Specification

Edexcel GCSE in Mathematics A (1387)

First examination 2003

November 2000

Edexcel

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Acknowledgements

This specification has been produced by Edexcel on the basis of consultation with teachers, examiners, consultants and other interested parties. Edexcel recognises and values all those who contributed their time and expertise to the development of GCSE specifications.

Authorised by Sue Parker

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Contents

Introduction

This specification offers a traditional, linear route to GCSE Mathematics, comprising of two terminal examination papers and coursework. Centres have the option of teacher-assessed, Edexcel-moderated coursework or Edexcel-marked coursework. Centres preferring a modular route should refer to Edexcel's GCSE (modular) in Mathematics (specification B 1388).

Key features

- Accessible assessment for all students.
- Choice of options for coursework.
- Advice from subject specialists.
- INSET support days.
- Coursework tasks and assessment guidelines provided by Edexcel.
- Support booklets on all aspects of the examination including coursework tasks and data-handling projects.
- Textbooks and multimedia resources available from Edexcel and Heinemann Summary of the specification content.

Summary of scheme of assessment

<table>
<tr><th></th><th colspan="2">Parallel examination papers AO1 – AO4 (options A and B)</th><th>Internal assessment AO1 and AO4</th></tr>
<tr><td>Weighting</td><td>40%</td><td>40%</td><td>20%</td></tr>
<tr><td>Foundation Tier (G to D)</td><td>Paper 1
Non-calculator
1 hour 30 min</td><td>Paper 2
With calculator
1 hour 30 min</td><td rowspan="3">Option A Paper 7a
Teacher-marked coursework (all tiers)
Option B Paper 7b
Edexcel-marked coursework (all tiers)
Both options A and B require:
a) Project (AO4) 10%
b) at least one task in context of Number and algebra or Shape, space and measure (AO1) 10%</td></tr>
<tr><td>Intermediate Tier (E to B)</td><td>Paper 3
Non-calculator
2 hours</td><td>Paper 4
With calculator
2 hours</td></tr>
<tr><td>Higher Tier (C to A*)</td><td>Paper 5
Non-calculator
2 hours</td><td>Paper 6
With calculator
2 hours</td></tr>
</table>

Examination papers in the Higher and Intermediate Tiers will offer a balanced assessment across the grades available in the tier. In the Foundation Tier, about one third of the marks will be allocated to grade G material and the remaining marks will be balanced across the other grades.

Summary of the specification content

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

Availability of external assessment

First assessment of this specification will be in June 2003.

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 paper**		
	Foundation Tier Papers 1, 2 and 7a or 7b (coursework)	Intermediate Tier Papers 3, 4 and 7a or 7b (coursework)	Higher Tier Papers 5, 6 and 7a or 7b (coursework)
June 2003 and all June sessions thereafter	✓	✓	✓
November 2003 and all November sessions thereafter		✓	✓

Prior learning and progression

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 forms a foundation for further study of the subject at level 3 of the National Framework.

Forbidden combinations and links with other subjects

Every specification is assigned 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.

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

There is some common content between this specification and Foundation and Intermediate Free Standing Mathematics Units.

Specification aims and assessment objectives

National Qualifications Framework criteria

This 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 A.

Aims

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

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 – 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 during coursework and 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.

Coursework tasks will be set which encourage candidates to make full use of ICT.

Methods of data collection will be tested through written papers; data collection, its synthesis and communication, will form part of the coursework activities.

Knowledge, skills and understanding

The knowledge, skills and understanding required for GCSE Mathematics are 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

Students for this qualification must be entered for one of three tiers.

The grades available for each tier are as follows.

Tier	Grades available
Foundation	G to D
Intermediate	E to B
Higher	C to A*

Students achieving a mark below the minimum for the award of the lowest grade in each tier will be ungraded.

Centres are advised to enter students for each tier as follows.

Tier	Estimated grade
Foundation	G, F, E
Intermediate	D, C,
Higher	B, A, A*

Assessment of the specification consists of:

For Foundation Tier students:

Paper	Weighting	Time	Calculator
Paper 1	40%	1hour 30 mins	✗
Paper 2	40%	1hour 30 mins	✓
Coursework			
Paper 7a or 7b (coursework)	20%	Coursework consists of a handling data project and an investigational task	✓

For Intermediate Tier students:

Paper	Weighting	Time	Calculator
Paper 3	40%	2 hours	✗
Paper 4	40%	2 hours	✓
Coursework			
Paper 7a or 7b (coursework)	20%	Coursework consists of a handling data project and an investigational task	✓

For Higher Tier students:

Paper	Weighting	Time	Calculator
Paper 5	40%	2 hours	✗
Paper 6	40%	2 hours	✓
Coursework			
Paper 7a or 7b (coursework)	20%	Coursework consists of a handling data project and an investigational task	✓

Relationship of assessment objectives to external assessment

The weighting for each attainment targets is shown below.

	Assessment objective		Weighting
Two parallel examination papers	AO1	Using and applying mathematics	10%
	AO2	Number and algebra	40%
	AO3	Shape, space and measures	20%
	AO4	Handling data	10%
Coursework	AO1	Using and applying mathematics	10%
	AO4	Handling data	10%

The distribution of the weightings given for the written papers will be broadly balanced across all examination papers.

External assessment

Examination papers 1 – 6

- Examination papers 1 – 6 will be combined question/answer books containing both shorter and longer questions.
- Examination papers 1, 3 and 5 will be timetabled in one session and examination papers 2, 4 and 6 in another.
- Examination papers 1, 3 and 5 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 available at each tier.
- Examination papers in the Higher and Intermediate Tiers will offer a balanced assessment across the grades available in the tier.
- In the Foundation Tier, about one third of the marks will be allocated to grade G material and the remaining marks will be balanced across the other available grades.
- There will be common questions across examination papers to aid standardisation and comparability of awards between tiers.
- Questions on the Intermediate 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.
- Questions on the Higher Tier examination papers will assume knowledge from the Intermediate 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 eg pair of compasses, ruler, protractor.
- Tracing paper may be used.
- Formulae sheets will be provided for the Intermediate and Higher Tiers only (see pages 77–79).

Calculators

- Candidates will be expected to have access to a suitable electronic calculator for examination papers 2, 4 and 6.
- The electronic calculator to be used by candidates attempting examination paper 2 should have, as a minimum, the following functions:

  $+, -, \times, \div, x^2, \sqrt{x}$, memory, brackets, xy, $x^{\frac{1}{y}}$
- The electronic calculator to be used by candidates attempting examination papers 4 and 6 should have, as a minimum, the following functions:

  $+, -, \times, \div, x^2, \sqrt{x}$, 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:
  - databanks; retrieval of text or formulae; QWERTY keyboards; built-in symbolic algebra manipulation; symbolic differentiation or integration.
- Calculators which are not permitted in any paper include calculators such as Texas TI-89, TI-92, Casio *cfx*-9970G, Hewlett Packard HP 48G, Casio C-300. (NB: there are almost certainly others that are not permitted.)

Coursework

The minimum coursework requirement is a data handling project assessing AO4 and one task assessing AO1 in the context of AO2 or AO3.

In order to meet this requirement students will be required to submit two pieces of work:

- a project, using the knowledge, skills and understanding in AO4 (Handling data) **and**
- at least one task, using the knowledge skills and understanding in AO1 (Using and applying mathematics), in the context of AO2 (number and algebra) or AO3 (Shape, space and measures).

Students may submit one data handling project only.

Students may submit more than one task to provide evidence of their attainment in AO1. In this case the best performance in each strand of AO1 will be counted in whichever task it occurs.

During the tasks and project, evidence will be collected of the candidate's ability to:

- respond orally to mathematics
- undertake practical work.

Brief notes of each student's achievements will be made on the coursework record form (see *Appendix 5*) or on the work of the candidate at the relevant place.

Some coursework assessment must be conducted in the classroom under the direct supervision of the teacher. Although students may conduct research in the field, in museums or in public libraries, they must undertake some of the associated or development work under circumstances in which teachers can see them at work and discuss their findings, and hence authenticate each candidate's work with confidence.

For option A coursework is centre-assessed, using the criteria in *Appendices 3* and *4* and is externally moderated by Edexcel.

For option B coursework is assessed by Edexcel using the criteria in *Appendices 3* and *4*.

Tasks

During the course students should be given tasks that allow them the opportunity to use the knowledge, skills and understanding in AO2 and AO3 and to demonstrate the ability to use and apply mathematics as given in AO1. The tasks could be practical and/or investigational and should involve the use of ICT as appropriate.

Edexcel will provide tasks for centres to select and integrate into their own schemes of work. Centres taking option A may choose to use these tasks, generate their own tasks or use a mixture of centre- and Edexcel-set tasks. Centres taking option B must submit task(s) from those set by Edexcel.

The general coursework assessment criteria will be used to assess tasks (see *Appendix 3*).

Use of assessment criteria for using and applying mathematics tasks

The general coursework criteria for AO1 are sub-divided into three strands. These strands are:

Strand 1 – making and monitoring decisions to solve problems

Strand 2 – communicating mathematically

Strand 3 – developing skills of mathematical reasoning.

Mark descriptions, comprising a number of statements, are provided for each strand. Each description within a strand is assigned one of the marks between 1 and 8. A candidate who fails to satisfy the description for a mark of 1 in a strand should be awarded a mark of 0 (zero) for that strand.

Whenever assessments are made, the mark descriptions given in the general coursework criteria for AO1 (together with the elaboration of AO1) should be used to judge the mark within each strand which best fits the candidate's performance. The statements within a description should not be taken as discrete and literal hurdles, all of which must be fulfilled for a mark to be awarded.

The mark descriptions within a strand are designed to be broadly hierarchical. This means that, in general, a description at a particular mark subsumes those at lower marks. Therefore the mark awarded may not be supported by direct evidence of achievement of lower marks in each strand.

It is assumed that tasks that access higher marks will involve a more sophisticated approach and/or a more complex treatment.

The tasks used for each candidate must provide evidence of performance in Using and applying mathematics (AO1) through contexts provided by the other assessment objectives (AO2 or AO3).

Arrival at mark for the task(s) (option A only)

Teacher-assessors are required to award a mark between 1 and 8 for each of the three strands. In the case where a candidate has submitted more than one task these marks should represent a candidate's best performance within a strand across the tasks submitted.

Marks in these three strands should be totalled to give a mark for the task(s) out of 24

For 2003, 12 tasks will be set, including six specimen tasks. Edexcel will set further tasks for 2004. Some of these tasks will be suitable for candidates entered at any tier. Some will be suitable for candidates entered at the Foundation Tier or Intermediate Tier. Some tasks will be suitable for candidates entered at the Intermediate Tier or Higher Tier.

Projects

During the course students should be given the opportunity to develop the knowledge, skills and understanding contained in AO4 (Handling data) through project work.

Edexcel will provide generic starting points, assessment guidance and sample data for these projects. Centres taking option A may choose to use this material, generate their own projects or use a mixture of centre and Edexcel material. Centres taking option B must submit projects based on the starting points and/or sample data set by Edexcel.

The general marking criteria for data handling will be used to assess projects (see *Appendix 4*).

Use of assessment criteria for data handling projects

The assessment criteria for data handling projects for AO4 are sub-divided into three areas. These areas are:

Area 1 – specify the problem and plan

Area 2 – collect, process and represent data

Area 3 – interpret and discuss results.

Mark descriptions comprising a number of statements are provided for each area of the project. Each of the three areas is marked out of 8. Descriptions are given for mark bands (eg 1–2, 3–4 etc) within each area. A candidate who fails to satisfy the description for a mark of 1 in an area should be awarded a mark of 0 (zero) for that area.

Whenever assessments are made, the mark descriptions given in the assessment criteria for data handling projects should be used to judge the mark within each area which best fits the candidate's performance. The statements within a description should not be taken as discrete and literal hurdles, all of which must be fulfilled for a mark to be awarded.

The mark descriptions within an area are designed to be broadly hierarchical. This means that, in general, a description at a particular mark subsumes those at lower marks. Therefore the mark awarded may not be supported by direct evidence of achievement of lower marks in each area.

It is assumed that projects that access higher marks will involve a more sophisticated approach and/or a more complex treatment.

Arrival at a mark for the project (option A only)

Teacher-assessors are required to award marks in each of the three areas of the AO4 criteria. (see *Appendix 4*).

Marks in these three areas should be totalled to give a mark for the project out of 24.

Arrival at a total mark for coursework (option A only)

The marks for the task and project should be added together to give a final **overall total mark** for coursework out of 48. This mark should be recorded on the student's coursework record form.

Adjustment of coursework marks by tier of entry

Students' coursework marks will be adjusted to give credit according to their tier of entry. The procedures for adjusting these marks will be subject to a common agreement between the awarding bodies. Further details will be made available to centres as soon as they have been agreed.

Internal assessment moderation procedures (option A)

To assist centres and to provide all the information required within this document, detailed internal assessment moderation procedures are given in *Appendix 2*. If it proves necessary to amend these procedures in any way in the future, centres will receive separate notification.

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 and GCE A/AS Code of Practice for courses starting in September 2001, which is published by QCA. Qualifications will be graded and certificated on an eight-grade scale from A* to G.

GCSEs have broad equivalence to General National Vocational Qualifications in the following terms:

- two GCSEs at grade D to G and two GCSEs at grade A* to C are equivalent to one three-unit GNVQ at Foundation and Intermediate level respectively
- four GCSEs at grades D to G and four GCSEs at grade A* to C are equivalent to one six-unit GNVQ at Foundation and Intermediate level respectively.

Assessment language

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.

Students with particular requirements

Regulations and guidance relating to students with special requirements are published annually by the Joint Council for General Qualifications and are circulated to examinations officers. Further copies of guidance documentation may be obtained from the following address or by telephoning 0870 240 9800.

Edexcel will assess whether or not special consideration or concession can be made for students with particular requirements. Requests should be addressed to:

Special Requirements
Edexcel Foundation
Stewart House
32 Russell Square
London WC1B 5DN

Specification content

Examination papers 1 – 6

The subject content for examination papers is presented in three tiers: Foundation, Intermediate and Higher.

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

The subject content for the GCSE Intermediate and Higher Tiers is drawn from the Higher Tier of 'The Mathematics National Curriculum for England'.

The content references in this specification match those given in 'The Mathematics National Curriculum for England'

In each tier the content is divided into two columns. The left-hand column is the programme of study as defined in 'The Mathematics National Curriculum for England' and the right hand column gives further guidance in the form of examples. These examples are also taken from 'The Mathematics National Curriculum for England'

New material introduced in the Intermediate Tier not included in the Foundation Tier is shown in **bold**. New material introduced in the Higher Tier not included in the Intermediate Tier is shown in **bold**.

The examples, **in conjunction with the specimen papers**, **are intended as guidance for the interpretation of the subject content**.

Foundation Tier

Candidates 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 do 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.

Ma2 Number and algebra

Content	Examples

Using and applying number and algebra

1 Pupils should be taught to:

Problem solving

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

b) break down a complex calculation into simpler steps before attempting to solve it

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

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

Content	Examples
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	using simple codes that substitute numbers for letters
k) show step-by-step deduction in solving a problem	
Numbers and the number system	
2 Pupils 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, both as positions and translations on a number line	
order integers	
use the concepts and vocabulary of factor (divisor), multiple and common factor	
Powers and roots	
b) use the terms square, positive square root, cube	
use index notation for squares, cubes and powers of 10	
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	$0.137 = \frac{137}{1000}$
order decimals	

Content	Examples
Percentages	
e) understand that 'percentage' means 'number of parts per 100' and use this to compare proportions	10% means 10 parts per 100
interpret percentage as the operator 'so many hundredths of'	15% of Y means $\frac{15}{100} \times Y$
use percentage in real-life situations	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	in maps and scale drawings, paper sizes and gears

Calculations

3 Pupils should be taught to:

Number operations and the relationships between them	
a) add, subtract, multiply and divide integers and then any number	
multiply or divide any number by powers of 10, and any positive number by a number between 0 and 1	
b) use brackets and the hierarchy of operations	
c) calculate a given fraction of a given quantity, expressing the answer as a fraction	for 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	

Content	Examples
d) understand and use unit fractions as multiplicative inverses	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)
multiply and divide a fraction by an integer, and multiply a fraction by a unit fraction	
e) convert simple fractions of a whole to percentages of the whole and vice versa	analysing diets, budgets or the costs of running, maintaining and owning a car
f) divide a quantity in a given ratio	share £15 in the ratio of 1:2
Mental methods	
g) recall all positive integer complements to 100	37 + 63 = 100
recall all multiplication facts to 10 × 10, and use them to derive quickly the corresponding division facts	
recall the cubes of 2, 3, 4, 5 and 10, and the fraction-to-decimal conversion of familiar simple fractions	$\frac{1}{2}, \frac{1}{4}, \frac{1}{5}, \frac{1}{10}, \frac{1}{100}, \frac{1}{3}, \frac{2}{3}, \frac{1}{8}$
h) round to the nearest integer and to one significant figure	
estimate answers to problems involving decimals	
i) develop a range of strategies for mental calculation	
derive unknown facts from those they know	estimate $\sqrt{85}$
add and subtract mentally numbers with up to two decimal places	13.76 – 5.21, 20.08 + 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	14.3 × 4, 56.7 ÷ 7
Written methods	
j) use standard column procedures for addition and subtraction of integers and decimals	

Content	Examples
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	
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	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	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 $z \times {}^{m}/_{y}$
Calculator methods	
o) use calculators effectively: know how to enter complex calculations and use function keys for reciprocals, squares and powers	
p) enter a range of calculations, including those involving measures	time calculations in which fractions of an hour must be entered as fractions or as decimals
q) understand the calculator display, interpreting it correctly, and knowing not to round during the intermediate steps of a calculation	in money calculations, or when the display has been rounded by the calculator

Solving numerical problems

4 Pupils should be taught to:

a) draw on their knowledge of the operations and the relationships between them, and of simple integer powers and their corresponding roots, to solve problems involving ratio and proportion, a range of measures including speed, 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	

Content	Examples
c) 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.	
Equations, formulae and identities	
5 Pupils should be taught to:	
Use of symbols	
a) distinguish the different roles played by letter symbols in algebra, 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	$5x + 1 = 16$ V = IR $3x + 2x = 5x$ for all values of x $y = 2x$
b) understand that the transformation of algebraic expressions obeys and generalises the rules of arithmetic	
manipulate algebraic expressions by collecting like terms, by multiplying a single term over a bracket, and by taking out single common term factors	$x + 5 – 2x – 1 = 4 – x$ $5(2x + 3) = 10x + 15$ $x^2 + 3x = x(x + 3)$
Index notation	
c) use index notation for simple integer powers	
substitute positive and negative numbers into expressions such as $3x^2 + 4$ and $2x^3$	
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

Content	Examples
Formulae	
f) use formulae from mathematics and other subjects expressed initially in words and then using letters and symbols	formulae for the area of a triangle, the area enclosed by a circle, wage earned = hours worked × rate per hour
substitute numbers into a formula	convert temperatures between degrees Fahrenheit and degrees Celsius
derive a formula.	find the perimeter of a rectangle given its area A and the length l of one side

Sequences, functions and graphs

6 Pupils should be taught to:

Sequences	
a) generate terms of a sequence using term-to-term and position-to-term definitions of the sequence	
Graphs to linear functions	
b) use the conventions for coordinates in the plane	
plot points in all four quadrants	
plot graphs of functions in which y is given explicitly in terms of x, or implicitly	$y = 2x + 3$, $x + y = 7$
c) construct linear functions from real-life problems and plot their corresponding graphs	
discuss and interpret graphs arising from real situations	
Interpret graphical information	
e) interpret information presented in a range of linear and non-linear graphs.	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

Ma3 Shape, space and measures

Content	Examples

Using and applying shape, space and measures

1 Pupils should be taught to:

Problem solving

a) select problem-solving strategies and resources, including ICT tools, to use in geometrical work, and monitor their effectiveness

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

Communicating

d) interpret, discuss and synthesise geometrical information presented in a variety of forms

e) communicate mathematically, by presenting and organising results and explaining geometrical diagrams

f) use geometrical language appropriately

Reasoning

i) apply mathematical reasoning, explaining and justifying inferences and deductions

j) show step-by-step deduction in solving a geometrical problem

Geometrical reasoning

2 Pupils 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

Content	Examples
b) distinguish between acute, obtuse, reflex and right angles	
estimate the size of an angle in degrees	
Properties of triangles and other rectilinear shapes	
c) use parallel lines, alternate angles and corresponding angles	
understand the 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 any 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 of special types of quadrilateral, including square, rectangle, parallelogram, trapezium and rhombus	
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	
Properties of circles	
i) recall the definition of a circle and the meaning of related terms, including centre, radius, chord, diameter, circumference, tangent and arc	
understand that inscribed regular polygons can be constructed by equal division of a circle	

Content	Examples
3-D shapes	
j) explore the geometry 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.	

Transformations and coordinates

3 Pupils should be taught to:	
Specifying transformations	
a) understand that rotations are specified by a centre and an (anticlockwise) angle	
rotate a shape about the origin	
measure the angle of rotation using right angles and simple fractions of a turn	
understand that reflections are specified by a mirror line, using a line parallel to an axis	
understand that translations are specified by a distance and direction, 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, recognising that these transformations preserve length and angle, so that any figure is congruent to its image under any of these transformations	
c) recognise, visualise and construct enlargements of objects using positive scale factors greater than one	
understand from this that any two circles and any two squares are mathematically similar, while, in general, two rectangles are not	

Content	Examples
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	
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	find the coordinates of the fourth vertex of a parallelogram with vertices at (2, 1) (−7, 3) and (5, 6)
find the coordinates of the midpoint of the line segment AB, given points A and B.	

Measures and construction

4 Pupils should be taught to:

Measures

a) interpret scales on a range of measuring instruments, including those for time and mass	
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	use bearings to specify direction
c) understand and use speed	

Content	Examples
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	
Mensuration	
f) find areas of rectangles, recalling the formula, understanding the connection to counting squares and how it extends this approach	
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	
g) find volumes of cuboids, recalling the formula and understanding the connection to counting cubes and how it extends this approach	
calculate volumes of shapes made from cubes and cuboids	
h) find circumferences of circles and areas enclosed by circles, recalling relevant formulae	
i) convert between area measures, including square centimetres and square metres, and volume measures, including cubic centimetres and cubic metres.	

Ma4 Handling data

Content	Examples
Using and applying handling data	
1 Pupils should be taught to:	
Problems 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: answer the initial question by drawing conclusions from the data	
b) identify what further information is needed to pursue a particular line of enquiry	
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	

Content	Examples
Reasoning	
h) apply mathematical reasoning, explaining inferences and deductions	
i) explore connections in mathematics and look for cause and effect when analysing data	
Specifying the problem and planning	
2 Pupils should be taught to:	
a) see that random processes are unpredictable	
b) identify questions that can be addressed by statistical methods	
c) discuss how data relate to a problem	
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 secondary data to use.	
Collecting data	
3 Pupils 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.	

Content	Examples

Processing and representing data

4 Pupils 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

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

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)

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

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

Interpreting and discussing results

5 Pupils should be taught to:

a) relate summarised data to the initial questions

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

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

Content	Examples
e) consider and check results, and modify their approach if necessary	
f) have a basic understanding of correlation as a measure of the strength of the association between two variables	
identify correlation or no correlation using lines of best fit	
g) use the vocabulary of probability to interpret results involving uncertainty and prediction	
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	the General Index of Retail Prices
time series	population growth
and survey data.	the National Census.

Intermediate Tier

Candidates 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.

Ma2 Number and algebra

Content	Examples

Using and applying number and algebra

1 Pupils 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 a solution 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

Content	Examples
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**	
Reasoning	
j) explore, identify, and use pattern and symmetry in algebraic contexts, investigating whether a particular case may be generalised further and understand 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	
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.	

Numbers and the number system

2 Pupils 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

Content	Examples
Powers and roots	
b) use the terms square, positive square root, **negative square root**, cube and cube root	
use index notation **and index laws for multiplication and division of integer powers**	**8^2, $8^{2/3}$**
use standard index form, **expressed in conventional notation and on a calculator display**	
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	$0.137 = \frac{137}{1000}$
recognise that recurring decimals are exact fractions, **and that some exact fractions are recurring decimals**	$\frac{1}{7} = \mathbf{0.142857142857}...$
order decimals	
Percentages	
e) understand that 'percentage' means 'number of parts per 100', and interpret percentage as the operator 'so many hundredths of '	10% means 10 parts per 100 and 15% of Y means $\frac{15}{100} \times Y$

Content	Examples
Ratio	
f) use ratio notation, including reduction to its simplest form and its various links to fraction notation.	

Calculations

3 Pupils 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 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	
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	

Content	Examples
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)	
d) understand and use unit fractions as multiplicative inverses	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)
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	**a 15% increase in value *Y*, followed by a 15% decrease is calculated as $1.15 \times 0.85 \times Y$**
calculate an original amount when given the transformed amount after a percentage change	**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	
h) round to a **given number** of significant figures	
develop a range of strategies for mental calculation	
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	**$0.1234 = 1.234 \times 10^{-1}$**

Content	Examples
Written methods	
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	simple interest, VAT, annual rate of inflation
reverse percentages	
k) **represent repeated proportional change using a multiplier raised to a power**	**compound interest**
l) **calculate an unknown quantity from quantities that vary in direct proportion**	
m) **calculate with standard index form**	**$2.4 \times 10^7 \times 5 \times 10^3 = 12 \times 10^{10} = 1.2 \times 10^{11}$, $(2.4 \times 10^7) \div (5 \times 10^3) = 4.8 \times 10^3$**
n) **use surds and π in exact calculations, without a calculator**	
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) 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	
r) **use standard index form display and how to enter numbers in standard index form**	
s) **use calculators for reverse percentage calculations by doing an appropriate division**.	

Content	Examples
Solving numerical problems	
4 Pupils 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**, **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.	
Equations, formulae and identities	
5 Pupils 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 formula, general, unspecified and independent numbers in identities, and in functions they define new expressions or quantities by referring to known quantities	$x^2 + 1 = 82$ V = IR $(x + 1)^2 = x^2 + 2x + 1$ **for all** x $y = 2 - 7x$; $f(x) = x^3$; $y = 1/x$ **with** $x \neq 0$

Content	Examples
b) understand that the transformation of algebraic entities obeys and generalises the well-defined rules of generalised arithmetic	a$(b + c) = ab + ac$
expand the product of two linear expressions	**$(x + 1)(x + 2) = x^2 + 3x + 2$**
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**	$9x – 3 = 3(3x – 1)$ **$x^2 – 9 = (x + 3)(x – 3)$** **$2(x + 1)^2/(x + 1) = 2(x + 1)$**
c) **know the meaning of and use the words 'equation', 'formula', 'identity' and 'expression'**	
Index notation	
d) use index notation for simple integer powers, **and simple instances of index laws**	**$x^3 \times x^2 = x^5$; $x^2/x^3 = x^{-1}$; $(x^2)^3 = x^6$**
substitute positive and negative numbers into expressions such as $3x^2 + 4$ and $2x^3$	
Equations	
e) **set up simple equations**	**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	**$5x = 7$; $11 – 4x = 2$; $3(2x + 1) = 8$; $2(1 – x) = 6(2 + x)$; $4x^2 = 49$; $3 = 12/x$**
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	
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	

Content	Examples
Formulae	
g) use formulae from mathematics and other subjects	for 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	
change the subject of a formula, **including cases where the subject occurs twice**, **or where a power of the subject appears**	find r given that $A = \pi r^2$, find x given $y = mx + c$
generate a formula	**find the perimeter of a rectangle given its area A and the length l of one side**
Simultaneous linear equations	
i) **find the exact solution 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**	
j) **solve simple linear inequalities in one variable**, **and represent the solution set on a number line**	
solve several linear inequalities in two variables and find the solution set	
Quadratic equations	
k) **solve quadratic equations by factorisation**	
Numerical methods	
m) **use systematic trial and improvement to find approximate solutions of equations where there is no simple analytical method of solving them**.	**$x^3 - x = 900$**

Content	Examples
Sequences, functions and graphs	
6 Pupils should be taught to:	
Sequences	
a) **generate common integer sequences (including sequences of odd or even integers, squared integers, powers of 2, powers of 10, triangular numbers)**	
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	
Graphs of linear functions	
b) use 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	$y = 2x + 3$ $x + y = 7$
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	**know that the lines represented by the equations *y* = –5*x* and *y* = 3 – 5*x* are parallel, each having gradient (–5)**

Content	Examples
Interpreting graphical information	
d) construct linear functions and plot the corresponding graphs arising from real-life problems	distance-time graph for a particle moving with constant speed, the velocity-time graph for a particle moving with constant acceleration
discuss and interpret graphs modelling real situations	the depth of water in a container as it empties
Quadratic functions	
e) **generate points and plot graphs of simple quadratic functions, then more general quadratic functions**	$y = x^2$, $y = 3x^2 + 4$ $y = x^2 - 2x + 1$
find approximate solutions of a quadratic equation from the graph of the corresponding quadratic function	
Other functions	
f) **plot graphs of: simple cubic functions, the reciprocal function $y = 1/x$ with $x \neq 0$, using a spreadsheet or graph plotter as well as pencil and paper**	$y = x^3$
recognise the characteristic shapes of all these functions	
Loci	
h) **construct the graphs of simple loci**.	

Ma3 Shape, space and measures

Content	Examples

Using and applying shape, space and measures

1 Pupils 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**

Communicating

review and justify their choice of mathematical presentation

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**

Reasoning

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** ...**'**

and ask questions 'What if ...**?' or 'Why?**'

Content	Examples
h) show step-by-step deduction in solving a geometrical problem	
i) state constraints and give starting points when making deductions.	
Geometrical reasoning	
2 Pupils 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	
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, hexagons	
calculate and use the angles of regular polygons	
f) **understand**, **recall and use Pythagoras' theorem in 2-D problems**	

Content	Examples
investigate the geometry of cuboids including cubes, and shapes made from cuboids	
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**	
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	
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 semi-circle is a right angle**, **that angles in the same segment are equal and that opposite angles of a cyclic quadrilateral sum to 180 degrees**	
3D 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 and cylinders.	

Content	Examples

Transformations and coordinates

3 Pupils 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 giving 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**

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 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

Content	Examples
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	
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, **then calculate the length AB**	
Vectors	
f) **understand and use vector notation**	

Measures and construction

4 Pupils should be taught to:

Measures	
a) use angle measure	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	

Content	Examples
Construction	
b) draw approximate constructions of triangles and other 2-D shapes, using a ruler and protractor, given information about side lengths and angles	
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	
d) find the surface area of simple shapes by using the formulae for the areas of triangles and rectangles	
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 volume measures including cm^3 and m^3	
find circumferences of circles and areas enclosed by circles, recalling relevant formulae	
Loci	
e) **find loci**, **both by reasoning and by using ICT to produce shapes and paths**	**a region bounded by a circle and an intersecting line**

Ma4 Handling data

Content	Examples

Using and applying handling data

1 Pupils 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**

Content	Examples
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**.	
Specifying the problem and planning	
2 Pupils 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**.	

Content	Examples

Collecting data

3 Pupils 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**

Processing and representing data

4 Pupils 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**, **and box plots**

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

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**

Content	Examples
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	
j) **use relevant statistical functions on a calculator or spreadsheet**.	
Interpreting and discussing results	
5 Pupils 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**	
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**	
e) consider and check results, and modify their approaches 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	'there is some evidence from this sample that ...'
h) compare experimental data and theoretical probabilities	

Content	Examples
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.	

Higher Tier

Candidates 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.

Ma2 Number and algebra

Content	Examples

Using and applying number and algebra

1 Pupils 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

Communicating

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

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

i) examine critically, improve, then justify their choice of mathematical presentation

present a concise, **reasoned argument**

Reasoning

j) understand the importance of a counter-example

identify exceptional cases when solving problems

k) understand the difference between a practical demonstration and a proof

l) **derive proofs using short chains of deductive reasoning**

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

Content	Examples
recognise the limitations of any assumptions that are made and the effect that varying the assumptions may have on the solution to a problem.	
Numbers and the number system	
2 Pupils should be taught to:	
Integers	
a) use the concepts and vocabulary of highest common factor, least common multiple, prime number and prime factor decomposition	
Powers and roots	
b) use index laws for multiplication and division of integer powers use standard index form, expressed in conventional notation and on a calculator display	
Decimals	
d) recognise that recurring decimals are exact fractions, and that some exact fractions are recurring decimals	$\frac{1}{7} = 0.142857142857...$
Ratio	
f) use ratio notation, including reduction to its simplest form and its various links to fraction notation.	
Calculations	
3 Pupils should be taught to:	
Number operations and the relationships between them	
a) multiply or divide any 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)	

Content	Examples
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 $\frac{1}{n}$**	
c) 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	**0.142857142857**... = $\frac{1}{7}$
d) multiply and divide a given fraction by a unit fraction and by a general fraction	by thinking of multiplication by $\frac{6}{7}$ as multiplication by 6 followed by division by 7 (or vice versa)
e) understand the multiplicative nature of percentages as operators	a 15% increase in value *Y*, followed by a 15% decrease is calculated as $1.15 \times 0.85 \times Y$]
calculate an original amount when given the transformed amount after a percentage change	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, $n^{1/2} = \sqrt{n}$ and $n^{1/3} = \sqrt[3]{n}$ for any positive number *n***	**$10^0 = 1$**; **$9^{-1} = \frac{1}{9}$** **$5^{-2} = \frac{1}{5^2} = \frac{1}{25}$** **$25^{1/2} = 5$** and **$64^{1/3} = 4$**
h) round to a given number of significant figures	

Content	Examples
convert between ordinary and standard index form representations, converting to standard index form to make sensible estimates for calculations involving multiplication and/or division	$0.1234 = 1.234 \times 10^{-1}$
Written methods	
j) solve percentage problems	simple interest, VAT, annual rate of inflation
reverse percentages	
k) represent repeated proportional change using a multiplier raised to a power	compound interest
l) calculate an unknown quantity from quantities that vary in direct **or inverse** proportion	
m) calculate with standard index form	$2.4 \times 10^7 \times 5 \times 10^3 = 12 \times 10^{10} = 1.2 \times 10^{11}$, $(2.4 \times 10^7) \div (5 \times 10^3) = 4.8 \times 10^3$
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	
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 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**.	**in science or geography**

Content	Examples
Solving numerical problems	
4 Pupils 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.	
Equations, formulae and identities	
5 Pupils 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 formula, general, unspecified and independent numbers in identities, and in functions they define new expressions or quantities by referring to known quantities	$x^2 + 1 = 82$ V = IR $(x + 1)^2 = x^2 + 2x + 1$ for all x $y = 2 – 7x$; $f(x) = x^3$; $y = 1/x$ with $x \neq 0$]
b) understand that the transformation of algebraic entities obeys and generalises the well-defined rules of generalised arithmetic	$a(b + c) = ab + ac$
expand the product of two linear	$(x + 1)(x + 2) = x^2 + 3x + 2$

expressions

Content	Examples
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	$9x - 3 = 3(3x - 1)$ $x^2 - 9 = (x + 3)(x - 3)$ $2(x + 1)^2/(x + 1) = 2(x + 1)$
c) know the meaning of and use the words 'equation', 'formula', 'identity' and 'expression'	
Index notation	
d) use index notation for simple instances of index laws	$x^3 \times x^2 = x^5$; $x^2/x^3 = x^{-1}$; $(x^2)^3 = x^6$
Equations	
e) set up simple equations	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	$5x = 7$; $11 - 4x = 2$; $3(2x + 1) = 8$; $2(1 - x) = 6(2 + x)$; $4x^2 = 49$; $3 = 12/x$
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	
Formulae	
g) use formulae from mathematics and other subjects	for 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	find r given that $A = \pi r^2$,
change the subject of a formula, including cases where the subject occurs twice, or where a power of the subject appears	find x given $y = mx + c$
generate a formula	find the perimeter of a rectangle given its area A and the length l of one side

Content	Examples
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**	$y \propto x$, $y \propto x^2$, $y \propto 1/x$, $y \propto 1/x^2$
Simultaneous linear equations	
i) find the exact solution 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	
j) solve simple linear inequalities in one variable, and represent the solution set on a number line solve several linear inequalities in two variables and find the solution set	
Quadratic equations	
k) solve 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 $x^2 + y^2 = r^2$**	**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.	$x^3 - x = 900$

Content	Examples
Sequences, functions and graphs	
6 Pupils should be taught to:	
Sequences	
a) generate common integer sequences (including sequences of odd or even integers, squared integers, powers of 2, powers of 10, triangular numbers)	
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	
Graphs of linear functions	
b) 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	
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 these lines	know that the lines represented by the equations $y = -5x$ and $y = 3 - 5x$ are parallel, each having gradient (-5) **and 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	distance-time graph for a particle moving with constant speed, the velocity-time graph for a particle moving with constant acceleration
discuss and interpret graphs modelling real situations	the depth of water in a container as it empties

Content	Examples
Quadratic functions	
e) generate points and plot graphs of simple quadratic functions, then more general quadratic functions	$y = x^2$, $y = 3x^2 + 4$ $y = x^2 - 2x + 1$
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 $y = 1/x$ 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	$y = x^3$ $\mathbf{y = 2^x}$; $\mathbf{y = (\frac{1}{2})^x}$
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

Content	Examples
Using and applying shape, space and measures	
1 Pupils 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**	
Reasoning	
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 ...' and ask questions 'What if ...?' or 'Why?'	

Content	Examples
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**.	

Geometrical reasoning

2 Pupils should be taught to:

Properties of triangles and other rectilinear shapes

a) distinguish between lines and line segments	
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**, problems 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)**	

Content	Examples
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 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	
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	
3D Shapes	
i) 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**.	

Content	Examples

Transformations and coordinates

3 Pupils should be taught to:

Specifying transformations

a) use any point as a centre of rotation

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

understand that translations are specified by a vector

Properties of transformations

b) transform triangles and other 2-D shapes by combinations of transformations

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

distinguish properties that are preserved under particular transformations

c) recognise, visualise and construct enlargements of objects using positive fractional and negative scale factors

d) 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) given the co ordinates of the points A and B, calculate the length AB

Vectors

f) understand and use vector notation

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

Content	Examples
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.	

Measures and construction

4 Pupils should be taught to:

Measures

a) 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

understand and use compound measures, including speed and density

Construction

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

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

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

convert between volume measures including cm^3 and m^3

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.

a region bounded by a circle and an intersecting line

Ma4 Handling data

Content	Examples

Using and applying handling data

1 Pupils 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

Content	Examples
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.	
Specifying the problem and planning	
2 Pupils should be taught to:	
c) identify possible sources of bias and plan to minimise it	
d) **select and justify a sampling scheme and a method to investigate a population**, **including random and stratified sampling**	
e) decide what primary and secondary data to use.	
Collecting data	
3 Pupils should be taught to:	
d) deal with practical problems such as non-response or missing data.	
Processing and representing data	
4 Pupils should be taught to:	
a) draw and produce, using paper and ICT, cumulative frequency tables and diagrams, box plots **and histograms for grouped continuous data**	

Content	Examples
b) understand and use estimates or measures of probability from theoretical models, or from relative frequency	
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)**	
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	
j) use relevant statistical functions on a calculator or spreadsheet.	
Interpreting and discussing results	
5 Pupils should be taught to:	
b) identify seasonality and trends in time series	
d) compare distributions and make inferences, using shapes of distributions and measures of average and spread, including median and quartiles	
understand frequency density	
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'.	

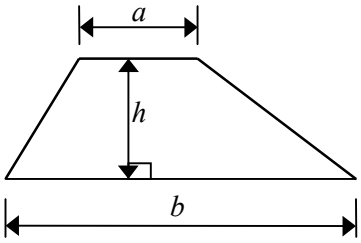
Formulae sheets

Edexcel Foundation

GCSE Mathematics 1387/8

Formulae Sheet Foundation Tier

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

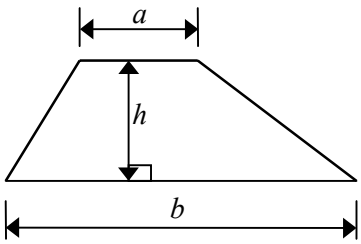


Edexcel Foundation

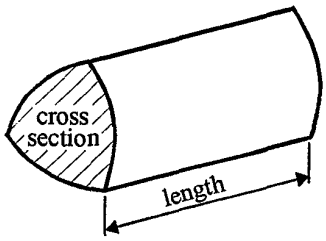
GCSE Mathematics 1387/8

Formulae sheet Intermediate Tier

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



Volume of a prism = area of cross section × length



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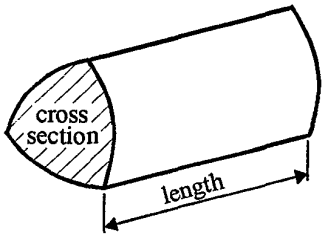
GCSE Mathematics 1387/6

Formulae sheet Higher Tier

Volume of prism = area of cross section × length



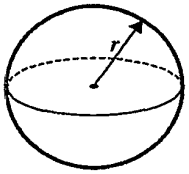
The Quadratic Equation

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

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

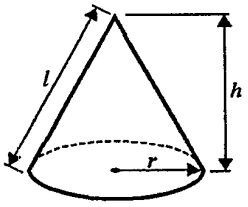
Volume of sphere = $\frac{4}{3}\pi r^3$

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



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

Curved surface area of cone = πrl

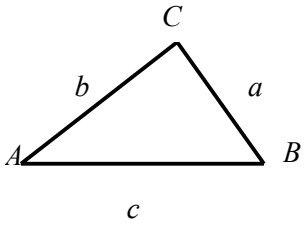


In any triangle ABC

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



Grade descriptions

The following grade descriptions indicate the level of attainment characteristic of the given grade at GCSE. They give a general indication of the required learning outcomes at each specified grade. The descriptions should be interpreted in relation to the content outlined in the specification; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the student has met the assessment objectives overall. Shortcomings in some aspects of the examination may be balanced by better performances 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 and right-angled triangles, and volumes of cuboids.

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 round to one significant figure 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 understand and use the equivalences between fractions, decimals and percentages and calculate using 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 quadratic; 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 use algebraic and graphical methods to solve simultaneous linear equations in two variables.

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 find 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 construct and interpret frequency diagrams. 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. They draw a line of best fit on a scatter diagram by inspection. 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 reasoned argument. Their reports include mathematical justifications, explaining their solutions to problems involving a number of features or variables.

Candidates understand and use rational and irrational numbers. 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. In finding formulae that approximately connect data, candidates express general laws in symbolic form. 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.

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 technology, application of number, improving own learning and performance, working with others and problem solving.

These opportunities are indicated in the key skills mapping grid and are detailed more fully in the key skills signposting (see *Appendix 1*).

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 candidates to discriminate between truth and falsehood. As students 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 GCSE specification for mathematics gives students 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), students 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) students 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 contexts in which they explore and develop their mathematical knowledge, skills and understanding.

Information and communication technology

Students 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 for the GCSE specification. Use of calculators, including graphic and programmable calculators also falls within the ICT category.

Papers 2, 4 and 6 will provide opportunities to assess candidates' ability to use a calculator efficiently.

Textbooks and other teaching resources

Core textbooks

New editions of Heinemann's textbooks for GCSE Mathematics will be available for the start of courses leading to examinations covered by this specification. These revised editions will support the new Edexcel GCSE specification and will provide:

- one book that covers each tier of entry
- coverage of the general topic areas of areas of the specification
- new data handling project unit
- progression from Key Stage 3
- comprehensive banks of practice questions
- detailed, worked examples and examination questions
- key topic summaries
- examination style question papers.

Revision books

- A framework for structured revision
- Key points to remember
- Worked examination questions and examples
- Revision exercises
- Test yourself questions for students to gauge their progress
- Links to chapters in core books.

Practice Books

- Additional exercises for homework and consolidation
- Links to course text exercises
- Concise and cost-effective.

Exambank

Heinemann will also be producing Exambank on CD ROM, which will enable centres to use past examination questions to:

- select past exam questions on chosen mathematical topics
- print immediately or save in Word files
- create tailored tests
- separate tests and answer sheets.

Details can be obtained from:

Heinemann Educational
Halley Court
Jordan Hill
Oxford OX2 8EJ

Tel: 01865 888080
Fax: 01865 314029
E-mail: orders@heinemann.co.uk

Support and training

Training

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

INSET
Edexcel Foundation
Stewart House
32 Russell Square
London WC1B 5DN

Tel: 020 7758 5620
Fax: 020 7758 5950
020 7758 5951 (second fax number)
E-mail: inset@edexcel.org.uk

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.

E-mail

Enquiries about this, or any other Edexcel mathematics qualification, can be made using the subject specific E-mail:

maths@edexcel.org.uk

Edexcel Publications

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

Edexcel Publications
Adamsway
Mansfield
Notts NG18 4FN

Tel: 01623 467467
Fax: 01623 450481
E-mail: publications@linneydirect.com

The following support materials will be available from spring 2001 onwards:

- specimen papers
- coursework guide
- teachers' guide.

Regional Offices and Customer Response Centre

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 Edexcel Customer Response Centre on 0870 240 9800.

Appendices

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 technology
- improving own learning and performance
- working with others
- problem solving.

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

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

The 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 the students' key skills portfolio. In addition, in order to achieve The Key Skills Qualification, students will need to take the additional external tests associated with communication, information 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 identifies the key skills evidence requirements and also provides a mapping of those opportunities. 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. Evidence for their key skills portfolio could be compiled as they complete their coursework tasks for GCSE.

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)	Intermediate 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 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 to both 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 are also required to undertake a substantial activity that includes straightforward tasks. This will involve students 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 or internal assessment**
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 an symbolic approach to a modelling task such as 'Mobile Phones', or 'Open Box Problem', 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 their 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 etc. NB Students must be given tasks to solve where they have to choose the methods of calculation. In completing GCSE 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 or internal assessment
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 etc • students demonstrate an understanding of 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, completing any of the coursework task 'Patterns with Fractions', 'Metro mono', 'The Dice Game', 'Bugs' • 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. Completing tasks such as 'Mobile phones', 'Open Box Problem', 'The Fencing Problem', 'The Carpet', etc beyond mark 4 of the GCSE criteria. • 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, eg completing tasks such as 'Gary's Car Sales'. • 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 the criteria for N2.2. However, it is important that students perform these calculations in the context of real life problems and tasks. Coursework tasks which are practical in nature or involve modelling/simulations are an ideal medium for satisfying the criteria.

Key skill portfolio evidence requirements		Opportunities for development or internal assessment
N2.3	Interpret results of your calculations and present your findings. You must use at least **one** graph, **one** chart and **one** diagram	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, eg when achieving mark 5 in strand 2 and beyond of the coursework criteria, 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, eg 'Open Box Problem', ' Fencing Problem', 'Mobile Phones', 'The Dice Game', 'Gary's Car Sales' etc • 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…' etc. NB A student who takes a task or problem which uses grade C concepts to set up, process and solve a particular problem and then refines her/his approach to arrive at a better solution is meeting the required standard. This redefining the model in an attempt to improve the solution is linked with mark 5 in strand 3 of the coursework assessment criteria and also satisfies N2.3.

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 or internal assessment
C2.1a	Contribute to a discussion about a straightforward subject.	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 a subject often met in their studies, etc 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 5 decimal places, the 'best' shape for a box of six tennis balls, the likely outcome of a probability experiment etc.
C21.b	Give a short talk about a straightforward subject, using an image	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 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 or internal assessment
C2.2	Read and summarise information from **two** extended documents about a straightforward subject. One of the documents should include at least **one** image.	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 for their GCSE. 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. Careful selection and choice of their statistical investigation for GCSE would 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 the students' own language, comparing the length of words and sentences in a newspaper from the 19th and 20th centuries, comparing data on a subject from abroad to the UK, etc.
C2.3	Write **two** different types of documents about straightforward subjects. **One** piece of writing should be an extended document and include at least **one** image.	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, etc. Students should ensure that the text is legible and that spelling, punctuation and grammar are accurate. In completing their two pieces of externally assessed work for GCSE, students should provide a commentary outlining their reasoning and choices made throughout the tasks. The use of diagrams, charts and/or images are expected in the extended piece of work.

Evidence

Student evidence for communication could include:

- tutor 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. However, both of the externally assessed pieces of work should be written in a form that would make some contribution to the assessment of this key skill.

Information technology level 2

When producing work for their GCSE in Mathematics, students will have numerous opportunities to use information 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 E-mailed to tutors for initial comments and feedback.

If students undertaking coursework as part of their GCSE in Mathematics use information technology, they will have opportunities to generate evidence for all three sections identified in Part B of the key skills specification.

In addition, students will be able to use information 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 IT as a modelling tool, particularly when using graphical calculators and spreadsheets. Accounts of their use in this way should be encouraged as part of the students' portfolio.

As part of their Mathematics programme students may not be able to generate sufficient evidence required for this 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 or internal assessment**
IT2.1	Search for and select information for **two** different purposes	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 • DfEE 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 or internal assessment
IT2.2	Explore and develop information, and derive new information for **two** different purposes.	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. For example, use of a spreadsheet to tabulate then graph a curve to achieve a maximum or optimum value, eg 'Open Box Problem', 'Maxi Product', 'The Fencing Problem' etc are all enhanced greatly through the use of a spreadsheet. Modelling exercises such as probability exercises, eg 'The Dice Game', 'Bugs', 'Metro-mono' etc can all use spreadsheets to arrive at the results much more quickly than by using conventional methods.
IT2.3	Present combined information for **two** different purposes. 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 GCSE coursework, OHTs/handouts for a presentation, etc. The document should have accurate spelling (use of spell-checker) and have been proof-read.

Evidence

Student evidence for information technology could include:

- tutor 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 co-operatively towards achieving identified objectives, and exchange information on progress.

The delivery of the majority of the concepts in GCSE 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, with the production of an externally assessed statistics task allowing further opportunities to satisfy WO2.1, 2.2 and 2.3.

Key skill portfolio evidence requirements		**Opportunities for development or internal assessment**
WO2.1	Plan straightforward work with others, identifying objectives and clarifying responsibilities, and confirm working arrangements.	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 the data collection phase of all statistical tasks, 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.

Key skill portfolio evidence requirements		Opportunities for development or internal assessment
WO2.2	Work co-operatively with others towards achieving identified objectives, organising tasks to meet responsibilities.	Students will need to organise tasks so that responsibilities can be met. For example, obtaining resources, completing tasks on time, etc. Tasks should be completed accurately and safely. Co-operative ways of working should be supported through, for example, anticipating the needs of others, avoiding actions that offend, etc. Advice from others, including group members, tutor, etc, should be sought when needed.
WO2.3	Exchange information on progress and agree ways of improving work with others to help achieve objectives.	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 the 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:

- tutor 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 standard required. Students are also required to improve their performance through studying a straightforward subject and through 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 a GCSE in Mathematics for certain topics within the specifications or from enrichment activities.

Activities that generate evidence for this 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 tutors and others**, **on their target setting and performance**.

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

Key skill portfolio evidence requirements		**Opportunities for development or internal assessment**
LP2.1	Help set short-term 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 tutor. This will include setting realistic targets and action points. Review dates with, for example, their tutor should be built into the plan. For example, when starting a sustained piece of work such as a piece of coursework or a longitudinal study over several weeks or months, the student, in conjunction with her/his 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 • develops a plan of action for her/his two pieces of externally assessed work.

Key skill portfolio evidence requirements		Opportunities for development or internal assessment
LP2.2	Take some responsibility for some decisions about your learning, using your plan and support from others to help meet targets. 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: • their externally assessed piece of coursework • their externally assessed piece of statistical analysis • 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, including how you have used learning from one task or activity to meet the demands of a new task.	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 tutor, action for improving their performance.

Evidence

Student evidence for improving own learning and performance could include:

- tutor 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 standard required. They need to show that they can identify problems, plan and try out options, 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 or internal assessment
PS2.1	Identify a problem and come up with **two** options for solving it.	Students will need to identify the problem and describe its main features and how to show 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, their tutor, as appropriate. For example, students should discuss and agree an approach to solving problems presented in class and transfer this acquired approach to their extended pieces of coursework. 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. Students would then transfer this approach to their externally assessed investigation. Alternatively, when solving a statistical investigation 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. Students should then transfer this approach to their extended piece of statistical analysis required for their externally assessed GCSE commitment.
PS2.2	Plan and try out at least **one** option for solving the problem, obtaining support and making changes to your plan when needed.	Students should confirm with their tutor, 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. At this level, for instance, a student should seek to use symbolism to solve, for example, 'The Open Box' problem rather than repeating calculations for specific cases. This process of the student redefining her/his method of solution in order to find a fuller solution is linked with mark 5 in strand 1 of the GCSE coursework criteria.

Key skill portfolio evidence requirements		Opportunities for development or internal assessment
PS2.3	Check if the problem has been solved by applying given methods, describe results and explain your approach to problem solving.	Students should check if the problem has been solved using agreed methods, for example by test, observation, inspection, etc. The results of this should be described with an explanation of 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 an investigation, 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. For example, in 'Hidden Faces' the student arranges the cubes in a horizontal single line and arrives at the expression 3n-2. The coefficients of this expression can then be linked to the structure of the cubes, ie 'the x3 comes from the addition of three more hidden faces for each additional cube on the line', and 'the -2 from the two end faces being visible' etc would lead to the student exploring further cases without the need to calculate and tabulate numerical values. In 'Mobile Phones', the tariffs for two phones could be rewritten algebraically and equated, either through a graphical approach or using simultaneous equations.

Evidence

Student evidence for problem solving could include:

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

Appendix 2 – Procedures for moderation of internal assessment

All centres will receive Optically-read Teacher Examiner Mark Sheets (OPTEMS) for each coursework component.

Centres will have the option of:

EITHER

recording marks on an Optically-read Teacher Examiner Mark Sheet (OPTEMS), Section 1

OR

recording marks on computer for transfer to Edexcel by means of Electronic Data Interchange (EDI), Section 2.

Sections 3 and 4 apply whichever option is selected and deal with Coursework Record Sheets and the sample of work required for moderation.

1 Centres using OPTEMS

1.1 OPTEMS will be pre-printed on three-part stationery with unit and paper number, centre details and candidate names in candidate number order. A number of blank OPTEMS for candidates not listed will also be supplied.

The top copy is designed so that the marks can be read directly by an Optical Mark Reader. It is important therefore to complete the OPTEMS carefully in accordance with the instructions below. **Please do not fold or crease the sheets**.

1.2 Before completing the OPTEMS please check the subject, paper and centre details, to ensure the correct sheet is being completed.

1.3 All candidates entered by the deadline date will be listed on the OPTEMS, except those carrying forward their centre-assessed marks from the previous year. Such candidates will be listed on a separate OPTEMS coded T for Transferred. Any OPTEMS coded T should be checked, signed to confirm the transfer, and the top copy returned to Edexcel. No mark should be entered.

NB: **Any candidate who wishes to transfer a moderated coursework mark must be entered for option T and a form CF99 completed**.

1.4 Late entries will need to be added in pencil either in additional spaces on the pre-printed OPTEMS or on one of the blank OPTEMS which will be supplied. Please note that full details of the centre, specification/unit, paper, candidates' names and candidate numbers must be added to ALL blank OPTEMS.

Candidates who have transferred between the tiers since the OPTEMS were printed should be coded as W on the incorrect OPTEMS and added to the bottom of the correct OPTEMS.

1.5 The OPTEMS should be completed **using an HB pencil**. Please ensure that you work on a firm flat surface and that figures written in the marks box go through to the second and third copies.

1.6 For each candidate, first ensure you have checked the arithmetic on the Coursework Record Sheet, then transfer the **Total Mark** to the box of the OPTEMS labelled 'Marks' for the correct candidate (please see exemplar).

1.7 Encode the component mark on the right-hand side by drawing a line to join the two dots inside the ellipses on the appropriate marks. Clear, dark **HB pencil** lines must be made but they must not extend outside the ellipses on either side of the two dots. Take care to remember the trailing zeros for candidates scoring 10, 20 etc and the leading zero for single figures, as shown.

1.8 If you make a mistake rub out the incorrect marks completely. Amend the number in the marks box and in the encoded section, but **please remember to amend separately the second and third copies** to ensure that the correct mark is clear.

1.9 Every candidate listed on the OPTEMS must have either a mark or one of the following codes in the marks box.

a 0 (zero marks) should be entered only if work submitted has been found to be worthless. It should **not** be used where candidates have failed to submit work.

b ABS in the marks box and an A in the encoded section for any candidate who has been absent or has failed to submit any work, even if an aegrotat award has been requested.

c W should be entered in the marks box and the encoded section where the candidate has been withdrawn.

Exemplar

Encoded section

Candidate name	Number	Marks												
NEW ALAN* SP	3200	0	~~(•0•)~~ ~~(•0•)~~	(•10•) (•1•)	(•20•) (•2•)	(•30•) (•3•)	(•40•) (•4•)	(•50•) (•5•)	(•60•) (•6•)	(•70•) (•7•)	(•80•) (•8•)	(•90•) (•9•)	(•100•) (•A•)	(•200•) (•W•)
OTHER AMY* SP	3201	5	~~(•0•)~~ (•0•)	(•10•) (•1•)	(•20•) (•2•)	(•30•) (•3•)	(•40•) (•4•)	(•50•) ~~(•5•)~~	(•60•) (•6•)	(•70•) (•7•)	(•80•) (•8•)	(•90•) (•9•)	(•100•) (•A•)	(•200•) (•W•)
SMITH JOHN AW	3202	47	(•0•) (•0•)	(•10•) (•1•)	(•20•) (•2•)	(•30•) (•3•)	~~(•40•)~~ (•4•)	(•50•) (•5•)	(•60•) (•6•)	(•70•) ~~(•7•)~~	(•80•) (•8•)	(•90•) (•9•)	(•100•) (•A•)	(•200•) (•W•)
WATTS MARK* SP	3203	ABS	(•0•) (•0•)	(•10•) (•1•)	(•20•) (•2•)	(•30•) (•3•)	(•40•) (•4•)	(•50•) (•5•)	(•60•) (•6•)	(•70•) (•7•)	(•80•) (•8•)	(•90•) (•9•)	(•100•) ~~(•A•)~~	(•200•) (•W•)
JONES ANN* AW	3205	40	(•0•) ~~(•0•)~~	(•10•) (•1•)	(•20•) (•2•)	~~(•30•)~~ (•3•)	(•40•) (•4•)	(•50•) (•5•)	(•60•) (•6•)	(•70•) (•7•)	(•80•) (•8•)	(•90•) (•9•)	(•100•) (•A•)	(•200•) (•W•)
WEST SARA SP	3207	W	(•0•) (•0•)	(•10•) (•1•)	(•20•) (•2•)	(•30•) (•3•)	(•40•) (•4•)	(•50•) (•5•)	(•60•) (•6•)	(•70•) (•7•)	(•80•) (•8•)	(•90•) (•9•)	(•100•) (•A•)	(•200•) ~~(•W•)~~

1.10 Where more than one teacher has assessed the work, the teachers' initials should be given to the right of each candidate's name as illustrated.

1.11 The authentication and internal standardisation statement on the OPTEMS must be signed. **Centres are reminded that it is their responsibility to ensure that internal standardisation of the marking has been carried out**.

Once completed and signed the three-part sets should then be divided and despatched, or retained as follows:

a **top copy** to be returned direct to Edexcel in the envelope provided **to be received by 1 May for the May/June examination series**, **and a date to be announced on the examination timetable for the winter examination series**. Please remember this form **must not be folded or creased**.

b **Second copy** to be sent **with the sampled coursework** as appropriate (see Section 4) to the moderator. The name and address of the moderator will either be printed on the OPTEMS or supplied separately.

c **Third copy** to be retained by the centre

2 Centres using EDI

2.1 Marks must be recorded on computer and transmitted to Edexcel by **1 May for the May/June examination series**, **and a date to be announced on the examination timetable for the winter examination series**. They must be recorded in accordance with the specifications in the booklet 'Formats for the Exchange of Examination Related Data using Microcomputers'. Each mark has a status as well as a value. Status codes are:

V – valid non-zero mark recorded; candidate not pre-selected as part of the sample for moderation

S – valid non-zero mark recorded and candidate included in sample for moderation (refer to OPTEMS and Section 4)

Z – zero mark recorded for work submitted

N – no work submitted but candidate **not** absent

A – absent for component

M – missing mark; no information available about the candidate's previous performance

F– mark carried forward from a previous examination series. (If the mark status is 'F', then no mark follows.)

The OPTEMS provided will indicate, with asterisks, the candidates whose work is to be sampled, where this is pre-selected (see Section 4).

2.2 **Printout**

Centres are required to produce a printout of the centre-assessed marks and annotate it as described below, before forwarding it **together with the sampled coursework** as appropriate (see Section 4) to the moderator, **to be received by 1 May for the May/June examination series**, **and a date to be announced on the examination timetable for the winter examination series**. The name and address of the moderator will either be printed on the OPTEMS or supplied separately.

ABS – absent

W – withdrawn

* – sampled candidate

✔ – additional sampled candidates.

Where more than one teacher has assessed the work the teachers' initials should be given beside each candidate's name.

Centres are reminded that it is their responsibility to ensure that internal standardisation of the marking is carried out. The following **authentication** and internal standardisation statement should be written at the bottom of the printout and signed by the teacher responsible:

'*I declare that the work of each candidate for whom marks are listed is, to the best of my knowledge, the candidate's own and that where several teaching groups are involved the marking has been internally standardised to ensure consistency across groups*.'

Signed . . . . . Date . . . .

Centres are advised to retain a copy of the annotated printout.

3 Coursework Record Sheets

A copy of the Coursework Record Sheet is provided in *Appendix 5* for centres to photocopy. The Coursework Record Sheet, to be completed for each candidate, provides details for the moderator of how each candidate's total mark is reached. It is the teacher's responsibility to ensure that:

- all marks are recorded accurately and that the arithmetic is correct
- the total mark is transferred correctly onto the OPTEMS or via EDI
- any required authentication statement is signed by the candidate and/or teacher as appropriate.

Where a candidate's work is included in the sample the coursework record sheet should be attached to the work.

4 Sample of work for moderation

4.1 **Where the pre-printed OPTEMS is asterisked** indicating the candidates whose work is to be sampled, this work, together with the second copy of the OPTEMS, should be posted to reach the moderator by 1 May for candidates seeking certification in the summer series, and **a date to be announced on the examination timetable** for candidates seeking certification in the winter series. The name and address of the moderator will either be printed on the OPTEMS or supplied separately.

In addition, the centre must send the work of the candidate awarded the **highest** mark and the work of the candidate awarded the **lowest** mark, if these are not already included within the initial samples selected. The centre should indicate the additional samples by means of a tick (✔) in the left-hand column against the names of each of the candidates concerned.

For all sampled work the associated record sheet must be attached to each candidate's work.

If the pre-selected sample does NOT adequately represent ALL parts of the entire mark range for the centre, additional samples in the range(s) not covered should also be sent to the moderator. As above, additional samples should be indicated by means of a tick (✔).

For centres submitting marks by EDI the candidates in the sample selected on the OPTEMS should be marked with an asterisk (*) or a tick (✔), as appropriate, on the EDI printout. The annotated printout must be sent to the moderator with the sample of work.

4.2 **In all cases** please note that the moderator may request further samples of coursework, as required and the work of all candidates should be readily available in the event of such a request.

Internal standardisation

Centres are reminded that it is their responsibility to ensure that where more than one teacher has marked the work, internal standardisation has been carried out. This procedure ensures that the work of all candidates at the centre is marked to the same standards. The statement confirming this on the OPTEMS or the EDI printout must be signed.

Appendix 3 – Assessment criteria for using and applying mathematics (tasks)

Mark	Making and monitoring decisions to solve problems	Communicating mathematically	Developing skills of mathematical reasoning
1	Candidates try different approaches and find ways of overcoming difficulties that arise when they are solving problems. They are beginning to organise their work and check results.	Candidates discuss their mathematical work and are beginning to explain their thinking. They use and interpret mathematical symbols and diagrams.	Candidates show that they understand a general statement by finding particular examples that match it.
2	Candidates are developing their own strategies for solving problems and are using these strategies both in working within mathematics and in applying mathematics to practical contexts.	Candidates present information and results in a clear and organised way, explaining the reasons for their presentation.	Candidates search for a pattern by trying out ideas of their own.
3	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.	Candidates make general statements of their own, based on evidence they have produced, and give an explanation of their reasoning.
4	Candidates carry through substantial tasks and solve quite complex problems by breaking them down into smaller, more manageable tasks.	Candidates interpret, discuss and synthesise information presented in a variety of mathematical forms. Their writing explains and informs their use of diagrams.	Candidates are beginning to give a mathematical justification for their generalisations; they test them by checking particular cases.
5	Starting from problems or contexts that have been presented to them, candidates introduce questions of their own, which generate fuller solutions.	Candidates examine critically and justify their choice of mathematical presentation, considering alternative approaches and explaining improvements they have made.	Candidates justify their generalisations or solutions, showing some insight into the mathematical structure of the situation being investigated. They appreciate the difference

			between mathematical explanation and experimental evidence.

6	Candidates develop and follow alternative approaches. They reflect on their own lines of enquiry when exploring mathematical tasks; in doing so they introduce and use a range of mathematical techniques.	Candidates convey mathematical meaning through consistent use of symbols.	Candidates examine generalisations or solutions reached in an activity, commenting constructively on the reasoning and logic employed, and make further progress in the activity as a result.
7	Candidates analyse alternative approaches to problems involving a number of features or variables. They give detailed reasons for following or rejecting particular lines of enquiry.	Candidates use mathematical language and symbols accurately in presenting a convincing reasoned argument.	Candidates' reports include mathematical justifications, explaining their solutions to problems involving a number of features or variables.
8	Candidates consider and evaluate a number of approaches to a substantial task. They explore extensively a context or area of mathematics which they are unfamiliar. They apply independently a range of appropriate mathematical techniques.	Candidates use mathematical language and symbols efficiently in presenting a concise reasoned argument.	Candidates provide a mathematically rigorous justification or proof of their solution to a complex problem, considering the conditions under which it remains valid.

Elaboration of Ma1 assessment criteria

Mark	Making and monitoring decisions to solve problems	Minimum requirements	Notes
1/1	Candidates try different approaches and find ways of overcoming difficulties that arise when they are solving problems. They are beginning to organise their work and check results.	The candidate can, with help, understand a simple task and produce some information or results.	Simple task eg matchstick row of squares, one or two random examples.
1/2	Candidates are developing their own strategies for solving problems and are using these strategies both in working within mathematics and in applying mathematics to practical contexts.	The candidate interprets a simple task showing **some evidence** of their own planning. and obtains a number of results, but no conclusion.	Planning may simply imply more calculations or results. Those may contain errors.
1/3	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.	The candidate obtains what is required to solve a simple task, finding and checking necessary information.	Checking: There should be no results that are obviously wrong eg 1, 2, 3, 5, 8, 25, 21 for Fibonacci. Checking is implied by correct results.
1/4	Candidates carry through substantial tasks and solve quite complex problems by breaking them down into smaller, more manageable tasks.	The candidate carries through a substantial task without additional direction, by breaking it down into smaller more manageable sub-tasks at least one of which is solved.	Substantial task: A task that needs to be subdivided into smaller tasks by the candidate in order to reach a solution.
1/5	Starting from problems or contexts that have been presented to them, candidates introduce questions of their own, which generate fuller solutions.	The candidate independently extends the task by changing one feature in order to give a fuller solution.	A feature is some aspect of the task such as a variable, constraint or condition
1/6	Candidates develop and follow alternative approaches. They reflect on their own lines of enquiry when exploring mathematical tasks; in doing so they introduce and use a range of mathematical techniques.	The candidate reflects on their line of enquiry and uses an additional relevant technique to extend the task further.	Reflects: Looks at and learns from their previous experience and moves the task on.
1/7	Candidates analyse alternative approaches to problems involving a number of features of variables. They give detailed reasons for following or rejecting particular lines of enquiry.	The candidate works on complex task(s) involving at least 3 features and gives reasons for following or rejecting lines of enquiry.	Complex task: Substantial involving at least 3 features requiring a range of techniques to reach a solution. The work must be at an appropriate level.
1/8	Candidates consider and evaluate a number of approaches to a substantial task. They explore extensively a context or area of mathematics with which they are unfamiliar. They apply independently a range of appropriate mathematical techniques.	The candidate applies, independently, appropriate mathematical techniques extensively to solve a complex problem.	The mathematics should be from the National Curriculum 'further material' or beyond.

In strand 1: a maximum of 3 marks should be awarded in relation to 'simple' tasks; a maximum of 6 marks should be awarded to 'substantial tasks; a maximum of 8 marks should be awarded in relation to 'complex' tasks.

To qualify for a mark of 4, 6 or 8 on any strand the content of the task must meet, or go beyond, the relevant aspects of the grade descriptors for grades F, C and A respectively.

Mark	Communicating mathematically	Minimum requirements	Notes
2/1	Candidates discuss their mathematical work and are beginning to explain their thinking. They use and interpret mathematical symbols and diagrams.	The candidate shows some evidence of their thinking	This may be oral, (supported by teacher annotation), or written and could take the form of random calculations or drawings etc.
2/2	Candidates present information and results in a clear and organised way, explaining the reasons for their presentation.	The candidates present some information or results in a clear or organised way.	This could include listing and/or diagrams.
2/3	Candidates show understanding of situations by describing them mathematically using symbols, words and diagrams.	The candidate shows some understanding of the task by describing a feature of the task mathematically by using words and symbols **or** symbols and diagrams.	Words can be headings, statements or connectives. It could be shown by a list with 'lettered' headings.
2/4	Candidates interpret, discuss and synthesise information presented in a variety of mathematical forms. Candidates' writing explains and informs their use of diagrams.	The candidate brings together more than one form of mathematical presentation with a **linking** commentary.	This is not a series of displays or diagrams included for no purpose. The commentary must allow the reader to understand what the candidate has done.
2/5	Candidates examine critically and justify their choice of mathematical presentation, considering alternative approaches and explaining improvements they have made.	The candidate gives some explanation for their choice of presentation which may be symbolic or diagrammatic.	The introduction of a simple algebraic formula does not justify 6 marks in this strand but, as best fit, could achieve 5 marks. Key words such as 'because', 'therefore', 'hence', 'since', … could be used when justifying improvements.
2/6	Candidates convey mathematical meaning through consistent use of symbols.	The candidate **conveys** mathematical meaning through the sustained **use of symbolism** * at the appropriate level.	Variables need to be defined and symbols must be correctly used in a number of cases. Some minor errors or omissions may occur without penalty.
2/7	Candidates use mathematical language and symbols accurately in presenting a convincing reasoned argument.	The candidate presents a convincing reasoned argument through the use of mathematical language and symbolism which is generally accurate.	There should be increased emphasis on accuracy. Incorrect algebra cannot lead to a convincing argument.
2/8	Candidates use mathematical language and symbols efficiently in presenting a concise reasoned argument.	The candidate produces an elegant argument.	

To qualify for a mark of 4, 6 or 8 on any strand the content of the task must meet, or go beyond, the relevant aspects of the grade descriptors for grades F, C and A respectively.

Symbolism might include for example:

1 Algebra

2 Trigonometry

3 Statistics

4 Probability.

Mark	Developing the skills of mathematical reasoning	Minimum requirements	Notes
3/1	Candidates show that they understand a general statement by finding particular examples that match it.	The candidate produces a simple example that shows an understanding of the task.	
3/2	Candidates search for a pattern by trying out ideas of their own.	The candidate gathers sufficient data from which a simple observation may be made.	In most situations this would involve at least 3 results.
3/3	Candidates make general statements of their own, based on evidence they have produced, and give an explanation of their reasoning.	The candidate makes a general statement based on **their** results.	Their result need not be correct for the task but should be consistent with their data. A general statement might be as simple as 'goes up in 2's' or 'all odd numbers'.
3/4	Candidates are beginning to give a mathematical justification for their generalisation; they test them by checking particular cases.	The candidate tests their generalisation by checking a further case.	A test is a prediction with a confirmation from the mathematical situation of the problem using new data.
3/5	Candidates justify their generalisation or solutions, showing some insight into the mathematical structure of the situation being investigated. They appreciate the difference between mathematical explanation and experimental evidence.	The candidate produces a sensible argument stating **why** the results occur by relating these results to he mathematical situation, eg physical, geometrical or graphic	For example, explaining why coefficients and constants in a generalisation occur, not simply from difference tables.
3/6	Candidates justify their generalisation or solutions reached in an activity, commenting constructively on the reasoning and logic employed, and make further progress in the activity as a result.	The candidate uses reasoning and logic to make further progress in the activity.	
3/7	Candidates' reports include mathematical justifications, explaining their solutions to problems involving a number of features or variables.	The candidate gives a general result or conclusion with justification for parts of the overall solution, co-ordinating at least 3 features.	This mark cannot be awarded without the award of 7 or 8 marks in strand 1.
3/8	Candidates provide a mathematically rigorous justification or proof of their solution to a complex problem, considering the conditions under which it remains valid.		

To qualify for a mark of 4, 6 or 8 on any strand the content of the task must meet, or go beyond, the relevant aspects of the grade descriptors for grades F, C and A respectively.

Appendix 4 – Assessment criteria for data handling projects

Notes

- One major project is expected, not several smaller ones.
- The criteria are to be used as best-fit indicative descriptions and the statements within them are not to be taken as hurdles. This means candidates' work should be assessed in relation to the criteria taken as holistic descriptions of performance. The first consideration is which of the descriptions in each strand best describes the work in a candidate's project. Once that is established, the final step is to decide between the lower and the higher mark available for that description; this decision may well involve looking again at the criteria above and below the selected best fitting criterion. It is not appropriate to take each statement in each description and regard it as a separate assessment criterion. Nor is it necessary to consider whether the majority of the statements within a criterion have been met.
- A mark of 0 should be awarded if a candidate's work fails to satisfy the requirements for 1 mark.
- Descriptions for higher marks subsume those for lower marks.
- Where there are references to 'at least the level detailed in the handling data paragraph of the grade description for grade X', work which uses no technique beyond the specified grade is indicative of the lower of the two marks. To obtain the higher of the two marks requires processing and analysis using techniques that best fit a more demanding standard.
- In these criteria, there is an intended approximate link between 7 marks and grade A, 5 marks and grade C, and 3 marks and grade F.

Specify the problem and plan

Mark	Mark description
1-2	Candidates choose a simple well-defined problem. Their aims have some clarity. The appropriate data to collect are reasonably obvious. An overall plan is discernible and some attention is given to whether the plan will meet the aims. The structure of the report as a whole is loosely related to the aims.
3-4	Candidates choose a problem involving routine use of simple statistical techniques and set out reasonably clear aims. Consideration is given to the collection of data. Candidates describe an overall plan largely designed to meet the aims and structure the project report so that results relating to some of the aims are brought out. Where appropriate, they use a sample of adequate size.
5-6	Candidates consider a more complex problem. They choose appropriate data to collect and state their aims in statistical terms with the selection of an appropriate plan. Their plan is designed to meet the aims and is well described. Candidates consider the practical problems of carrying out the survey or experiment. Where appropriate, they give reasons for choosing a particular sampling method. The project report is well structured so that the project can be seen as a whole.
7-8	Candidates work on a problem requiring creative thinking and careful specification. They state their aims clearly in statistical terms and select and develop an appropriate plan to meet these aims giving reasons for their choice. They foresee and plan for practical problems in carrying out the survey or experiment. Where appropriate, they consider the nature and size of sample to be used and take steps to avoid bias. Where appropriate, they use techniques such as control groups, or pre-tests of questionnaires or data sheets, and refine these to enhance the project. The project report is well structured and the conclusions are related to the initial aims.

Collect, process and represent data

Mark	Mark description
1-2	Candidates collect data with limited relevance to the problem and plan. The data are collected or recorded with little thought given to processing. Candidates use calculations of the simplest kind. The results are frequently correct. Candidates present information and results in a clear and organised way. The data presentation is sometimes related to their overall plan.
3-4	Candidates collect data with some relevance to the problem and plan. The data are collected or recorded with some consideration given to efficient processing. Candidates use straightforward and largely relevant calculations involving techniques of at least the level detailed in the handling data paragraph of the grade description for grade F. The results are generally correct. Candidates show understanding of situations by describing them using statistical concepts, words and diagrams. They synthesise information presented in a variety of forms. Their writing explains and informs their use of diagrams, which are usually related to their overall plan. They present their diagrams correctly, with suitable scales and titles.
5-6	Candidates collect largely relevant and mainly reliable data. The data are collected in a form designed to ensure that they can be used. Candidates use a range of more demanding, largely relevant calculations that include techniques of at least the level detailed in the handling data paragraph of the grade description for grade C. The results are generally correct and no obviously relevant calculation is omitted. There is little redundancy in calculation or presentation. Candidates convey statistical meaning through precise and consistent use of statistical concepts that is sustained throughout the work. They use appropriate diagrams for representing data and give a reason for their choice of presentation, explaining features they have selected.
7-8	Candidates collect reliable data relevant to the problem under consideration. They deal with practical problems such as non-response, missing data or ensuring secondary data are appropriate. Candidates use a range of relevant calculations that include techniques of at least the level detailed in the handling data paragraph of the grade description for grade A. These calculations are correct and no obviously relevant calculation is omitted. Numerical results are rounded appropriately. There is no redundancy in calculation or presentation. Candidates use language and statistical concepts effectively in presenting a convincing reasoned argument. They use an appropriate range of diagrams to summarise the data and show how variables are related.

Interpret and discuss results

Mark	Mark description
1-2	Candidates comment on patterns in the data. They summarise the results they have obtained but make little attempt to relate the results to the initial problem.
3-4	Candidates comment on patterns in the data and any exceptions. They summarise and give a reasonably correct interpretation of their graphs and calculations. They attempt to relate the summarised data to the initial problem, though some conclusions may be incorrect or irrelevant. They make some attempt to evaluate their strategy.
5-6	Candidates comment on patterns in the data and suggest reasons for exceptions. They summarise and correctly interpret their graphs and calculations, relate the summarised data to the initial problem and draw appropriate inferences. Candidates use summary statistics to make relevant comparisons and show an informal appreciation that results may not be statistically significant. Where relevant, they allow for the nature of the sampling method in making inferences about the population. They evaluate the effectiveness of the overall strategy and make a simple assessment of limitations.
7-8	Candidates comment on patterns and give plausible reasons for exceptions. They correctly summarise and interpret graphs and calculations. They make correct and detailed inferences from the data concerning the original problem using the vocabulary of probability. Candidates appreciate the significance of results they obtain. Where relevant, they allow for the nature and size of the sample and any possible bias in making inferences about the population. They evaluate the effectiveness of the overall strategy and recognise limitations of the work done, making suggestions for improvement. They comment constructively on the practical consequences of the work.

Appendix 5 – Task form

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GCSE Mathematics Specifications A and B (1387/8)
Coursework record form

Candidate name: _____ Candidate no: _____

Centre name: _____ Centre no: _____

Task: _____ Project: _____

Date: _____ Date: _____

Tier of Entry_____

Overall Total Mark (out of 48) _____

Task 1		Task 2 (optional)		Project	
Strand	Mark	Strand	Mark	Area	Mark
1		1		1	
2		2		2	
3		3		3	

1 Help given over and above normal classroom practice

Date	Nature of Help

2 Candidate's oral contribution

3 Candidate's practical work

Declaration to be signed by the teacher-examiner responsible for completing the task form

I declare that the task and project of the candidate in respect of the marks on this form have been kept under regular supervision and that, to the best of my knowledge, no assistance has been given apart from any which is acceptable under the scheme of assessment and has been identified and recorded.

Signed: ……. **Date** ……

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