

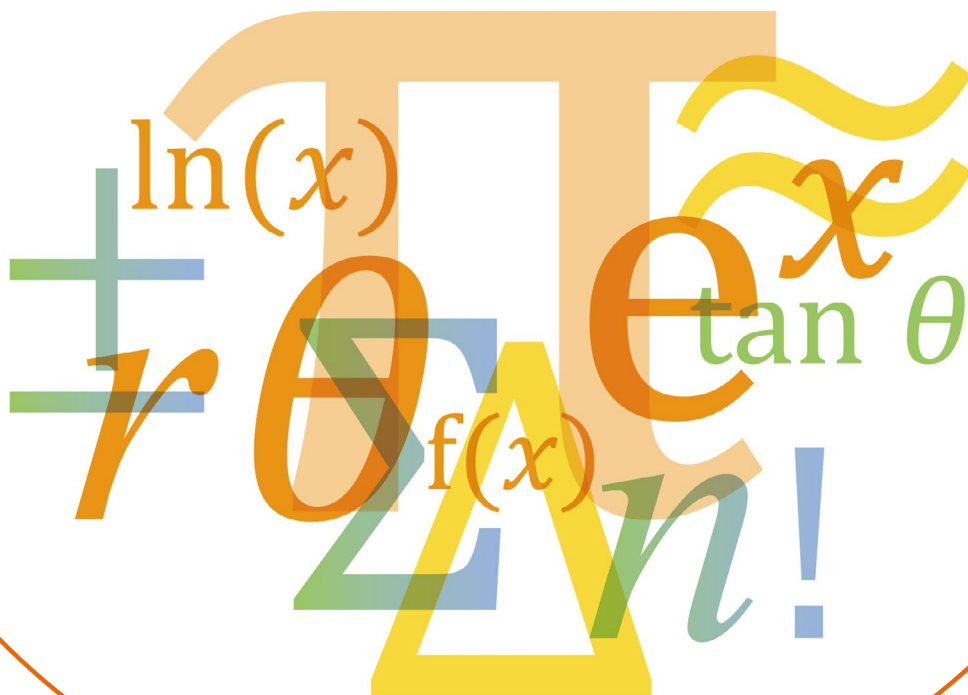


Syllabus

Cambridge O Level

Additional Mathematics 4037

For examination in June and November 2020, 2021 and 2022.



Why choose Cambridge?

Cambridge Assessment International Education prepares school students for life, helping them develop an informed curiosity and a lasting passion for learning. We are part of the University of Cambridge.

Our international qualifications are recognised by the world's best universities and employers, giving students a wide range of options in their education and career. As a not-for-profit organisation, we devote our resources to delivering high-quality educational programmes that can unlock learners' potential.

Our programmes and qualifications set the global standard for international education. They are created by subject experts, rooted in academic rigour and reflect the latest educational research. They provide a strong platform for learners to progress from one stage to the next, and are well supported by teaching and learning resources.

Our mission is to provide educational benefit through provision of international programmes and qualifications for school education and to be the world leader in this field. Together with schools, we develop Cambridge learners who are confident, responsible, reflective, innovative and engaged – equipped for success in the modern world.

Every year, nearly a million Cambridge students from 10 000 schools in 160 countries prepare for their future with an international education from Cambridge International.

'We think the Cambridge curriculum is superb preparation for university.'

Christoph Guttentag, Dean of Undergraduate Admissions, Duke University, USA



Quality management

Our systems for managing the provision of international qualifications and education programmes for students aged 5 to 19 are certified as meeting the internationally recognised standard for quality management, ISO 9001:2008. Learn more at www.cambridgeinternational.org/ISO9001

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Changes to this syllabus

For information about changes to this syllabus for 2020, 2021 and 2022, go to page 19.
The latest syllabus is version 1, published September 2017.



1 Why choose this syllabus?

Key benefits

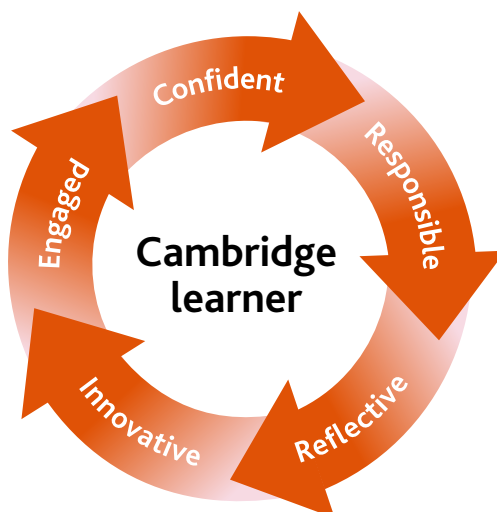
Cambridge O Level syllabuses are created especially for international students. For over 25 years, we have worked with schools and teachers worldwide to develop syllabuses that are suitable for different countries, different types of schools and for learners with a wide range of abilities. These qualifications are designed for students whose first language may or may not be English and this is acknowledged throughout the examination process.

Cambridge O Level Additional Mathematics supports learners in building competency, confidence and fluency in their use of techniques and mathematical understanding. This course helps learners to develop a feel for quantity, patterns and relationships. Learners will develop their reasoning, problem-solving and analytical skills in a variety of contexts.

Cambridge O Level Additional Mathematics provides a strong foundation of mathematical knowledge both for candidates studying mathematics at a higher level and those who will require mathematics to support skills in other subjects. It is designed to stretch the most able candidates and provides a smooth transition to Cambridge AS & A Level Mathematics.

Our programmes balance a thorough knowledge and understanding of a subject and help to develop the skills learners need for their next steps in education or employment.

Our approach encourages learners to be:



'Cambridge O Level has helped me develop thinking and analytical skills which will go a long way in helping me with advanced studies.'

Kamal Khan Virk, former student at Beaconhouse Garden Town Secondary School, Pakistan, who went on to study Actuarial Science at the London School of Economics

Recognition and progression

The combination of knowledge and skills in Cambridge O Level Additional Mathematics gives learners a solid foundation for further study. Candidates who perform well should be able to progress to the advanced study of mathematics. Teachers and learners should discuss anticipated achievement, taking into account learners' individual strengths in the subject. From Cambridge O Level Additional Mathematics, learners can progress straight to Cambridge International AS & A Level Mathematics, or other qualifications at that level.

Cambridge O Levels are accepted and valued by leading universities and employers around the world as evidence of academic achievement. Many universities require a combination of Cambridge International AS & A Levels and Cambridge O Levels or equivalent to meet their entry requirements.

Learn more at www.cambridgeinternational.org/recognition

'Cambridge Additional Mathematics not only prepares students for success in Cambridge International AS & A Level Mathematics (9709) but also helps them understand different areas of Higher Mathematics in further studies, such as Engineering, Mathematics, Statistics, Economics and Business.'

Ishrat Jahan Nabila, Senior Faculty (Mathematics and Additional Mathematics)
Coordinator for Higher Primary and Secondary, Singapore School Kinderland, Dhaka, Bangladesh

Supporting teachers

We provide a wide range of practical resources, detailed guidance and innovative training and professional development so that you can give your learners the best possible preparation for Cambridge O Level.



2 Syllabus overview

Aims

The aims describe the purposes of a course based on this syllabus.

They are not listed in order of priority.

The aims are to:

- consolidate and extend their mathematical skills, and use these in the context of more advanced techniques
- further develop their knowledge of mathematical concepts and principles, and use this knowledge for problem solving
- appreciate the interconnectedness of mathematical knowledge
- acquire a suitable foundation in mathematics for further study in the subject or in mathematics-related subjects
- devise mathematical arguments and use and present them precisely and logically
- integrate information technology (IT) to enhance the mathematical experience
- develop the confidence to apply their mathematical skills and knowledge in appropriate situations
- develop creativity and perseverance in the approach to problem solving
- derive enjoyment and satisfaction from engaging in mathematical pursuits, and gain an appreciation of the elegance and usefulness of mathematics
- provide foundation for AS Level/Higher study.

Content overview

All candidates will study the following topics:

- 1 Functions
- 2 Quadratic functions
- 3 Equations, inequalities and graphs
- 4 Indices and surds
- 5 Factors of polynomials
- 6 Simultaneous equations
- 7 Logarithmic and exponential functions
- 8 Straight line graphs
- 9 Circular measure
- 10 Trigonometry
- 11 Permutations and combinations
- 12 Series
- 13 Vectors in two dimensions
- 14 Differentiation and integration

The content of Cambridge O Level Mathematics is assumed as prerequisite knowledge for this qualification.

Calculators

The syllabus assumes that candidates will be in possession of a scientific calculator for both papers.

Candidates must show all necessary working; no marks will be given to unsupported answers from a calculator.

Non-exact numerical answers will be required to be given correct to three significant figures, or one decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

Mathematical notation

The list of mathematical notation that may be used in examinations for this syllabus is available on our website at www.cambridgeinternational.org/4037



Support for Cambridge O Level Additional Mathematics

Our School Support Hub www.cambridgeinternational.org/support provides Cambridge schools with a secure site for downloading specimen and past question papers, mark schemes, grade thresholds and other curriculum resources specific to this syllabus. The School Support Hub community offers teachers the opportunity to connect with each other and to ask questions related to the syllabus.

Assessment overview

All candidates take **two** papers.

All candidates take:

Paper 1 2 hours
50%

80 marks

Candidates answer all questions

Scientific calculators are required

Assessing grades A*–E

Externally assessed

and:

Paper 2 2 hours
50%

80 marks

Candidates answer all questions

Scientific calculators are required

Assessing grades A*–E

Externally assessed

Assessment objectives

The assessment objectives (AOs) are:

AO1 Demonstrate knowledge and understanding of mathematical techniques

Candidates should be able to:

- recall and use mathematical manipulative techniques
- interpret and use mathematical data, symbols and terminology
- comprehend numerical, algebraic and spatial concepts and relationships.

AO2 Apply mathematical techniques

Candidates should be able to:

- recognise the appropriate mathematical procedure for a given situation
- formulate problems into mathematical terms and select and apply appropriate techniques.

Weighting for assessment objectives

The approximate weightings allocated to each of the assessment objectives (AOs) are summarised below.

Assessment objectives as a percentage of the qualification

Assessment objective	Weighting in O Level %
AO1 Demonstrate knowledge and understanding of mathematical techniques	50
AO2 Apply mathematical techniques	50

Assessment objectives as a percentage of each component

Assessment objective	Weighting in components %	
	Paper 1	Paper 2
AO1 Demonstrate knowledge and understanding of mathematical techniques	50	50
AO2 Apply mathematical techniques	50	50

3 Subject content

Knowledge of the content of Cambridge O Level Mathematics (or an equivalent syllabus) is assumed.

Cambridge O Level material which is not included in the subject content will not be tested directly but it may be required in response to questions on other topics.

Proofs of results will not be required unless specifically mentioned in the syllabus.

Candidates will be expected to be familiar with the scientific notation for the expression of compound units, e.g. 5 ms^{-1} for 5 metres per second.

1 Functions

- understand the terms: function, domain, range (image set), one-one function, inverse function and composition of functions
- use the notation $f(x) = \sin x$, $f: x \mapsto \lg x$, $(x > 0)$, $f^{-1}(x)$ and $f^2(x)$ [= $f(f(x))$]
- understand the relationship between $y = f(x)$ and $y = |f(x)|$, where $f(x)$ may be linear, quadratic or trigonometric
- explain in words why a given function is a function or why it does not have an inverse
- find the inverse of a one-one function and form composite functions
- use sketch graphs to show the relationship between a function and its inverse

2 Quadratic functions

- find the maximum or minimum value of the quadratic function $f: x \mapsto ax^2 + bx + c$ by any method
- use the maximum or minimum value of $f(x)$ to sketch the graph or determine the range for a given domain
- know the conditions for $f(x) = 0$ to have:
 - (i) two real roots, (ii) two equal roots, (iii) no real roots
 and the related conditions for a given line to
 - (i) intersect a given curve, (ii) be a tangent to a given curve, (iii) not intersect a given curve
- solve quadratic equations for real roots and find the solution set for quadratic inequalities

3 Equations, inequalities and graphs

- solve graphically or algebraically equations of the type $|ax + b| = c$ ($c \geq 0$) and $|ax + b| = |cx + d|$
- solve graphically or algebraically inequalities of the type $|ax + b| > c$ ($c \geq 0$), $|ax + b| \leq c$ ($c > 0$) and $|ax + b| \leq (cx + d)$
- use substitution to form and solve a quadratic equation in order to solve a related equation
- sketch the graphs of cubic polynomials and their moduli, when given in factorised form $y = k(x - a)(x - b)(x - c)$
- solve cubic inequalities in the form $k(x - a)(x - b)(x - c) \leq d$ graphically

4 Indices and surds

- perform simple operations with indices and with surds, including rationalising the denominator

5 Factors of polynomials

- know and use the remainder and factor theorems
- find factors of polynomials
- solve cubic equations

6 Simultaneous equations

- solve simple simultaneous equations in two unknowns by elimination or substitution

7 Logarithmic and exponential functions

- know simple properties and graphs of the logarithmic and exponential functions including $\ln x$ and e^x (series expansions are not required) and graphs of $ke^{nx} + a$ and $k\ln(ax + b)$ where n, k, a and b are integers
- know and use the laws of logarithms (including change of base of logarithms)
- solve equations of the form $a^x = b$

8 Straight line graphs

- interpret the equation of a straight line graph in the form $y = mx + c$
- transform given relationships, including $y = ax^n$ and $y = Ab^x$, to straight line form and hence determine unknown constants by calculating the gradient or intercept of the transformed graph
- solve questions involving mid-point and length of a line
- know and use the condition for two lines to be parallel or perpendicular, including finding the equation of perpendicular bisectors

9 Circular measure

- solve problems involving the arc length and sector area of a circle, including knowledge and use of radian measure

10 Trigonometry

- know the six trigonometric functions of angles of any magnitude (sine, cosine, tangent, secant, cosecant, cotangent)
- understand amplitude and periodicity and the relationship between graphs of related trigonometric functions, e.g. $\sin x$ and $\sin 2x$
- draw and use the graphs of

$$y = a \sin bx + c$$

$$y = a \cos bx + c$$

$$y = a \tan bx + c$$
 where a is a positive integer, b is a simple fraction or integer (fractions will have a denominator of 2, 3, 4, 6 or 8 only), and c is an integer
- use the relationships

$$\sin^2 A + \cos^2 A = 1$$

$$\sec^2 A = 1 + \tan^2 A, \operatorname{cosec}^2 A = 1 + \cot^2 A$$

$$\frac{\sin A}{\cos A} = \tan A, \frac{\cos A}{\sin A} = \cot A$$
- solve simple trigonometric equations involving the six trigonometric functions and the above relationships (not including general solution of trigonometric equations)
- prove simple trigonometric identities

11 Permutations and combinations

- recognise and distinguish between a permutation case and a combination case
- know and use the notation $n!$ (with $0! = 1$), and the expressions for permutations and combinations of n items taken r at a time
- answer simple problems on arrangement and selection (cases with repetition of objects, or with objects arranged in a circle, or involving both permutations and combinations, are excluded)

12 Series

- use the Binomial Theorem for expansion of $(a + b)^n$ for positive integer n
- use the general term $\binom{n}{r} a^{n-r} b^r$, $0 \leq r \leq n$ (knowledge of the greatest term and properties of the coefficients is not required)
- recognise arithmetic and geometric progressions
- use the formulae for the n th term and for the sum of the first n terms to solve problems involving arithmetic or geometric progressions
- use the condition for the convergence of a geometric progression, and the formula for the sum to infinity of a convergent geometric progression

13 Vectors in two dimensions

- use vectors in any form, e.g. $\begin{pmatrix} a \\ b \end{pmatrix}$, \overrightarrow{AB} , \mathbf{p} , $a\mathbf{i} - b\mathbf{j}$
- know and use position vectors and unit vectors
- find the magnitude of a vector; add and subtract vectors and multiply vectors by scalars
- compose and resolve velocities

14 Differentiation and integration

- understand the idea of a derived function
- use the notations $f'(x)$, $f''(x)$, $\frac{dy}{dx}$, $\frac{d^2y}{dx^2}$ $\left[= \frac{d}{dx} \left(\frac{dy}{dx} \right) \right]$
- use the derivatives of the standard functions x^n (for any rational n), $\sin x$, $\cos x$, $\tan x$, e^x , $\ln x$, together with constant multiples, sums and composite functions of these
- differentiate products and quotients of functions
- apply differentiation to gradients, tangents and normals, stationary points, connected rates of change, small increments and approximations and practical maxima and minima problems
- use the first and second derivative tests to discriminate between maxima and minima
- understand integration as the reverse process of differentiation
- integrate sums of terms in powers of x including $\frac{1}{x}$ and $\frac{1}{ax+b}$
- integrate functions of the form $(ax+b)^n$ for any rational n , $\sin(ax+b)$, $\cos(ax+b)$, e^{ax+b}
- evaluate definite integrals and apply integration to the evaluation of plane areas
- apply differentiation and integration to kinematics problems that involve displacement, velocity and acceleration of a particle moving in a straight line with variable or constant acceleration, and the use of $x-t$ and $v-t$ graphs

4 Details of the assessment

All candidates will take **two** written papers.

Candidates must show all necessary working; no marks will be given to unsupported answers from a calculator.

Paper 1

2 hours, 80 marks

Candidates answer **all** questions.

This paper consists of questions of various lengths.

Electronic calculators are required.

This is a compulsory component for all candidates.

This written paper is an externally set assessment, marked by Cambridge International.

Paper 2

2 hours, 80 marks

Candidates answer **all** questions.

This paper consists of questions of various lengths.

Electronic calculators are required.

This is a compulsory component for all candidates.

This written paper is an externally set assessment, marked by Cambridge International.

Each paper includes the formulae list.

List of formulae

1. ALGEBRA

Quadratic Equation

For the equation $ax^2 + bx + c = 0$,

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

Binomial Theorem

$$(a + b)^n = a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \dots + \binom{n}{r}a^{n-r}b^r + \dots + b^n$$

where n is a positive integer and $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series

$$u_n = a + (n-1)d$$

$$S_n = \frac{1}{2}n(a + l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series

$$u_n = ar^{n-1}$$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

$$\begin{aligned} \sin^2 A + \cos^2 A &= 1 \\ \sec^2 A &= 1 + \tan^2 A \\ \operatorname{cosec}^2 A &= 1 + \cot^2 A \end{aligned}$$

Formulae for $\triangle ABC$

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

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

$$\Delta = \frac{1}{2} bc \sin A$$

Command words

This glossary should help candidates understand what is expected when responding to questions in the assessment. The number of marks allocated for any part of a question is a guide to the depth required for the answer.

Command word	What it means
Calculate	work out from given facts, figures or information, generally using a calculator
Describe	state the points of a topic/give characteristics and main features
Determine	establish with certainty
Explain	set out purposes or reasons/ make the relationships between things evident/provide why and/or how and support with relevant evidence
Give	produce an answer from a given source or recall/memory
Plot	mark point(s) on a graph
Show (that)	provide structured evidence that leads to a given result
Sketch	make a simple freehand drawing showing the key features
State	express in clear terms
Verify	confirm a given statement/result is true
Work out	calculate from given facts, figures or information with or without the use of a calculator
Write	give an answer in a specific form
Write down	give an answer without significant working

5 What else you need to know

This section is an overview of other information you need to know about this syllabus. It will help to share the administrative information with your exams officer so they know when you will need their support. Find more information about our administrative processes at www.cambridgeinternational.org/examsofficers

Before you start

Previous study

We recommend that learners starting this course should have studied a mathematics curriculum such as O Level/IGCSE® Mathematics and the Cambridge Lower Secondary programme or equivalent national educational framework.

Guided learning hours

We design Cambridge O Level syllabuses based on learners having about 130 guided learning hours for each subject during the course but this is for guidance only. The number of hours a learner needs to achieve the qualification may vary according to local practice and their previous experience of the subject.

Availability and timetables

You can enter candidates in the June and November exam series. You can view the timetable for your administrative zone at www.cambridgeinternational.org/timetables

Cambridge O Levels are available to centres in Administrative Zones 3, 4 and 5. Centres in Administrative Zones 1, 2 or 6 wishing to enter candidates for Cambridge O Level examinations should contact Cambridge International Customer Services.

Private candidates can enter for this syllabus.

Combining with other syllabuses

Candidates can take this syllabus alongside other Cambridge International syllabuses in a single exam series. The only exceptions are:

- Cambridge IGCSE Additional Mathematics (0606)
- syllabuses with the same title at the same level.

Cambridge O Level, Cambridge IGCSE and Cambridge IGCSE (9–1) syllabuses are at the same level.

Making entries

Exams officers are responsible for submitting entries to Cambridge International. We encourage them to work closely with you to make sure they enter the right number of candidates for the right combination of syllabus components. Entry option codes and instructions for submitting entries are in the *Cambridge Guide to Making Entries*. Your exams officer has a copy of this guide.

Exam administration

To keep our exams secure, we produce question papers for different areas of the world, known as 'administrative zones'. We allocate all Cambridge schools to one administrative zone determined by their location. Each zone has a specific timetable. Some of our syllabuses offer candidates different assessment options. An entry option code is used to identify the components the candidate will take relevant to the administrative zone and the available assessment options.

Support for exams officers

We know how important exams officers are to the successful running of exams. We provide them with the support they need to make your entries on time. Your exams officer will find this support, and guidance for all other phases of the Cambridge Exams Cycle, at www.cambridgeinternational.org/examsOfficers

Retakes

Candidates can retake the whole qualification as many times as they want to. This is a linear qualification so candidates cannot re-sit individual components.

Equality and inclusion

We have taken great care to avoid bias of any kind in the preparation of this syllabus and related assessment materials. In compliance with the UK Equality Act (2010) we have designed this qualification to avoid any direct and indirect discrimination.

The standard assessment arrangements may present unnecessary barriers for candidates with disabilities or learning difficulties. We can put arrangements in place for these candidates to enable them to access the assessments and receive recognition of their attainment. We do not agree access arrangements if they give candidates an unfair advantage over others or if they compromise the standards being assessed.

Candidates who cannot access the assessment of any component may be able to receive an award based on the parts of the assessment they have completed.

Information on access arrangements is in the *Cambridge Handbook* at www.cambridgeinternational.org/examsOfficers

Language

This syllabus and the related assessment materials are available in English only.

After the exam

Grading and reporting

Grades A*, A, B, C, D or E indicate the standard a candidate achieved at Cambridge O Level.

A* is the highest and E is the lowest. 'Ungraded' means that the candidate's performance did not meet the standard required for grade E. 'Ungraded' is reported on the statement of results but not on the certificate. In specific circumstances your candidates may see one of the following letters on their statement of results:

- Q (result pending)
- X (no result)
- Y (to be issued)

These letters do not appear on the certificate.

How students and teachers can use the grades

Assessment at Cambridge O Level has two purposes.

- To measure learning and achievement.
The assessment:
 - confirms achievement and performance in relation to the knowledge, understanding and skills specified in the syllabus, to the levels described in the grade descriptions.
- To show likely future success.
The outcomes:
 - help predict which students are well prepared for a particular course or career and/or which students are more likely to be successful
 - help students choose the most suitable course or career.

Grade descriptions

Grade descriptions are provided to give an indication of the standards of achievement candidates awarded particular grades are likely to show. Weakness in one aspect of the examination may be balanced by a better performance in some other aspect.

Grade descriptions for Cambridge O Level Additional Mathematics will be published after the first assessment of the O Level in 2020. Find more information at www.cambridgeinternational.org/olevel

Changes to this syllabus for 2020, 2021 and 2022

The syllabus has been reviewed and revised for first examination in 2020.

Changes to syllabus content

- The following topics have been removed: *Set language and notation* and *Matrices*. The subtopic *Relative velocity* has been removed from topic *Vectors in two dimensions*.
 - A new topic *Series* has been introduced and the previous topic *Binomial Expansions* has been incorporated into this topic.
 - Content has been combined into the topic *Equations, inequalities and graphs*.
 - Subject content topics have been renumbered, i.e.
 - 1 Functions
 - 2 Quadratic functions
 - 3 Equations, inequalities and graphs
 - 4 Indices and surds
 - 5 Factors of polynomials
 - 6 Simultaneous equations
 - 7 Logarithmic and exponential functions
 - 8 Straight line graphs
 - 9 Circular measure
 - 10 Trigonometry
 - 11 Permutations and combinations
 - 12 Series
 - 13 Vectors in 2 dimensions
 - 14 Differentiation and integration
 - Other minor updates have been made to the content of the following topics: *Straight line graphs*, *Simultaneous equations*, *Trigonometry*, *Vectors in two dimensions* and *Differentiation and integration*.
 - A list of command words now appears in the syllabus.
 - The list of notation no longer appears in the syllabus, it is now available from the public website.
 - The list of formulae now appears in the syllabus, in section 4 Details of the assessment.
-

**Changes to assessment
(including changes to
specimen papers)**

- The assessment objectives have been revised, renamed and grouped into two broad objectives.
- The relationship between the assessment objectives and the components as well as the relationship between the assessment objectives as a percentage of the whole qualification has been clarified. Each assessment objective is weighted at approximately 50% of the qualification in each component.
- The following statement now appears on the front cover of the specimen question papers: 'You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.' A similar statement has been inserted into the syllabus, section 2 Syllabus overview and section 4 Details of the assessment.
- All part questions are now numbered using the labelling (a), (b), (c), whether the parts are dependent or independent. Roman numerals will only be used for labelling further divisions within a part e.g. (a)(i).

In addition to reading the syllabus, teachers should refer to the updated specimen assessment materials.

You are strongly advised to read the whole syllabus before planning your teaching programme.

'The Cambridge Additional Mathematics syllabus provides a solid bridge between Cambridge IGCSE Mathematics (0580) and Cambridge International AS & A Level Mathematics (9709). Students learn an array of mathematical skills that enable them to proceed to the next stage with confidence.'

George K Biaru, Head of Department: Mathematics and ICT, Braeside High School, Nairobi, Kenya

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