x$
$x^2 + 1 = 82$
$(x + 1)^2 = x^2 + 2x + 1$ for all x
$y = 2 - 7x$
$y = \frac{1}{x}$ with $x \neq 0$

b understand that the transformation of algebraic expressions obeys and generalises the rules of generalised arithmetic

Example: $a(b + c) = ab + ac$

manipulate algebraic expressions by collecting like terms, by multiplying a single term over a bracket, and by taking out common factors

Example: $x + 5 - 2x - 1 = 4 - x$
$5(2x + 3) = 10x + 15$
$x^2 + 3x = x(x + 3)$
$9x - 3 = 3(3x - 1)$ or $x^2 - 3x = x(x - 3)$

distinguish in meaning between the words 'equation', 'formula', 'identity' and 'expression'

b expand the product of two linear expressions

Example: $(x + 2)(x - 5) = x^2 - 3x - 10$

Index notation

c use index notation for simple integer powers

use simple instances of index laws

Example: $x^2 \times x^3 = x^5$ $\quad x^6 \div x^4 = x^2$

substitute positive and negative numbers into expressions such as $3x^2 + 4$ and $2x^3$

Equations

e set up simple equations

Example: find the angle a in a triangle with angles a, $a + 10$, $a + 20$

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

Examples: $11 - 4x = 2$; $3(2x + 1) = 8$
$2(1 - x) = 6(2 + x)$; $3x^2 = 48$
$3 = \frac{12}{x}$

Linear equations

e solve linear equations, with integer coefficients, in which the unknown appears on either side or on both sides of the equation

solve linear equations that require prior simplification of brackets, including those that have negative signs occurring anywhere in the equation, and those with a negative solution

Formulae

f use formulae from mathematics and other subjects expressed initially in words and then using letters and symbols

Examples: formulae for the area of a triangle, the area enclosed by a circle
wage earned = hours worked × rate per hour
for area of a triangle or a parallelogram, area enclosed by a circle, volume of a prism
find r given that $C = 2\pi r$
find x given $y = mx + c$

substitute numbers into a formula

Example: convert temperatures between degrees Fahrenheit and degrees Celsius

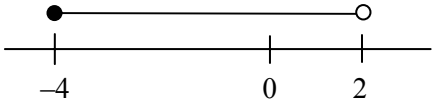
derive a formula and change its subject

Examples: find the perimeter of a rectangle given its area A and the length l of one side
use V = IR to generate a formula for R in terms of V and I

Inequalities

d solve simple linear inequalities in one variable, and represent the solution set on a number line

Example: notation $-4 \leq x < 2$ represented on a number line:



Numerical methods

m use systematic trial and improvement to find approximate solutions of equations where there is no simple analytical method of solving them

Examples: $x^3 = x - 900$,
$\frac{1}{x} = x^2 - 5$

6 Sequences, Functions and Graphs

Students should be taught to:

Sequences

a generate terms of a sequence using term-to-term and position-to-term definitions of the sequence

Examples: generating simple sequence of odd or even numbers squared integers and sequences derived from diagrams

use linear expressions to describe the nth term of an arithmetic sequence, justifying its form by referring to the activity or context from which it was generated

a generate common integer sequences (including sequences of odd or even integers, squared integers, powers of 2, powers of 10, triangular numbers)

Graphs of linear functions

b use the conventions for coordinates in the plane

plot points in all four quadrants

recognise (when values are given for m and c) that equations of the form $y = mx + c$ correspond to straight-line graphs in the coordinate plane

plot graphs of functions in which y is given explicitly in terms of x, or implicitly

Example: $y = 2x + 3, x + y = 7$

c construct linear functions from real-life problems and plot their corresponding graphs

discuss and interpret graphs modelling real situations

understand that the point of intersection of two different lines in the same two variables that simultaneously describe a real situation is the solution to the simultaneous equations represented by the lines

draw line of best fit through a set of linearly related points and find its equation

Gradients

d find the gradient of lines given by equations of the form $y = mx + c$ (when values are given for m and c)

investigate the gradients of parallel lines

Interpret graphical information

e interpret information presented in a range of linear and non-linear graphs

Examples: graphs describing trends, conversion graphs, distance-time graphs, graphs of height or weight against age, graphs of quantities that vary against time, such as employment
distance-time graph for a particle moving with constant speed, the depth of water in a container as it empties

Quadratic equations

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

Examples: $y = x^2$; $y = 3x^2 + 4$
$y = x^2 - 2x + 1$

find approximate solutions of a quadratic equation from the graph of the corresponding quadratic function

Ma3 Shape, space and measures

1 Using and Applying Shape, Space and Measures

Students should be taught to:

Sequences	d	select problem-solving strategies and resources, including ICT tools, to use in geometrical work, and monitor their effectiveness
	a	consider and explain the extent to which the selections they made were appropriate
	b	select and combine known facts and problem-solving strategies to solve complex problems
	c	identify what further information is needed to solve a geometrical problem
		break complex problems down into a series of tasks
	c	develop and follow alternative lines of enquiry
Communicating	d	interpret, discuss and synthesise geometrical information presented in a variety of forms
	d	communicate mathematically with emphasis on a critical examination of the presentation and organisation of results, and on effective use of symbols and geometrical diagrams
	f	use geometrical language appropriately
	g	review and justify their choices of mathematics presentation
Reasoning	h	distinguish between practical demonstrations and proofs
	i	apply mathematical reasoning, explaining and justifying inferences and deductions
	j	show step-by-step deduction in solving a geometrical problem
	k	state constraints and give starting points when making deductions
	l	recognise the limitations of any assumptions that are made
		understand the effects that varying the assumptions may have on the solution
	m	identify exceptional cases when solving geometrical problems

2 Geometrical Reasoning

Students should be taught to:

Angles

a recall and use properties of angles at a point, angles on a straight line (including right angles), perpendicular lines, and opposite angles at a vertex

b distinguish between acute, obtuse, reflex and right angles

estimate the size of an angle in degrees

Properties of triangles and other rectilinear shapes

a distinguish between lines and line segments

c use parallel lines, alternate angles and corresponding angles

understand the consequent properties of parallelograms and a proof that the angle sum of a triangle is 180 degrees

understand a proof that the exterior angle of a triangle is equal to the sum of the interior angles at the other two vertices

d use angle properties of equilateral, isosceles and right-angled triangles

understand congruence

explain why the angle sum of a quadrilateral is 360 degrees

e use their knowledge of rectangles, parallelograms and triangles to deduce formulae for the area of a parallelogram, and a triangle, from the formula for the area of a rectangle

f recall the essential properties and definitions of special types of quadrilateral, including square, rectangle, parallelogram, trapezium and rhombus

Example: includes kite

classify quadrilaterals by their geometric properties

g calculate and use the sums of the interior and exterior angles of quadrilaterals, pentagons and hexagons

calculate and use the angles of regular polygons

Example: includes octagons and decagons

h understand, recall and use Pythagoras' theorem

Properties of circles

i recall the definition of a circle and the meaning of related terms, including centre, radius, chord, diameter, circumference, tangent, arc, sector and segment

understand that inscribed regular polygons can be constructed by equal division of a circle

3-D shapes

j explore the geometry of cuboids (including cubes), and shapes made from cuboids

Example: isometric drawing of cuboids (including cubes) and shapes made from cuboids

k use 2-D representations of 3-D shapes and analyse 3-D shapes through 2-D projections and cross-sections, including plan and elevation

i solve problems involving surface areas and volumes of prisms

3 Transformations and Coordinates

Students should be taught to:

Specifying transformations

a understand that rotations are specified by a centre and an (anticlockwise) angle

Example: the order of rotational symmetry of a shape and includes tessellations

rotate a shape about the origin, or any other point

measure the angle of rotation using right angles, simple fractions of a turn or degrees

understand that reflections are specified by a mirror line, at first using a line parallel to an axis, then a mirror line such as $y = x$ or $y = -x$

Example: reflection in the x-axis or y-axis or in a given mirror line

understand that translations are specified by a distance and direction (or a vector), and enlargements by a centre and positive scale factor

Properties of transformations

b recognise and visualise rotations, reflections and translations, including reflection symmetry of 2-D and 3-D shapes, and rotation symmetry of 2-D shapes

transform triangles and other 2-D shapes by translation, rotation and reflection and combinations of these transformations, recognising that these transformations preserve length and angle, so that any figure is congruent to its image under any of these transformations

Examples: reflection in $x = c$, $y = c$, $y = x$ or $y = -x$
describe the single transformation equivalent to a combination of transformations

distinguish properties that are preserved under particular transformations

c recognise, visualise and construct enlargements of objects using positive scale factors greater than one, then positive scale factors less than one

Examples: enlarging a shape on a grid
enlarging a shape by shape factor 3, given the centre of enlargement

understand from this that any two circles and any two squares are mathematically similar, while, in general, two rectangles are not

d recognise that enlargements preserve angle but not length

identify the scale factor of an enlargement as the ratio of the lengths of any two corresponding line segments and apply this to triangles

understand the implications of enlargement for perimeter

use and interpret maps and scale drawings

understand the implications of enlargement for area and for volume

distinguish between formulae for perimeter, area and volume by considering dimensions

understand and use simple examples of the relationship between enlargement and areas and volumes of shapes and solids

Coordinates

e understand that one coordinate identifies a point on a number line, two coordinates identify a point in a plane and three coordinates identify a point in space, using the terms '1-D', '2-D' and '3-D'

use axes and coordinates to specify points in all four quadrants

locate points with given coordinates

find the coordinates of points identified by geometrical information

Examples: find the coordinates of the fourth vertex of a parallelogram with vertices at (2, 1), (–7, 3) and (5, 6)
identify the coordinates of the vertex of a cuboid drawn on a 3-D grid

find the coordinates of the midpoint of the line segment AB, given points A and B, then calculate the length AB

Vectors

f understand and use vector notation for translations

Example: column vector notation

4 Measures and Construction

Students should be taught to:

Measures

a interpret scales on a range of measuring instruments, including those for time and mass

know that measurements using real numbers depend on the choice of unit

recognise that measurements given to the nearest whole unit may be inaccurate by up to one half in either direction

convert measurements from one unit to another

know rough metric equivalents of pounds, feet, miles, pints and gallons

make sensible estimates of a range of measures in everyday settings

b understand angle measure using the associated language

Example: use bearings to specify direction

c understand and use compound measures, including speed and density

Example: how far do you go if you travel at 40 mph for 3 hours?

Construction

d measure and draw lines to the nearest millimetre, and angles to the nearest degree

draw triangles and other 2-D shapes using a ruler and protractor, given information about their side lengths and angles

understand, from their experience of constructing them, that triangles satisfying SSS, SAS, ASA and RHS are unique, but SSA triangles are not

construct cubes, regular tetrahedra, square-based pyramids and other 3-D shapes from given information

e use straight edge and compasses to do standard constructions, including an equilateral triangle with a given side, the midpoint and perpendicular bisector of a line segment, the perpendicular from a point to a line, the perpendicular from a point on a line, and the bisector of an angle

Mensuration

f find areas of rectangles, recalling the formula, understanding the connection to counting squares and how it extends this approach

Example: perimeter of simple shapes

recall and use the formulae for the area of a parallelogram and a triangle

find the surface area of simple shapes using the area formulae for triangles and rectangles

calculate perimeters and areas of shapes made from triangles and rectangles

Example: areas of parallelograms and trapeziums

g find volumes of cuboids, recalling the formula and understanding the connection to counting cubes and how it extends this approach

calculate volumes of right prisms and of shapes made from cubes and cuboids

h find circumferences of circles and areas enclosed by circles, recalling relevant formulae

Example: half-circles and quarter circles

i convert between area measures, including square centimetres and square metres, and volume measures, including cubic centimetres and cubic metres

Loci

j find loci, both by reasoning and by using ICT to produce shapes and paths

Example: a region bounded by a circle and an intersecting line

Ma4 Handling data

1 Using and Applying Handling Data

Students should be taught to:

Problem solving

a carry out each of the four aspects of the handling data cycle to solve problems:

i specify the problem and plan: formulate questions in terms of the data needed, and consider what inferences can be drawn from the data

decide what data to collect (including sample size and data format) and what statistical analysis is needed

ii collect data from a variety of suitable sources, including experiments and surveys, and primary and secondary sources

iii process and represent the data: turn the raw data into usable information that gives insight into the problem

iv interpret and discuss the data: answer the initial question by drawing conclusions from the data

b identify what further information is needed to pursue a particular line of enquiry

b select the problem-solving strategies to use in statistical work, and monitor their effectiveness (these strategies should address the scale and manageability of the tasks, and should consider whether the mathematics and approach used are delivering the most appropriate solutions)

c select and organise the appropriate mathematics and resources to use for a task

d review progress while working

check and evaluate solutions

Communicating

e interpret, discuss and synthesise information presented in a variety of forms

f communicate mathematically, including using ICT, making use of diagrams and related explanatory text

g examine critically, and justify, their choices of mathematical presentation of problems involving data

Reasoning

h apply mathematical reasoning, explaining and justifying inferences and deductions

e identify exceptional or unexpected cases when solving statistical problems

i explore connections in mathematics and look for relationships between variables when analysing data

j recognise the limitations of any assumptions and the effects that varying the assumptions could have on the conclusions drawn from data analysis

2 Specifying the Problem and Planning

Students should be taught to:

a see that random processes are unpredictable

b identify key questions that can be addressed by statistical methods

c discuss how data relate to a problem, identify possible sources of bias and plan to minimise it

d identify which primary data they need to collect and in what format, including grouped data, considering appropriate equal class intervals

e design an experiment or survey

decide what primary and secondary data to use

3 Collecting Data

Students should be taught to:

a design and use data-collection sheets for grouped discrete and continuous data

collect data using various methods, including observation, controlled experiment, data logging, questionnaires and surveys

b gather data from secondary sources, including printed tables and lists from ICT-based sources

c design and use two-way tables for discrete and grouped data

4 Processing and Representing Data

Students should be taught to:

a draw and produce, using paper and ICT, pie charts for categorical data, and diagrams for continuous data, including line graphs for time series, scatter graphs, frequency diagrams and stem-and-leaf diagrams

Example: pictograms and bar charts
frequency polygons, histograms with equal class intervals and frequency diagrams for grouped discrete data

b calculate mean, range and median of small data sets with discrete then continuous data

Example: the mode

identify the modal class for grouped data

c understand and use the probability scale

d understand and use estimates or measures of probability from theoretical models (including equally likely outcomes), or from relative frequency

Example: addition of simple probabilities

e list all outcomes for single events, and for two successive events, in a systematic way

f identify different mutually exclusive outcomes and know that the sum of the probabilities of all these outcomes is 1

g find the median for large data sets and calculate an estimate of the mean for large data sets with grouped data

h draw lines of best fit by eye, understanding what these represent

Example: using a line of best fit

j use relevant statistical functions on a calculator or spreadsheet

5 Interpreting and Discussing Results

Students should be taught to:

a relate summarised data to the initial questions

b interpret a wide range of graphs and diagrams and draw conclusions

Example: interpreting a stem-and-leaf diagram

c look at data to find patterns and exceptions

d compare distributions and make inferences, using the shapes of distributions and measures of average and range

e consider and check results and modify their approach if necessary

f appreciate that correlation is a measure of the strength of the association between two variables

distinguish between positive, negative and zero correlation using lines of best fit

appreciate that zero correlation does not necessarily imply 'no relationship' but merely 'no linear relationship'

g use the vocabulary of probability to interpret results involving uncertainty and prediction

Example: 'there is some evidence from this sample that …'

h compare experimental data and theoretical probabilities

i understand that if they repeat an experiment, they may — and usually will — get different outcomes, and that increasing sample size generally leads to better estimates of probability and population characteristics

j discuss implications of findings in the context of the problem

k interpret social statistics including index numbers

Example: the General Index of Retail Prices

time series

Example: population growth

and survey data

Example: the National Census

Higher tier

Students should be taught the knowledge, skills and understanding contained in this specification through:

a activities that ensure they become familiar with and confident using standard procedures for the range of calculations appropriate to this level of study

b solving familiar and unfamiliar problems in a range of numerical, algebraic and graphical contexts and in open-ended and closed form

c using standard notations for decimals, fractions, percentages, ratio and indices

d activities that show how algebra, as an extension of number using symbols, gives precise form to mathematical relationships and calculations

e activities in which they progress from using definitions and short chains of reasoning to understanding and formulating proofs in algebra and geometry

f a sequence of practical activities that address increasingly demanding statistical problems in which they draw inferences from data and consider the uses of statistics in society

g choosing appropriate ICT tools and using these to solve numerical and graphical problems, to represent and manipulate geometrical configurations and to present and analyse data.

Higher tier

Ma2 Number and algebra

1 Using and Applying Number and Algebra

Students should be taught to:

Problem solving

a select and use appropriate and efficient techniques and strategies to solve problems **of increasing complexity**, **involving numerical and algebraic manipulation**

b identify what further information may be required in order to pursue a particular line of enquiry and give reasons for following or rejecting particular approaches

c break down a complex calculation into simpler steps before attempting to solve it and justify their choice of methods

d make mental estimates of the answers to calculations

present answers to sensible levels of accuracy

understand how errors are compounded in certain calculations

Communicating

e discuss their work and explain their reasoning **using an increasing range of mathematical language and notation**

f use a **variety** of strategies **and diagrams for establishing** algebraic or graphical representations of a problem and its solution

move from one form of representation to another to get different perspectives on the problem

g present and interpret solutions in the context of the original problem

h use notation and symbols correctly and consistently within a given problem

i examine critically, improve, then justify their choice of mathematical presentation,
present a concise, reasoned argument

Reasoning

j explore, identify, and use pattern and symmetry in algebraic contexts, investigating whether particular cases can be generalised further, and understanding the importance of a counter-example

identify exceptional cases when solving problems

k understand the difference between a practical demonstration and a proof

l show step-by-step deduction in solving a problem

derive proofs using short chains of deductive reasoning

m recognise the significance of stating constraints and assumptions when deducing results

recognise the limitations of any assumptions that are made and the effect that varying the assumptions may have on the solution to a problem

2 Numbers and the Number System

Students should be taught to:

Integers

a use their previous understanding of integers and place value to deal with arbitrarily large positive numbers and round them to a given power of 10

understand and use negative integers both as positions and translations on a number line

order integers

use the concepts and vocabulary of factor (divisor), multiple, common factor, highest common factor, least common multiple, prime number and prime factor decomposition

Powers and roots

b use the terms square, positive and negative square root, cube and cube root

use index notation and index laws for multiplication and division of integer powers

use standard index form, expressed in conventional notation and on a calculator display

Example: interpretation of calculator displays

Fractions

c understand equivalent fractions, simplifying a fraction by cancelling all common factors

order fractions by rewriting them with a common denominator

Decimals

d recognise that each terminating decimal is a fraction

Example: $0.137 = \frac{137}{1000}$

recognise that recurring decimals are exact fractions, and that some exact fractions are recurring decimals

Example: $\frac{1}{7} = 0.142857142857...$

order decimals

Percentages

e understand that 'percentage' means 'number of parts per 100' and use this to compare proportions

Example: 10% means 10 parts per 100

interpret percentage as the operator 'so many hundredths of'

Example: 15% of Y means $\frac{15}{100} \times Y$

e use percentage in real-life situations

Example: commerce and business, including rate of inflation, VAT and interest rates

Ratio

f use ratio notation, including reduction to its simplest form and its various links to fraction notation

3 Calculations

Students should be taught to:

Number operations and the relationships between them

a multiply or divide any number by powers of 10, and any positive number by a number between 0 and 1

find the prime factor decomposition of positive integers

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)

multiply and divide by a negative number

use index laws to simplify and calculate the value of numerical expressions involving multiplication and division of integer, **fractional and negative** powers

use inverse operations, **understanding that the inverse operation of raising a positive number to power n is raising the result of this operation to power $\frac{1}{n}$**

b use brackets and the hierarchy of operations

c calculate a given fraction of a given quantity, expressing the answer as a fraction

express a given number as a fraction of another

add and subtract fractions by writing them with a common denominator

perform short division to convert a simple fraction to a decimal

distinguish between fractions with denominators that have only prime factors of 2 and 5 (which are represented by terminating decimals), and other fractions (which are represented by recurring decimals)

convert a recurring decimal to a fraction

Example: **0.142857142857...** $= \frac{1}{7}$

d 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)
addition, subtraction, **multiplication and division** of mixed numbers

multiply and divide a given fraction by an integer, by a unit fraction and by a general fraction

e convert simple fractions of a whole to percentages of the whole and vice versa

then understand the multiplicative nature of percentages as operators

Example: a 15% increase in value Y, followed by a 15% decrease is calculated as $1.15 \times Y \times 0.85$

calculate an original amount when given the transformed amount after a percentage change

Example: given that a meal in a restaurant costs £36 with VAT at 17.5%, its price before VAT is calculated as £$\frac{36}{1.175}$

reverse percentage problems

f divide a quantity in a given ratio

Mental methods

g recall integer squares from **2 × 2** to 15×15 and the corresponding square roots, the cubes of 2, 3, 4, 5 and 10,

the fact that $n^0 = 1$ and $n^{-1} = \frac{1}{n}$ for positive integers n,

the corresponding rule for negative numbers, $n^{\frac{1}{2}} = \sqrt{n}$ and $n^{\frac{1}{3}} = \sqrt[3]{n}$ for any positive number n

Example: **$10^0 = 1$; $9^{-1} = \frac{1}{9}$**
$5^{-2} = \frac{1}{5^2} = \frac{1}{25}$
$25^{1/2} = 5$ and $64^{1/3} = 4$

h round to **a given number** of significant figures

derive unknown facts from those they know

convert between ordinary and standard index form representations, **converting to standard index form to make sensible estimates for calculations involving multiplication and/or division**

Example: $\mathbf{0.1234 = 1.234 \times 10^{-1}}$

i develop a range of strategies for mental calculation

Example: $13.76 - 5.21$, $20.08 + 12.4$

add and subtract mentally numbers with up to one decimal place

multiply and divide numbers with no more than one decimal digit, using the commutative, associative, and distributive laws and factorisation where possible, or place value adjustments

Example: 1.8×2, $3.6 \div 4$

Written methods

k division by decimal (up to 2 decimal places) by division using an integer

understand where to position the decimal point by considering what happens if they multiply equivalent fractions

Example: given that…work out…

i use efficient methods to calculate with fractions, including cancelling common factors before carrying out the calculation, recognising that, in many cases, only a fraction can express the exact answer

j solve percentage problems, including **percentage** increase and decrease

Example: simple interest, VAT, annual rate of inflation, income tax, discounts

reverse percentages

n solve word problems about ratio and proportion, including using informal strategies and the unitary method of solution

Example: given that m identical items cost £y, then one item costs £y/m and n items cost £$(n \times y/m)$, the number of items that can be bought for £z is $z \times m/y$

k **represent repeated proportional change using a multiplier raised to a power**

Example: compound interest

l **calculate an unknown quantity from quantities that vary in direct or inverse proportion**

m **calculate with standard index form**

Example: $\mathbf{2.4 \times 10^7 \times 5 \times 10^3 = 12 \times 10^{10} = 1.2 \times 10^{11}}$, $\mathbf{(2.4 \times 10^7) \div (5 \times 10^3) = 4.8 \times 10^3}$

n use **surds and** π in exact calculations, without a calculator

rationalise a denominator such as $\frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3}$

Calculator methods

o use calculators effectively and efficiently, knowing how to enter complex calculations

use an extended range of function keys, **including trigonometrical and statistical functions relevant across this programme of study**

p enter a range of calculations, including those involving measures

Example: time calculations in which fractions of an hour must be entered as fractions or as decimals

p understand the calculator display, knowing when to interpret the display, when the display has been rounded by the calculator, and not to round during the intermediate steps of a calculation

q **use calculators**, **or written methods**, **to calculate the upper and lower bounds of calculations**, **particularly when working with measurements**

r **use standard index form display and know how to enter numbers in standard index form**

s **use calculators for reverse percentage calculations by doing an appropriate division**

t **use calculators to explore exponential growth and decay, using a multiplier and the power key**

Example: **in science or geography**

4 Solving Numerical Problems

Students should be taught to:

a draw on their knowledge of operations and inverse operations **(including powers and roots)**, and of methods of simplification (including factorisation and the use of the commutative, associative and distributive laws of addition, multiplication and factorisation) in order to select and use suitable strategies and techniques to solve problems and word problems, including those involving ratio and proportion, **repeated proportional change**, fractions, percentages and **reverse percentages**, **inverse proportion**, **surds**, measures and conversion between measures, and compound measures defined within a particular situation

b **check** and estimate answers to problems

select and justify appropriate degrees of accuracy for answers to problems

recognise limitations on the accuracy of data and measurements

5 Equations, Formulae and Identities

Students should be taught to:

Use of symbols

a distinguish the different roles played by letter symbols in algebra, using the correct notational conventions for multiplying or dividing by a given number, and knowing that letter symbols represent definite unknown numbers in equations, defined quantities or variables in formulae, general, unspecified and independent numbers in identities, and in functions they define new expressions or quantities by referring to known quantities

Examples: $x^2 + 1 = 82$

$(x + 1)^2 = x^2 + 2x + 1$ for all values of x

$y = 2 - 7x$

$y = \frac{1}{x}$ with $x \neq 0$

f(x) notation may be used

b understand that the transformation of algebraic entities obeys and generalises the **well-defined** rules of generalised arithmetic

Example: $a(b + c) = ab + bc$

expand the product of two linear expressions

Example: $(x + 2)(x - 5) = x^2 - 3x - 10$

manipulate algebraic expressions by collecting like terms, multiplying a single term over a bracket, taking out common factors, **factorising quadratic expressions including the difference of two squares and cancelling common factors in rational expressions**

Example: simplify $\frac{1}{x} + \frac{3}{2 - x}$

$\frac{2(x+1)^2}{(x+1)} = 2(x + 1)$

$x^2 - 9 = (x + 3)(x - 3)$

$4x^2 + 6xy = 2x(2x + 3y)$

$9x - 3 = 3(x - 1)$ or $x^2 - 3x = x(x - 3)$

c **know the meaning of and use** the words 'equation', 'formula', 'identity' and 'expression'

Index notation

d use index notation for simple integer powers

use simple instances of index laws

Example: $x^2 \times x^3 = x^5$, $x^6 \div x^4 = x^2$, $x^2 \div x^3 = x^{-1}$, $(x^2)^3 = x^6$

substitute positive and negative numbers into expressions such as $3x^2 + 4$ and $2x^3$

Equations

e set up simple equations

Example: find the angle a in a triangle with angles a, $a + 10$, $a + 20$

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

Example: $11 - 4x = 2$; $3(2x + 1) = 8$

$2(1 - x) = 6(2 + x)$; $3x^2 = 48$

$3 = \frac{12}{x}$

Linear equations

f 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

Example: $\frac{2x-3}{6}+\frac{x+2}{3}=\frac{5}{2}$; $\frac{17-x}{4}=2-x$

solve linear equations that require prior simplification of brackets, including those that have negative signs occurring anywhere in the equation, and those with a negative solution

Formulae

g use formulae from mathematics and other subjects

Example: area of a triangle or a parallelogram, area enclosed by a circle, volume of a prism, volume of a cone

substitute numbers into a formula

Example: find r, given that $C = 2\pi r$
find x, given $y = mx + c$

change the subject of a formula **including cases where the subject occurs twice**, **or where a power of the subject appears**

generate a formula

Example: find the perimeter of a rectangle given its area A and the length l of one side

Direct and inverse proportion

h **set up and use equations to solve word and other problems involving direct proportion or inverse proportion and relate algebraic solutions to graphical representation of the equations**

Example: $y \propto x$, $y \propto x^2$, $y \propto \frac{1}{x}$, $y \propto \frac{1}{x^2}$

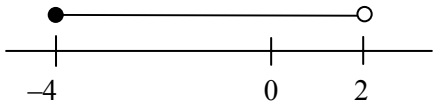
Simultaneous linear equations

i **find exact solutions of two simultaneous equations in two unknowns by eliminating a variable and interpret the equations as lines and their common solution as the point of intersection**

Inequalities

j solve linear inequalities in one variable, and represent the solution set on a number line

Example: notation $-4 \leq x < 2$ represented on a number line:



solve several linear inequalities in two variables and find the solution set

Quadratic equations

k **solve simple quadratic equations by factorisation, completing the square and using the quadratic formula**

Simultaneous linear and quadratic equations

l **solve exactly, by elimination of an unknown, two simultaneous equations in two unknowns, one of which is linear in each unknown, and the other is linear in one unknown and quadratic in the other, or where the second is of the form $x^2 + y^2 = r^2$**

Example: solve the simultaneous equations $y = 11x - 2$ and $y = 5x^2$

Numerical methods

m use systematic trial and improvement to find approximate solutions of equations where there is no simple analytical method of solving them

Example: $x^3 = x - 900$,
$\frac{1}{x} = x^2 - 5$

6 Sequences, Functions and Graphs

Students should be taught to:

Sequences

a generate terms of a sequence using term-to-term and position-to-term definitions of the sequence

use linear expressions to describe the nth term of an arithmetic sequence, justifying its form by reference to the activity or context from which it was generated

generate common integer sequences (including sequences of odd or even integers, squared integers, powers of 2, powers of 10, triangular numbers)

Graphs of linear functions

b use the conventions for coordinates in the plane

plot points in all four quadrants

recognise (when values are given for m and c) that equations of the form $y = mx + c$ correspond to straight-line graphs in the coordinate plane

plot graphs of functions in which y is given explicitly in terms of x, or implicitly

c find the gradient of lines given by equations of the form $y = mx + c$ (when values are given for m and c)

understand that the form $y = mx + c$ represents a straight line and that m is the gradient of the line and c is the value of the y- intercept

explore the gradients of parallel lines and lines perpendicular to each other

Example: **know that the lines represented by the equations $y = -5x$ and $y = 3 - 5x$ are parallel, each having gradient (-5) and know that the line with equation $y = \frac{x}{5}$ is perpendicular to these lines and has gradient $\frac{1}{5}$**

Interpreting graphical information

d construct linear functions and **plot the corresponding** graphs arising from real-life problems

discuss and interpret graphs modelling real situations

Example: distance-time graph for a particle moving with constant speed
depth of water in a container as it empties
velocity-time graph for a particle moving with constant acceleration

Quadratic functions

e generate points and plot graphs of simple quadratic functions, then more general quadratic functions

Example: $y = x^2$; $y = 3x^2 + 4$
$y = x^2 - 2x + 1$

find approximate solutions of a quadratic equation from the graph of the corresponding quadratic function

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

Other functions

f plot graphs of simple cubic functions, the reciprocal function $y = \frac{1}{x}$ with $x \neq 0$, the exponential function $y = k^x$ for integer values of x and simple positive values of k, the circular functions $y = \sin x$ and $y = \cos x$, using a spreadsheet or graph plotter as well as pencil and paper

Example: $y = x^3$
$y = 2^x$; $y = (\frac{1}{2})^x$

recognise the characteristic shapes of all these functions

Transformation of functions

g **apply to the graph of $y = f(x)$ the transformations $y = f(x) + a$, $y = f(ax)$, $y = f(x + a)$, $y = af(x)$ for linear, quadratic, sine and cosine functions $f(x)$**

Loci	h	**construct the graphs of simple loci including the circle $x^2 + y^2 = r^2$ for a circle of radius *r* centred at the origin of coordinates** **find graphically the intersection points of a given straight line with this circle and know that this corresponds to solving the two simultaneous equations representing the line and the circle**

Ma3 Shape, space and measures

1 Using and Applying Shape, Space and Measures

Students should be taught to:

Problem solving	a	select the problem-solving strategies **to use in geometrical work**, and consider and explain the extent to which the selections they made were appropriate
	b	select and combine known facts and problem-solving strategies to solve **more complex geometrical** problems
	c	develop and follow alternative lines of enquiry, **justifying their decisions to follow or reject particular approaches**
Communicating	d	communicate mathematically, with emphasis on a critical examination of the presentation and organisation of results, and on effective use of symbols and geometrical diagrams
	e	**use precise formal language and exact methods for analysing geometrical configurations**
	g	review and justify their choices of mathematics presentation
Reasoning	*h*	distinguish between practical demonstrations and proofs
	f	apply mathematical reasoning, **progressing from brief mathematical explanations towards full justifications in more complex contexts**
	g	**explore connections in geometry** **pose conditional constraints of the type 'If… then…'** **ask questions 'What if…?' or 'Why?'**
	h	show step-by-step deduction in solving a geometrical problem
	i	state constraints and give starting points when making deductions
	j	**understand the necessary and sufficient conditions under which generalisations**, **inferences and solutions to geometrical problems remain valid**

2 Geometrical Reasoning

Students should be taught to:

Properties of triangles and other rectilinear shapes

a distinguish between lines and line segments

use parallel lines, alternate angles and corresponding angles

understand the consequent properties of parallelograms and a proof that the angle sum of a triangle is 180 degrees

understand a proof that the exterior angle of a triangle is equal to the sum of the interior angles at the other two vertices

b use angle properties of equilateral, isosceles and right-angled triangles

explain why the angle sum of a quadrilateral is 360 degrees

e use their knowledge of rectangles, parallelograms and triangles to deduce formulae for the area of a parallelogram, and a triangle, from the formula for the area of a rectangle

c recall the definitions of special types of quadrilateral, including square, rectangle, parallelogram, trapezium and rhombus

classify quadrilaterals by their geometric properties

d calculate and use the sums of the interior and exterior angles of quadrilaterals, pentagons and hexagons

calculate and use the angles of regular polygons

e **understand and use SSS**, **SAS**, **ASA and RHS conditions to prove the congruence of triangles using formal arguments**, **and to verify standard ruler and compass constructions**

f understand, recall and use Pythagoras' theorem in 2-D, **then 3-D problem**s

investigate the geometry of cuboids including cubes, and shapes made from cuboids, **including the use of Pythagoras' theorem to calculate lengths in three dimensions**

g **understand similarity of triangles and of other plane figures**, **and use this to make geometric inferences**

understand, **recall and use trigonometrical relationships in right-angled triangles**, **and use these to solve problems**, **including those involving bearings**, **then use these relationships in 3-D contexts**, **including finding the angles between a line and a plane (but not the angle between two planes or between two skew lines)**

		calculate the area of a triangle using $\frac{1}{2}ab\sin C$
		draw, sketch and describe the graphs of trigonometric functions for angles of any size, including transformations involving scalings in either or both the x and y directions
		use the sine and cosine rules to solve 2-D and 3-D problems
Properties of circles	h	recall the definition of a circle and the meaning of related terms, including centre, radius, chord, diameter, circumference, tangent, arc, sector and segment
		understand that the tangent at any point on a circle is perpendicular to the radius at that point
		understand and use the fact that tangents from an external point are equal in length
		explain why the perpendicular from the centre to a chord bisects the chord
		understand that inscribed regular polygons can be constructed by equal division of a circle
		prove and use the facts that the angle subtended by an arc at the centre of a circle is twice the angle subtended at any point on the circumference, the angle subtended at the circumference by a semicircle is a right angle, that angles in the same segment are equal, and that opposite angles of a cyclic quadrilateral sum to 180 degrees
		prove and use the alternate segment theorem
3-D shapes	i	use 2-D representations of 3-D shapes and analyse 3-D shapes through 2-D projections and cross-sections, including plan and elevation
		solve problems involving surface areas and volumes of prisms, pyramids, cylinders, **cones and spheres**
		solve problems involving more complex shapes and solids, including segments of circles and frustums of cones

3 Transformations and Coordinates

Students should be taught to:

Specifying transformations

a understand that rotations are specified by a centre and an (anticlockwise) angle

use any point as the centre of rotation

measure the angle of rotation, using right angles, fractions of a turn or degrees

understand that reflections are specified by a (mirror) line

understand that translations are specified by a distance and direction (or a vector), and enlargements by a centre and a positive scale factor

Properties of transformations

b recognise and visualise rotations, reflections and translations including reflection symmetry of 2-D and 3-D shapes, and rotation symmetry of 2-D shapes

transform triangles and other 2-D shapes by translation, rotation and reflection and combinations of these transformations

Example: reflection in $x = c$, $y = c$, $y = x$ or $y = -x$

use congruence to show that translations, rotations and reflections preserve length and angle, so that any figure is congruent to its image under any of these transformations

Example: describe the single transformation equivalent to a combination of transformations

distinguish properties that are preserved under particular transformations

c recognise, visualise and construct enlargements of objects

understand from this that any two circles and any two squares are mathematically similar, while, in general, two rectangles are not, **then use positive fractional and negative scale factors**

d recognise that enlargements preserve angle but not length

identify the scale factor of an enlargement as the ratio of the lengths of any two corresponding line segments

understand the implications of enlargement for perimeter

use and interpret maps and scale drawings

understand the difference between formulae for perimeter, area and volume by considering dimensions

understand and **use the effect of** enlargement on areas and volumes of shapes and solids

Coordinates

e understand that one coordinate identifies a point on a number line, that two coordinates identify a point in a plane and three coordinates identify a point in space, using the terms '1-D', '2-D' and '3-D'

use axes and coordinates to specify points in all four quadrants

locate points with given coordinates

find the coordinates of points identified by geometrical information

find the coordinates of the midpoint of the line segment AB, given the points A and B, calculate the length AB

Example: identify the coordinates of the midpoint of a line segment in 3-D

Vectors

f understand and use vector notation

Example: column vector notation

calculate, and represent graphically, the sum of two vectors, the difference of two vectors and a scalar multiple of a vector

calculate the resultant of two vectors

understand and use the commutative and associative properties of vector addition

solve simple geometrical problems in 2-D using vector methods

4 Measures and Construction

Students should be taught to:

Measures

a use angle measure

Example: use bearings to specify direction

know that measurements using real numbers depend on the choice of unit

recognise that measurements given to the nearest whole unit may be inaccurate by up to one half in either direction

convert measurements from one unit to another

understand and use compound measures, including speed and density

Construction

d draw **approximate constructions** of triangles and other 2-D shapes, using a ruler and protractor, given information about their side lengths and angles

b understand, from their experience of constructing them, that triangles satisfying SSS, SAS, ASA and RHS are unique, but SSA triangles are not

construct **specified** cubes, regular tetrahedra, square-based pyramids and other 3-D shapes

c use straight edge and compasses to do standard constructions including an equilateral triangle with a given side, the midpoint and perpendicular bisector of a line segment, the perpendicular from a point to a line, the perpendicular from a point on a line, and the bisector of an angle

Mensuration

f calculate perimeters and areas of shapes made from triangles and rectangles

d find the surface area of simple shapes using the formulae for the areas of triangles and rectangles

Example: areas of parallelograms and trapeziums

find volumes of cuboids, recalling the formula and understanding the connection to counting cubes and how it extends this approach

calculate volumes of right prisms and of shapes made from cubes and cuboids

convert between area measures, including square centimetres and square metres, and volume measures, including cubic centimetres and cubic metres

find circumferences of circles and areas enclosed by circles, recalling relevant formulae

Example: half-circles and quarter circles

calculate the lengths of arcs and the areas of sectors of circles

Loci

e find loci, both by reasoning and by using ICT to produce shapes and paths

Example: a region bounded by a circle and an intersecting line

Ma4 Handling data

1 Using and Applying Handling Data

Students should be taught to:

Problem solving

a carry out each of the four aspects of the handling data cycle to solve problems:

- i specify the problem and plan: formulate questions in terms of the data needed, and consider what inferences can be drawn from the data

  decide what data to collect (including sample size and data format) and what statistical analysis is needed
- ii collect data from a variety of suitable sources, including experiments and surveys, and primary and secondary sources
- iii process and represent the data: turn the raw data into usable information that gives insight into the problem
- iv interpret and discuss the data: answer the initial question by drawing conclusions from the data

b select the problem-solving strategies to use in statistical work, and monitor their effectiveness (these strategies should address the scale and manageability of the tasks, and should consider whether the mathematics and approach used are delivering the most appropriate solutions)

Communicating

c communicate mathematically, **with emphasis on the use of an increasing range** of diagrams and related explanatory text, **on the selection of their mathematical presentation**, **explaining its purpose and approach**, **and on the use of symbols to convey statistical meaning**

Reasoning

d apply mathematical reasoning, explaining and justifying inferences and deductions, **justifying arguments and solutions**

e identify exceptional or unexpected cases when solving statistical problems

f explore connections in mathematics and look for relationships between variables when analysing data

g recognise the limitations of any assumptions and the effects that varying the assumptions could have on the conclusions drawn from data analysis

2 Specifying the Problem and Planning

Students should be taught to:

a see that random processes are unpredictable

b identify key questions that can be addressed by statistical methods

c discuss how data relate to a problem, identify possible sources of bias and plan to minimise it

d identify which primary data they need to collect and in what format, including grouped data, considering appropriate equal class intervals

select and justify a sampling scheme and a method to investigate a population, including random and stratified sampling

e design an experiment or survey

decide what primary and secondary data to use

3 Collecting Data

Students should be taught to:

a collect data using various methods, including observation, controlled experiment, data logging, questionnaires and surveys

b gather data from secondary sources, including printed tables and lists from ICT-based sources

c design and use two-way tables for discrete and grouped data

d **deal with practical problems such as non-response or missing data**

4 Processing and Representing Data

Students should be taught to:

a draw and produce, using paper and ICT, pie charts for categorical data, and diagrams for continuous data, including line graphs (time series), scatter graphs, frequency diagrams, stem-and-leaf diagrams, **cumulative frequency tables and diagrams**, **box plots and histograms for grouped continuous data**

Example: frequency polygons, histograms with equal class intervals and frequency diagrams for grouped discrete data

b understand and use estimates or measures of probability from theoretical models, or from relative frequency

Example: addition of simple probabilities

c list all outcomes for single events, and for two successive events, in a systematic way

d identify different mutually exclusive outcomes and know that the sum of the probabilities of all these outcomes is 1

e find the median, **quartiles and interquartile range** for large data sets and calculate the mean for large data sets with grouped data

f **calculate an appropriate moving average**

g **know when to add or multiply two probabilities**: **if *A* and *B* are mutually exclusive**, **then the probability of *A* or *B* occurring is P(*A*) + P(*B*)**, **whereas if *A* and *B* are independent events**, **the probability of *A* and *B* occurring is P(*A*) × P(*B*)**

Example: **conditional probabilities**

h **use tree diagrams to represent outcomes of compound events**, **recognising when events are independent**

i draw lines of best fit by eye, understanding what these represent

Example: use of line of best fit

j use relevant statistical functions on a calculator or spreadsheet

5 Interpreting and Discussing Results

Students should be taught to:

a relate summarised data to the initial questions

b interpret a wide range of graphs and diagrams and draw conclusions

identify seasonality and trends in time series

Example: using a moving average graph

c look at data to find patterns and exceptions

d compare distributions and make inferences, using shapes of distributions and measures of average and **spread**, **including median and quartiles**

understand frequency density

e consider and check results, and modify their approach if necessary

f appreciate that correlation is a measure of the strength of the association between two variables

distinguish between positive, negative and zero correlation using lines of best fit

appreciate that zero correlation does not necessarily imply 'no relationship' but merely 'no linear relationship'

g use the vocabulary of probability to interpret results involving uncertainty and prediction

Example: 'there is some evidence from this sample that …'

h compare experimental data and theoretical probabilities

i understand that if they repeat an experiment, they may — and usually will — get different outcomes, and that increasing sample size generally leads to better estimates of probability and population **parameters**

k interpret social statistics including index numbers

Example: the General Index of Retail Prices

time series

Example: population growth

and survey data

Example: the National Census

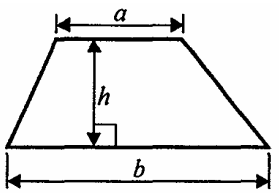
Formulae sheets

EDEXCEL

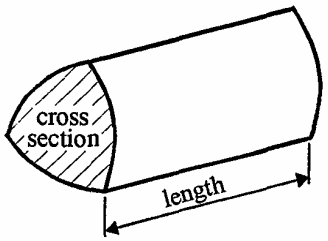
GCSE Mathematics

Formulae sheet — Foundation tier

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



Volume of prism = area of cross-section × length

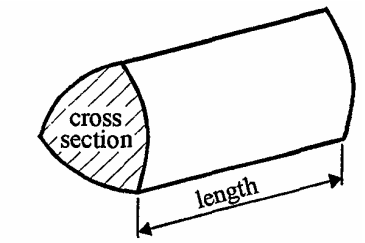


EDEXCEL

GCSE Mathematics

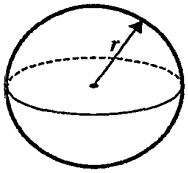
Formulae sheet — Higher tier

Volume of prism = area of cross-section × length



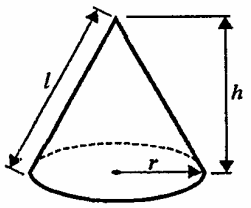
Volume of sphere = $\frac{4}{3}\pi r^3$

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



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

Curved surface area of cone = πrl

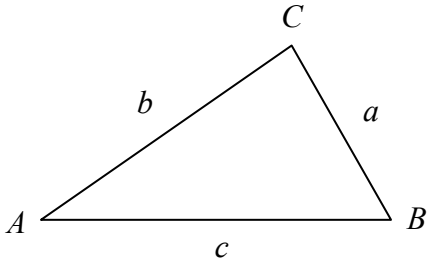


In any triangle *ABC*

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

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

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



The Quadratic Equation

The solutions of $ax^2 + bx + c = 0$, where $a \neq 0$, are given by $x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$

Specification aims and assessment objectives

Aims

This specification is consistent with the requirements of the English National Curriculum Orders for Mathematics. Additionally, it entirely meets the GCSE criteria for Mathematics, the general criteria for GCSE as well as the GCSE Mandatory Code of Practice. The aims of this specification are that students:

Using and applying mathematics

- use and apply mathematics in practical tasks, in real-life problems and within mathematics itself
- work on problems that pose a challenge
- encounter and consider different lines of mathematical argument.

Number

- use calculators and computer software, eg spreadsheets
- develop and use flexibly a range of methods of computation, and apply these to a variety of problems.

Algebra

- explore a variety of situations that lead to the expression of relationships
- consider how relationships between number operations underpin the techniques for manipulating algebraic expressions
- consider how algebra can be used to model real-life situations and solve problems.

Shape, space and measures

- use a variety of different representations
- explore shape and space through drawing and practical work using a wide range of materials
- use computers to generate and transform graphic images and to solve problems.

Handling data

- formulate questions that can be considered using statistical methods
- undertake purposeful enquiries based on data analysis
- use computers as a source of large samples, a tool for exploring graphical representations and as a means to simulate events
- engage in practical and experimental work in order to appreciate some of the principles which govern random events
- look critically at some of the ways in which representations of data can be misleading and conclusions uncertain.

Some of the aims are reflected in the assessment objectives, whilst others are not as they cannot be readily assessed. However, mental calculation without the aid of a calculator, estimation, understanding of 3-D shape, practical activities, use of ICT and data collection need to be incorporated into schemes of work.

Note

Mental calculation should be encouraged as it will be assumed that in written papers mental calculations are being performed to solve problems. Calculations without the aid of a calculator will be tested in a written paper where candidates are not allowed the use of a calculator.

Estimation will be tested through questions on written papers.

Questions testing candidates' understanding of 3-D shape will be tested on written papers.

Methods of data collection will be tested through written papers.

Knowledge, skills and understanding

The knowledge, skills and understanding required for GCSE Mathematics is contained in the National Curriculum Key Stage 4 Programme of Study for Mathematics.

Assessment objectives

The specification requires candidates to demonstrate their knowledge understanding and skills in the following:

AO1: **Using and applying mathematics**

- Problem solving
- Communicating
- Reasoning

AO2: **Number and algebra**

- Numbers and the number system
- Calculations
- Solving numerical problems
- Equations, formulae and identities
- Sequences, functions and graphs

AO3: **Shape**, **space and measures**

- Geometrical reasoning
- Transformation and coordinates
- Measures and construction

AO4: **Handling data**

- Specifying the problem and planning
- Collecting data
- Processing and representing data
- Interpreting and discussing results

Assessment objective AO1, Using and applying mathematics, will be assessed in contexts provided by the other assessment objectives.

Scheme of assessment

Entry tiers

Candidates for this qualification must be entered for one of two tiers.

The grades available for each tier are as follows:

Tier	Grades available
Foundation	G to C
Higher	D to A* (E)

(E) indicates that grade E is allowed for Higher tier candidates. Candidates achieving a mark below the minimum for the award of the lowest grade in each tier will be ungraded.

Assessment of the specification consists of:

For Foundation tier candidates:

Paper	Weighting	Time	Calculator
Paper 1	50%	1 hour 30 minutes	no
Paper 2	50%	1 hour 30 minutes	yes

For Higher tier candidates:

Paper	Weighting	Time	Calculator
Paper 3	50%	1 hour 45 minutes	no
Paper 4	50%	1 hour 45 minutes	yes

Relationship of assessment objectives to external assessment

The weighting for each attainment target is shown below:

	Assessment objective		Weighting
Two parallel examination papers	AO1	Using and applying mathematics	20%
	AO2	Number and algebra	50–55%
	AO3	Shape, space and measures	25–30%
	AO4	Handling data	18–22%

Marks are allocated to AO2-AO4 in the ranges above. AO1 marks are then allocated across assessments, over at least 20 per cent of the marks.

AO1 is assessed in the context of the other assessment objectives.

External assessment

Examination papers 1–4

- Examination papers 1–4 will be combined question/answer books containing both shorter and longer questions.
- Examination papers 1 and 3 will be timetabled in one session, and examination papers 2 and 4 in another.
- Examination papers 1 and 3 will be non-calculator papers. In these papers calculators, slide rules, logarithm tables and all other calculating aids are forbidden.
- The non-calculator examination papers may test any topic in the subject content appropriate to the tier of entry, except those that expressly require the use of a calculator.
- The with-calculator examination papers may test any topic in the subject content appropriate to the tier of entry, except those that expressly prohibit the use of a calculator.
- There will be a number of questions demanding the unprompted solution of multi-step problems.
- There will be a number of questions requiring the use of manipulative algebra.
- Each examination paper will carry a maximum mark of 100.
- There will be two parallel examination papers for each tier. Each examination paper will assess the full range of grades at each tier.
- There will be common questions across examination papers to aid standardisation and comparability of awards between tiers.
- Questions on the Higher tier examination papers will assume knowledge from the Foundation tier. However, material related to grades below the range of the tier will not be the focus of assessment.
- Diagrams will not necessarily be drawn to scale and measurements should not be taken from diagrams unless instructions to this effect are given.
- Each candidate may be required to use mathematical instruments, for example pair of compasses, ruler, protractor.
- Tracing paper may be used.
- Formulae sheets will be provided for both Foundation and Higher tiers (see pages 49–50).

Calculators

Candidates will be expected to have access to a suitable electronic calculator for examination papers 2 and 4.

Electronic calculators to be used by candidates attempting examination paper 2 should have, as a minimum, the following functions:

+, −, ×, ÷, x^2, $\sqrt{x}$, memory, brackets, x^y, $x^{\frac{1}{y}}$, $\bar{x}$, Σx, Σfx, standard form

Electronic calculators to be used by candidates attempting examination paper 4 should have, as a minimum, the following functions:

+, −, ×, ÷, x^2, $\sqrt{x}$, memory, constant function, brackets, x^y, $x^{\frac{1}{y}}$, $\bar{x}$, Σx, Σfx, standard form, sine, cosine, tangent and their inverses.

Calculators with any of the following facilities are prohibited from any examination paper:

- databanks
- retrieval of text or formulae
- QWERTY keyboards
- built-in symbolic algebra manipulations
- symbolic differentiation or integration, language translators
- communication with other machines or the internet.

Quality of written communication

This specification does not formally assess the quality of written communication. Many of the elements of the key skill of communication may be delivered through this specification by the use of appropriate teaching and learning styles.

Awarding, reporting and equivalence

The grading, awarding and certification of this specification will comply with the requirements of the GCSE Code of Practice for courses starting in September 2006, which is published by QCA.

Qualifications will be graded and certificated on an eight-grade scale from A* to G.

Overall differentiation is achieved within the specification by allowing levels of entry in two overlapping tiers. These tiers of entry allow a full and balanced opportunity for candidates at all levels of attainment to show what they know, understand and can do. The examination papers 1–4 provide differentiation by task.

Language of assessment

Assessment of this specification will be available in English only. Assessment materials will be published in English only and all written and spoken work submitted for examination and moderation must be produced in English.

Access arrangements and special considerations

Edexcel's policy on access arrangements and special considerations for GCE, VCE, GCSE, GNVQ, Entry Level and key skills aims to enhance access to the qualifications for learners with disabilities and other difficulties (as defined by the Disability Discrimination Act 1995 and the amendments to the act) without compromising the assessment of skills, knowledge, understanding or competence.

Please visit the Edexcel website (www.edexcel.org.uk/sfc) for details on:

- the latest JQC policy Access Arrangements and Special Considerations, Regulations and Guidance Relating to Candidates who are eligible for Adjustments in Examinations
- the forms to submit for requests for access arrangements and special considerations
- dates for submission of the forms.

Requests for access arrangements and special considerations must be addressed to:

Special Requirements
Edexcel
One90 High Holborn
London WC1V 7BH

Grade descriptions

Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by candidates awarded particular grades. The descriptions must be interpreted in relation to the content in the specification; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of candidates' performance in the assessment may be balanced by better performance in others.

Grade F

In order to carry through tasks and solve mathematical problems, candidates identify and obtain necessary information; they check their results, considering whether these are sensible. Candidates show understanding of situations by describing them mathematically using symbols, words and diagrams. They draw simple conclusions of their own and give an explanation of their reasoning.

Candidates use their understanding of place value to multiply and divide whole numbers and decimals by 10, 100 and 1000. They order, add and subtract negative numbers in context. They use all four operations with decimals to two places. They reduce a fraction to its simplest form by cancelling common factors and solve simple problems involving ratio and direct proportion. They calculate fractional or percentage parts of quantities and measurements, using a calculator where necessary. Candidates understand and use an appropriate non-calculator method for solving problems involving multiplying and dividing any three-digit by any two-digit number. In solving problems with or without a calculator, candidates check the reasonableness of their results by reference to their knowledge of the context or to the size of the numbers, by applying inverse operations or by estimating using approximations. Candidates explore and describe number patterns and relationships including multiple, factor and square. They construct, express in symbolic form, and use simple formulae involving one or two operations.

When constructing models, and when drawing or using shapes, candidates measure and draw angles as accurately as practicable, and use language associated with angle. They know the angle sum of a triangle and that of angles at a point. They identify all the symmetries of 2-D shapes. They know the rough metric equivalents of imperial units still in daily use and convert one metric unit to another. They make sensible estimates of a range of measures in relation to everyday situations. Candidates calculate areas of rectangles. Candidates use coordinates in all four quadrants to locate and specify points.

Candidates understand and use the mean of discrete data. They compare two simple distributions, using the range and one of the mode, median or mean. They interpret graphs and diagrams, including pie charts, and draw conclusions. They understand and use the probability scale from 0 to 1. Candidates make and justify estimates of probability by selecting and using a method based on equally likely outcomes or on experimental evidence as appropriate. They understand that different outcomes may result from repeating an experiment.

Grade C

Starting from problems or contexts that have been presented to them, candidates refine or extend the mathematics used to generate fuller solutions. They give a reason for their choice of mathematical presentation, explaining features they have selected. Candidates justify their generalisations, arguments or solutions, showing some insight into the mathematical structure of the problem. They appreciate the difference between mathematical explanation and experimental evidence.

In making estimates candidates use appropriate techniques and multiply and divide mentally. They solve numerical problems involving multiplication and division with numbers of any size using a calculator efficiently and appropriately. They understand the effects of multiplying and dividing by numbers between 0 and 1. They use ratios in appropriate situations. They understand and use proportional changes. Candidates find and describe in symbols the next term or the nth term of a sequence, where the rule is linear. Candidates calculate one quantity as a percentage of another. They multiply two expressions of the form $(x + n)$; they simplify the corresponding quadratic expressions. They solve simple polynomial equations by trial and improvement and represent inequalities using a number line. They formulate and solve linear equations with whole number coefficients. They manipulate simple algebraic formulae, equations and expressions. Candidates draw and use graphs of quadratic functions.

Candidates solve problems using angle and symmetry properties of polygons and properties of intersecting and parallel lines. They understand and apply Pythagoras' theorem when solving problems in two dimensions. Candidates solve problems involving areas and circumferences of circles. They calculate lengths, areas and volumes in plane shapes and right prisms. Candidates enlarge shapes by a positive whole number or fractional scale factor. They appreciate the imprecision of measurement and recognise that a measurement given to the nearest whole number may be inaccurate by up to one half in either direction. They understand and use compound measures such as speed. Candidates use mathematical instruments to carry out accurate constructions of loci.

Candidates construct and interpret frequency diagrams with grouped data. They specify hypotheses and test them. They determine the modal class and estimate the mean, median and range of a set of grouped data, selecting the statistic most appropriate to their line of enquiry. They use measures of average and range with associated frequency polygons, as appropriate, to compare distributions and make inferences. Candidates understand relative frequency as an estimate of probability and use this to compare outcomes of experiments.

Grade A

Candidates give reasons for the choices they make when investigating within mathematics itself or when using mathematics to analyse tasks; these reasons explain why particular lines of enquiry or procedures are followed and others rejected. Candidates apply the mathematics they know in familiar and unfamiliar contexts. Candidates use mathematical language and symbols effectively in presenting a convincing and reasoned argument. Their reports include mathematical justifications, explaining their solutions to problems involving a number of features or variables.

Candidates manipulate simple surds. They determine the bounds of intervals. Candidates understand and use direct and inverse proportion. They manipulate algebraic formulae, equations and expressions, finding common factors and multiplying two linear expressions. In simplifying algebraic expressions, they use rules of indices for negative and fractional values. They solve problems using intersections and gradients of graphs.

Candidates sketch the graphs of sine, cosine and tangent functions for any angle and generate and interpret graphs based on these functions. Candidates use sine, cosine and tangent of angles of any size, and Pythagoras' theorem, when solving problems in two and three dimensions. They use the conditions for congruent triangles in formal geometric proofs. They calculate lengths of circular arcs and areas of sectors, and calculate the surface area of cylinders and volumes of cones and spheres. They understand and use the effect of enlargement on areas and volumes of shapes and solids.

Candidates interpret and construct histograms. They understand how different methods of sampling and different sample sizes may affect the reliability of conclusions drawn; they select and justify a sample and method to investigate a population. They recognise when and how to work with probabilities associated with independent and mutually exclusive events.

The wider curriculum

Key skills

This specification will provide opportunities, as appropriate, to develop the key skills of communication, information and communication technology, application of number, improving own learning and performance, working with others and problem solving.

- A*–C examination performance in GCSE Mathematics provides exemption from the external test in application of number at Level 2.
- D–G examination performance in GCSE Mathematics provides exemption from the external test in application of number at Level 1.

Spiritual, moral, ethical, social, cultural and environmental issues, health and safety considerations and the European dimension

This specification will enable centres to provide courses in mathematics that will allow students to discriminate between truth and falsehood. As candidates explore mathematical models of the real world there will be many naturally arising moral and cultural issues, environmental and safety considerations and aspects of European developments for discussion.

Education for citizenship

The specification for GCSE Mathematics gives candidates the opportunity to develop their skills of enquiry and communication in relation to citizenship. In particular they will be able to develop their ability to analyse information from different sources, including ICT-based sources, and explore the use and abuse of statistics. They will also have the opportunity to develop their knowledge and understanding of citizenship. In particular through their work in handling data (AO4), candidates may have the opportunity to explore the use of statistical information in the media and its role in providing information and affecting opinion. Through their work on number (AO2) candidates may explore the practical applications of their work in the fields of business and financial services. Other opportunities for developing ideas of citizenship will present themselves depending on the contexts in which they explore and develop their mathematical knowledge, skills and understanding.

Information and communication technology

Candidates following this specification will have many opportunities to use ICT. These include use of spreadsheets to make calculations, create formulas, charts and graphs and using the internet to gather statistics and data. Dedicated software such as a multimedia CD ROM or dedicated websites can be used to support mathematics work. There is also software available to enhance the delivery of some of the requirements of the GCSE specification. Use of calculators, including graphic and programmable calculators, also falls within the ICT category.

Papers 2 and 4 will provide opportunities to assess candidates' ability to use a calculator efficiently.

Support and training

Textbooks and other resources

A number of publishers will be producing textbooks and electronic resources to support this qualification. Publishers include:

- Causeway Press
- Harcourt
- HarperCollins
- Hodder Murray
- Longman
- Oxford University Press.

Training

A programme of professional development courses covering various aspects of the specification and assessment will be arranged by Edexcel each year on a regional basis. Full details may be obtained from:

Professional Development and Training
Edexcel
One90 High Holborn
London WC1V 7BH

Telephone: 0870 240 9800
Fax: 020 7190 5700

Website

www.edexcel.org.uk

Please visit the Edexcel website, where further information about training and support for all qualifications, including this GCSE, can be found.

The website is regularly updated and an increasing amount of support material and information will become available through it.

Edexcel publications

Support materials and further copies of this specification can be obtained from:

Edexcel Publications
Adamsway
Mansfield
Nottinghamshire NG18 4FN

Telephone: 01623 467467
Fax: 01623 450481
Email: publications@linneydirect.com

The following support materials will be available from Summer 2007 onwards:

- specimen papers
- ICT guide
- schemes of work
- content exemplification.

Regional offices and Customer Services

Further advice and guidance is available through a national network of regional offices. For general enquiries, and for details of your nearest office, please call the Customer Services on 0870 240 9800. Calls may be recorded for training purposes.

Appendices

Appendix 1: Key skills 65

Appendix 1: Key skills

The GCSE in Mathematics offers a range of opportunities for students to:

- develop their key skills
- generate assessed evidence for their portfolio.

In particular, the following key skills can be developed and assessed through this specification at Level 2:

- application of number
- communication
- information and communication technology
- improving own learning and performance
- problem solving
- working with others.

Further guidance on the development of Level 1 key skills through the GCSE in Mathematics will be made available in future publications.

Copies of the key skills specifications can be ordered from Edexcel Publications.

Individual key skills units are divided into three parts:

Part A — what you need to know	this identifies the underpinning knowledge and skills required of the student
Part B — what you must do	this identifies the evidence that students must produce for their portfolio
Part C — guidance	this gives examples of possible activities and types of evidence that may be generated.

This GCSE specification signposts development and internal assessment opportunities which are based on Part B of the Level 2 key skills units.

The evidence generated through this GCSE will be internally assessed and contribute to students' key skills portfolios. In addition, in order to achieve the key skills Qualification, students will need to take the additional external tests associated with communication, information and communication technology and application of number. Centres should check the current position on proxy qualifications as some students may be exempt from part or all of the assessment of a specific key skill.

The GCSE in Mathematics will provide many opportunities for the development of the key skills identified. This appendix provides a mapping of those opportunities and also identifies the key skills evidence requirements. Students will need to have opportunities to develop their skills over time before they are ready for assessment. In order to satisfy the key skills requirements, students will need to apply their mathematical skills **in context**. Teachers need to adopt a method of delivering the specifications which ensures that students are given the opportunities to use and apply their knowledge in a sustained way, creating a portfolio of evidence as they progress through the GCSE syllabus.

This appendix contains illustrative activities for each key skill that will aid development and facilitate the generation of appropriate portfolio evidence. To assist in the recording of key skills evidence Edexcel has produced recording documentation which can be ordered from Edexcel Publications.

Mapping of key skills: summary table

Key skills (Level 2)	Foundation tier	Higher tier
Application of number		
N2.1	✓ (grade C standard or above)	✓
N2.2	✓ (grade C standard or above)	✓
N2.3	✓	✓
Communication		
C2.1a	✓	✓
C2.1b	✓	✓
C2.2	✓	✓
C2.3	✓	✓
Information and communication technology		
IT2.1	✓	✓
IT2.2	✓	✓
IT2.3	✓	✓
Working with others		
WO2.1	✓	✓
WO2.2	✓	✓
WO2.3	✓	✓
Improving own learning and performance		
LP2.1	✓	✓
LP2.2	✓	✓
LP2.3	✓	✓
Problem solving		
PS2.1	✓	✓
PS2.2	✓	✓
PS2.3	✓	✓

Application of number Level 2

The GCSE in Mathematics provides opportunities for students both to develop the key skill of application of number and also to generate evidence for their portfolio. As well as undertaking tasks related to the three areas of evidence required students also undertake a substantial activity that includes straightforward tasks. This will involve them obtaining and interpreting information, using this information when carrying out calculations, and interpreting and presenting the results of the calculations.

Key skill portfolio evidence requirements	Opportunities for development
N2.1: Interpret information from **two** different sources, including material containing a graph.	Students are required to: • choose how to obtain the information needed to meet the purpose of their activity • obtain the relevant information • select the appropriate methods to get the results they need. For example, the criteria for N2.1 are satisfied when: • producing a plan of action and breaking down a task into manageable components when given a practical problem to solve, eg designing a drinks can which maximises volume against minimising surface area, choosing to adopt a symbolic approach to a modelling task, deciding to group a large amount of data to enable a concise estimate of suitable average and spread to be calculated • designing a data collection sheet/questionnaire to gather relevant data for a statistics task, eg redesigning of a questionnaire after a pilot survey, using open and/or closed questioning techniques in the appropriate place • deciding upon a suitable sample and sampling method when collecting data from a large sample frame, eg ensure that in a sample of 50 students in school, proportions of male and female and/or numbers in each year group are maintained • gathering relevant information from a secondary data source, in chart or graphical form or written as an article, eg accident statistics, health statistics, newspaper articles. NB Students must be given tasks to solve where they have to choose the methods of calculation. In completing the GCSE in Mathematics at Level 2 students may not be given the opportunity to 'read scales on a range of equipment to given levels of accuracy'.

Key skill portfolio evidence requirements	Opportunities for development
N2.2: Carry out calculations to do with: a amounts and sizes b scales and proportions c handling statistics d using formulae.	Students must: • carry out calculations, clearly showing their methods and levels of accuracy • check their methods to identify and correct any errors, and make sure their results make sense. For example, the criteria for N2.2 are satisfied when: • students carry out multi-stage calculations throughout the GCSE course, particularly when solving problems set in a real life context, eg using Pythagoras' theorem or trigonometry in surveying problems, using percentages when calculating interest or percentage profit and loss over several years, using indices when solving problems relating to population growth or radioactive decay • students understand and use fractions, decimals, ratio, proportion and percentages in context, eg creating and maintaining a shares portfolio over the GCSE course, producing a scale drawing of a room or building which is then used to redesign its layout for a purpose • converting measurements between systems, eg comparing prices of a selection of items from an overseas country to their own, comparing historical records of prices, athletic records, etc, to the present day • using the appropriate formulae to calculate, for example, lengths, areas and volumes, distance, speed or time • performing statistical calculations to enable comparisons of central tendency and spread for two data sets containing a minimum of 20 items of data in each • building in checking procedures into their extended tasks, making sure results are sensible, eg calculating percentage errors, using maximum and minimum values in compound calculations and recognising the effect this has on optimum solutions. NB The content of the GCSE specification from grade C upward would normally cover N2.2. However, it is important that students perform these calculations in the context of real life problems.

Key skill portfolio evidence requirements	Opportunities for development
N2.3: Interpret results of your calculations and present your finding in two different ways using charts, graphs or diagrams.	Based on their findings, students must: • select effective methods of presentation • use appropriate charts, diagrams, and tables to present their findings clearly and describe their methods • explain how the results of their calculations meet the purpose of the activity undertaken. For example, the criteria for N2.3 are satisfied when: • methods of calculation are discussed and justified, a student discusses the change of approach and explains the benefits of their restructuring, 'If I use n to stand for any number then the result will work for all values…', 'If I put these values on a graph I can see where they cross…', 'If I put this equation and this one together…', 'If I substitute this expression in this equation…' • students construct and use graphs, charts or diagrams to make further progress in a task • arriving at conclusions that are explained and justified, eg 'A square is the greatest area for a quadrilateral because…' 'Boys are generally taller in year 10 because…' 'An ISA will give you a better return for your money because…'

Evidence

Student evidence for application of number could include:

- description of the substantial activity
- a plan for obtaining and using the information required
- copies of source materials
- records of calculations showing methods used and levels of accuracy
- descriptions of findings, including justification of their presentation methods and explanations of how their results relate to their activity.

Communication Level 2

For the communication key skill, students are required to hold discussions and give presentations, read and summarise information, and write documents. Students will be able to develop all of these skills through an appropriate teaching and learning programme based on this GCSE specification.

Key skill portfolio evidence requirements	Opportunities for development
C2.**1a**: Take part in a group discussion.	Many of the topics in this specification are suitable as the basis of a group discussion. The discussion should be about a straightforward subject. This may be, for example, a subject often met in their studies and the vocabulary will be familiar. During the discussion students should make clear and relevant contributions, listen and respond to others, helping to move the discussion forward. Many topics within the specification lend themselves to group discussion, eg the validity of an answer given to five decimal places, the 'best' shape for a box of six tennis balls, the likely outcome of a probability experiment.
C21.**b**: Give a talk of at least four minutes.	Following a period of research students could be given the opportunity to give a short talk to the rest of their group. During the talk students should speak clearly in a way that suits the subject and situation. They should keep to the subject. The structure of the talk should help listeners follow points made. The talk should include an image to illustrate the main points clearly. Images could include charts and diagrams or other statistical diagrams, etc. Students could make presentations to a small group or class relating to topics in the specifications. Teachers should involve students in explaining results they have achieved in small and extended tasks. A student could illustrate using diagrams, for example, why the exterior angle of a nonagon is 140°, or use an overhead projector slide to illustrate the solution to a problem involving circle theorems.

Key skill portfolio evidence requirements	Opportunities for development
C2.2: Read and summarise information from **two** documents about the same subject. Each document must be at least 500 words long.	Students will have a number of opportunities to read and synthesise information from two extended documents, for example, as part of their preparation for the discussion and talk, or as preparation for a piece of written work. Extended documents may include textbooks and reports and articles of more than three pages. At least one of these documents should contain an image from which students can draw appropriate and relevant information. Students will need to select and read relevant material. From this information they will need to identify accurately the lines of reasoning and main points from the text and images. Students will then need to summarise this information in a form that suits the purpose, eg for a talk, discussion or an essay. A statistical investigation could allow students to collect two sets of primary and/or secondary data which would enable a comparison to be drawn between the two, eg comparing the length of words and sentences of a foreign language to students' own language, comparing the length of words and sentences in newspapers from the 19th and 20th centuries, comparing data on a subject from abroad to the UK.
C2.3: Write **two** different types of documents, each one giving different information. **One** document must be at least 500 words long.	Students are required to produce two different types of document. At least one of these should be an extended document, for example a report or an essay of more than three pages. The document should present relevant information in an appropriate form. At least one of the documents should include an appropriate image that contains and effectively conveys relevant information. The information in the document should be clearly structured, eg through the use of headings, paragraphs. Students should ensure that the text is legible and that spelling, punctuation and grammar are accurate.

Evidence

Student evidence for communication could include:

- teacher observation records
- preparatory notes
- audio/video tapes
- notes based on documents read
- essays.

It is not expected that the evidence produced during the GCSE in Mathematics for this key skill would be sufficient to satisfy the requirements.

Information and communication technology Level 2

When producing work for their GCSE in Mathematics, students will have numerous opportunities to use information and communication technology. The internet, CD ROM, etc could be used to collect information. Documents can be produced using relevant software and images may be incorporated in those documents. Early drafts of documents could be emailed to tutors for initial comments and feedback.

In addition, students will be able to use information and communication technology to generate evidence for the communication key skill. For example the extended document with images, required for C2.3, could be generated using appropriate software.

Mathematics students should utilise ICT as a modelling tool, particularly when using graphical calculators and spreadsheets. Accounts of their use in this way should be encouraged as part of students' portfolios.

As part of their mathematics programme students may not be able to generate sufficient evidence required for this key skills unit. For example, working with numbers through the use of a spreadsheet application, or some aspects of database use. In this situation, students may use stand-alone IT sessions for development and evidence generation and/or other parts of their GCSE course.

Key skill portfolio evidence requirements	Opportunities for development
ICT2.1: Search for and select information to suit your needs. Use different information sources for each task and multiple search criteria in at least one case. You should include at least one ICT based source and one non-ICT based information source. You should present evidence of purposeful use of email.	Students will need to identify suitable sources of information and effectively search for information using multiple criteria. Information selected should be interpreted and students should decide what is relevant for their purpose. For example, opportunities for partially satisfying this criteria include: Collecting data from a variety of internet sources including: • Office for Health Statistics • DfES website for educational performance tables • www.ons.gov.uk • www.detr.gov.uk • www.stats.demon.nl • www.hea.org.uk/research/index.html Interrogating a database.

Key skill portfolio evidence requirements	Opportunities for development
ICT2.2: Explore and develop information and to suit the task and derive new information.	Students are required to bring together information in formats, such as tables, that help development. The information should be explored by, for example, changing information in a spreadsheet model. Information should also be developed and new information derived as appropriate, for example through the use of headings, tables, charts and graphs. New information should be derived from, for example, comparing information from different sources, using formulae to calculate totals or averages.
ICT2.3: Present combined information such as text with image, text with number and image with number. This work must include at least **one** example of text, **one** example of images and **one** example of numbers.	In presenting combined information students will need to select and use appropriate layouts in a consistent way through, for example, the use of margins, headings, borders, font size, etc. Layouts, etc, should be refined to suit both the purpose and the needs of the audience (early drafts should be kept as portfolio evidence). The final piece of work should be suitable for its purpose and audience, eg OHTs/handouts for a presentation. The document should have accurate spelling (use of spell-checker) and have been proof read.

Evidence

Student evidence for information and communication technology could include:

- teacher observation records
- notes of sources used
- print-outs with annotations
- draft documents.

Working with others Level 2

To achieve this key skill, students are required to carry out at least two activities. One example must show that they can work in one-to-one situations and one example must show that they can work in group situations. Students will plan their work with others and confirm working arrangements; work cooperatively towards achieving identified objectives, and exchange information on progress. Students should provide at least two examples of meeting the standards for each of WO2.1, WO2.2 and WO2.3.

The delivery of the majority of the concepts in the GCSE in Mathematics can be modified to include group work. However, this approach should not be adopted solely to satisfy the criteria for this key skill. However, the content of AO4, handling data, can be modified readily to accommodate 'working with others'. Data collection can incorporate a collaborative approach, allowing further opportunities to satisfy WO2.1, 2.2 and 2.3.

Key skill portfolio evidence requirements	Opportunities for development
WO2.1: Plan work with others	Students should identify the objectives of working together and the tasks, resources and timescales required to meet these objectives. Information should be exchanged to clarify responsibilities. For example, suggesting ways help can be given, asking what others can do, checking their own and others' responsibilities. The group needs to confirm responsibilities and working arrangements. For example, throughout a data collection phase of a statistical activity, students should be encouraged to: • discuss and agree on a hypothesis to be tested • share out the data collection within the group, taking the opportunity to discuss relevant sampling techniques • effectively manage the time of each group, agreeing targets and deadlines. Partial satisfaction of these criteria relies on the teacher creating opportunities for data collection rather than allocating data that has already been prepared.
WO2.2: Work cooperatively with others towards achieving identified objectives.	Students will need to organise tasks so that responsibilities can be met. For example, obtaining resources, completing tasks on time. Tasks should be completed accurately and safely. Cooperative ways of working should be supported through, for example, anticipating the needs of others, avoiding actions that offend. Advice from others, including group members, teachers, etc, should be sought when needed.

Key skill portfolio evidence requirements	Opportunities for development
WO2.3: Review your contributions and agree ways to improve your work with others.	Once completed the full group needs to review outcomes against the agreed objectives. In doing this they should identify what has gone well and what has gone less well. Students should listen and respond to progress reports from others and agree ways of improving work with others to help achieve objectives. For example, throughout data collection activities, students should be encouraged to: • review outcomes against the agreed hypotheses • identify factors that have influenced the outcome • agree on the ways that the activity could have been carried out more effectively or modified to allow further progress.

Evidence

Student evidence for working with others could include:

- teacher observation records
- preparatory notes
- records of process and progress made.

Improving own learning and performance Level 2

Within GCSE in Mathematics programmes, students will have opportunities to develop and generate evidence that meets part of the evidence requirement of this key skill.

To achieve this key skill, students will need to provide at least **two** examples of meeting the required standard. Students are also required to improve their performance through studying a straightforward subject and by learning through a straightforward practical activity. This GCSE in Mathematics will provide opportunities for students to study a straightforward subject. Evidence for learning through a practical activity may come from certain topics within the specifications or from enrichment activities.

Activities that generate evidence for this key skill should take place over a period of a few weeks. **Over the period of the activity there will be times when the students should work without close supervision**. **However**, **students should seek and receive feedback**, **from teachers and others**, **on their target setting and performance**.

Any project work is a suitable learning activity and may be used to generate evidence for this key skill.

Key skill portfolio evidence requirements	Opportunities for development
LP2.1: Help set targets with an appropriate person and plan how these will be met.	Students plan how they are to meet short-term targets with an appropriate person, eg agreeing a project with their teacher. This will include setting realistic targets and action points. Review dates with, for example, their teacher should be built into the plan. For example, when starting a sustained piece of work, the student, in conjunction with their teacher: • completes a plan of action with the student identifying target dates, sources of information and methods of presentation • plans a rigorous timetable for home study, reviews and tutorials for each half term.

Key skill portfolio evidence requirements	Opportunities for development
LP2.2: Take some responsibility for some decisions about your learning, using your plan to help meet targets and improve your learning. Improve your performance by: • studying a straightforward subject • learning through a straightforward practical activity.	The plan should be implemented with performance reviews and should include working for short periods without close supervision. Students use their plan effectively when producing, for example: • a write up of an experiment or modelling exercise using – a spreadsheet – a database – practical equipment. This will involve: • prioritising action • managing their time effectively • revising their plan of action as necessary. Students should: • seek and use feedback and support and draw on different approaches to learning as outlined in their detailed plan of action.
LP2.3: Review progress with an appropriate person and provide evidence of your achievements.	Students should review their own progress with the help, for example, of their tutor. They should identify, with evidence, what and how they have learned and provide information on what has gone well and what has gone less well indicating which targets have been met and providing evidence of achievements from relevant sources. They should identify with, for example, their teacher, action for improving their performance.

Evidence

Student evidence for improving own learning and performance could include:

- teacher records
- annotated action plans
- records of discussions
- learning log
- work produced.

Problem solving Level 2

To achieve this key skill, students will need to provide at least **two** examples of meeting the required standard. **Each** example should cover a different problem and identify at least two different ways of solving it. Students should show that they can identify problems, plan and try out options to solve the problem and check whether the problem has been solved. For this GCSE, students may not be able to try out options and check results as there may be difficulties in implementing practical solutions in a school or college context.

Key skill portfolio evidence requirements	Opportunities for development
PS2.1: Identify a problem, with help from an appropriate person, and identify different ways of tackling it.	Students will need to identify the problem, describe its main features and show how it has been solved. They need to identify different ways of tackling the problem and ways of identifying success. They should use the help of others, for example, as appropriate. For example, students should discuss and agree an approach to solving problems presented in class. When solving investigations in class, students may agree to break the task down into smaller, more manageable pieces, adopt a systematic or symbolic approach and predict and test a conjecture with a further case. Alternatively, when solving a statistical problem in class, students may discuss and agree the hypothesis to be tested, agree a suitable data collection method and appropriate methods of analysis and presentation.
PS2.2: Plan and try out at least **one** way of solving the problem.	Students should confirm with their teacher, for example, their chosen option and how they will implement it. Upon implementation relevant tasks should be organised and changes made as necessary. Support should be obtained when needed. Students may identify several routes to a solution but choose, with justification, the most appropriate.
PS2.3: Check if the problem has been solved and identify ways to improve problem solving.	Students should check if the problem has been solved using agreed methods, for example by test, observation, inspection. The results of this should be described with an explanation of the decisions taken. Students should identify the strengths and weaknesses of their approach and how they would do things differently if they met a similar problem. Students may, as part of a solution to a problem, make a conjecture which is then tested. This should lead to the reformation of the problem, often progressing into a more general approach. In a modelling task, students often refine the model to accommodate more of the initial constraints, thus improving the effectiveness of the model.

Evidence

Student evidence for problem solving could include:

- description of the problem
- teacher records and agreement of standards and approaches
- annotated action plans
- records of discussions
- descriptions of options
- records of reviews.

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