

SYLLABUS

Cambridge O Level
Additional Mathematics

4037

For examination in June and November 2015

Changes to syllabus for 2015

This syllabus has been updated, but there are no significant changes.

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1. Introduction

1.1 Why choose Cambridge?

Recognition

Cambridge International Examinations is the world's largest provider of international education programmes and qualifications for learners aged 5 to 19. We are part of Cambridge Assessment, a department of the University of Cambridge, trusted for excellence in education. Our qualifications are recognised by the world's universities and employers.

Cambridge O Level is internationally recognised by schools, universities and employers as equivalent in demand to Cambridge IGCSE® (International General Certificate of Secondary Education). Learn more at www.cie.org.uk/recognition

Excellence in education

Our mission is to deliver world-class international education through the provision of high-quality curricula, assessment and services.

More than 9000 schools are part of our Cambridge learning community. We support teachers in over 160 countries who offer their learners an international education based on our curricula and leading to our qualifications. Every year, thousands of learners use Cambridge qualifications to gain places at universities around the world.

Our syllabuses are reviewed and updated regularly so that they reflect the latest thinking of international experts and practitioners and take account of the different national contexts in which they are taught.

Cambridge programmes and qualifications are designed to support learners in becoming:

- **confident** in working with information and ideas – their own and those of others
- **responsible** for themselves, responsive to and respectful of others
- **reflective** as learners, developing their ability to learn
- **innovative** and equipped for new and future challenges
- **engaged** intellectually and socially, ready to make a difference.

Support for teachers

A wide range of materials and resources is available to support teachers and learners in Cambridge schools. Resources suit a variety of teaching methods in different international contexts. Through subject discussion forums and training, teachers can access the expert advice they need for teaching our qualifications. More details can be found in Section 2 of this syllabus and at www.cie.org.uk/teachers

Support for exams officers

Exams officers can trust in reliable, efficient administration of exams entries and excellent personal support from our customer services. Learn more at www.cie.org.uk/examsOfficers

Not-for-profit, part of the University of Cambridge

We are a not-for-profit organisation where the needs of the teachers and learners are at the core of what we do. We continually invest in educational research and respond to feedback from our customers in order to improve our qualifications, products and services.

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

1.2 Why choose Cambridge O Level?

Cambridge O Levels have been designed for an international audience and are sensitive to the needs of different countries. These qualifications are designed for students whose first language may not be English and this is acknowledged throughout the examination process. The Cambridge O Level syllabus also allows teaching to be placed in a localised context, making it relevant in varying regions.

Our aim is to balance knowledge, understanding and skills in our programmes and qualifications to enable candidates to become effective learners and to provide a solid foundation for their continuing educational journey.

Through our professional development courses and our support materials for Cambridge O Levels, we provide the tools to enable teachers to prepare students to the best of their ability and work with us in the pursuit of excellence in education.

Cambridge O Levels are considered to be an excellent preparation for Cambridge International AS and A Levels, the Cambridge AICE (Advanced International Certificate of Education) Group Award, Cambridge Pre-U, and other education programmes, such as the US Advanced Placement program and the International Baccalaureate Diploma programme. Learn more about Cambridge O Levels at www.cie.org.uk/cambridgesecundary2

Guided learning hours

Cambridge O Level syllabuses are designed on the assumption that candidates have about 130 guided learning hours per subject over the duration of the course, but this is for guidance only. The number of hours required to gain the qualification may vary according to local curricular practice and the learners' prior experience of the subject.

1.3 Why choose Cambridge O Level Additional Mathematics?

Cambridge O Levels are established qualifications that keep pace with educational developments and trends. The Cambridge O Level curriculum places emphasis on broad and balanced study across a wide range of subject areas. The curriculum is structured so that students attain both practical skills and theoretical knowledge.

Cambridge O Level Additional Mathematics is recognised by universities and employers throughout the world as proof of mathematical knowledge and understanding. Successful Cambridge O Level Additional Mathematics candidates gain lifelong skills, including:

- the further development of mathematical concepts and principles
- the extension of mathematical skills and their use in more advanced techniques

- an ability to solve problems, present solutions logically and interpret results
- a solid foundation for further study.

Students may also study for a Cambridge O Level in Mathematics and in Statistics. In addition to Cambridge O Levels, Cambridge also offers Cambridge IGCSE and Cambridge International AS and A Levels for further study in Mathematics as well as other maths-related subjects. See www.cie.org.uk for a full list of the qualifications you can take.

Prior learning

We recommend that candidates who are beginning this course should be currently studying or have previously studied Cambridge O Level or Cambridge IGCSE Mathematics.

Progression

Cambridge O Level Certificates are general qualifications that enable candidates to progress either directly to employment, or to proceed to further qualifications.

Candidates who are awarded grades C to A* in Cambridge O Level Additional Mathematics are well prepared to follow courses leading to Cambridge International AS and A Level Mathematics, or the equivalent.

1.4 How can I find out more?

If you are already a Cambridge school

You can make entries for this qualification through your usual channels. If you have any questions, please contact us at info@cie.org.uk

If you are not yet a Cambridge school

Learn about the benefits of becoming a Cambridge school at www.cie.org.uk/startcambridge. Email us at info@cie.org.uk to find out how your organisation can register to become a Cambridge school.

2. Teacher support

2.1 Support materials

Cambridge syllabuses, past question papers and examiner reports to cover the last examination series are on the *Syllabus and Support Materials* DVD, which we send to all Cambridge schools.

You can also go to our public website at www.cie.org.uk/olevel to download current and future syllabuses together with specimen papers or past question papers and examiner reports from one series.

For teachers at registered Cambridge schools a range of additional support materials for specific syllabuses is available online. For Teacher Support go to <http://teachers.cie.org.uk> (username and password required).

2.2 Resource lists

We work with publishers providing a range of resources for our syllabuses including textbooks, websites, CDs etc. Any endorsed, recommended and suggested resources are listed on both our public website and on Teacher Support.

The resource lists can be filtered to show all resources or just those which are endorsed or recommended by Cambridge. Resources endorsed by Cambridge go through a detailed quality assurance process and are written to align closely with the Cambridge syllabus they support.

2.3 Training

We offer a range of support activities for teachers to ensure they have the relevant knowledge and skills to deliver our qualifications. See www.cie.org.uk/events for further information.

3. Assessment at a glance

All candidates will take two written papers.

The syllabus content will be assessed by Paper 1 and Paper 2.

Paper 1	Duration	Marks
10–12 questions of various lengths There will be no choice of question.	2 hours	80
Paper 2	Duration	Marks
10–12 questions of various lengths There will be no choice of question.	2 hours	80

Calculators

The syllabus assumes that candidates will be in possession of a silent electronic calculator with scientific functions for both papers. The General Regulations concerning the use of electronic calculators are contained in the *Cambridge Handbook*.

Mathematical Instruments

Apart from the usual mathematical instruments, candidates may use flexicurves in this examination.

Mathematical Notation

Attention is drawn to the list of mathematical notation at the end of this booklet.

Availability

This syllabus is examined in the May/June examination series and the October/November examination series.

Detailed timetables are available from www.cie.org.uk/examsOfficers

This syllabus is available to private candidates.

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 Customer Services.

Combining this with other syllabuses

Candidates can combine this syllabus in an examination series with any other Cambridge syllabus, except:

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

Please note that Cambridge O Level, Cambridge IGCSE and Cambridge International Level 1/Level 2 Certificate syllabuses are at the same level.

4. Syllabus aims and assessment objectives

4.1 Syllabus aims

The aims of the syllabus listed below are not in order of priority. The aims are to enable candidates to:

- consolidate and extend their elementary 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 beauty, power and usefulness of mathematics.

4.2 Assessment objectives

The examination will test the ability of candidates to:

- recall and use manipulative technique
- interpret and use mathematical data, symbols and terminology
- comprehend numerical, algebraic and spatial concepts and relationships
- recognise the appropriate mathematical procedure for a given situation
- formulate problems into mathematical terms and select and apply appropriate techniques of solution.

5. Syllabus content

Knowledge of the content of Cambridge's Ordinary level Syllabus D (or an equivalent Syllabus) is assumed.

Cambridge O Level material which is not repeated in the syllabus below 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.

Theme or topic	Curriculum objectives																								
	<i>Candidates should be able to:</i>																								
1. Set language and notation	<ul style="list-style-type: none"> use set language and notation, and Venn diagrams to describe sets and represent relationships between sets as follows: $A = \{x: x \text{ is a natural number}\}$ $B = \{(x, y): y = mx + c\}$ $C = \{x: a \leq x \leq b\}$ $D = \{a, b, c, \dots\}$ understand and use the following notation: <table style="width: 100%; border: none;"> <tr> <td>Union of A and B</td> <td style="text-align: right;">$A \cup B$</td> </tr> <tr> <td>Intersection of A and B</td> <td style="text-align: right;">$A \cap B$</td> </tr> <tr> <td>Number of elements in set A</td> <td style="text-align: right;">$n(A)$</td> </tr> <tr> <td>"...is an element of..."</td> <td style="text-align: right;">\in</td> </tr> <tr> <td>"...is not an element of..."</td> <td style="text-align: right;">\notin</td> </tr> <tr> <td>Complement of set A</td> <td style="text-align: right;">A'</td> </tr> <tr> <td>The empty set</td> <td style="text-align: right;">\emptyset</td> </tr> <tr> <td>Universal set</td> <td style="text-align: right;">\mathcal{U}</td> </tr> <tr> <td>A is a subset of B</td> <td style="text-align: right;">$A \subseteq B$</td> </tr> <tr> <td>A is a proper subset of B</td> <td style="text-align: right;">$A \subset B$</td> </tr> <tr> <td>A is not a subset of B</td> <td style="text-align: right;">$A \not\subseteq B$</td> </tr> <tr> <td>A is not a proper subset of</td> <td style="text-align: right;">$A \not\subset B$</td> </tr> </table> 	Union of A and B	$A \cup B$	Intersection of A and B	$A \cap B$	Number of elements in set A	$n(A)$	"...is an element of..."	\in	"...is not an element of..."	\notin	Complement of set A	A'	The empty set	\emptyset	Universal set	\mathcal{U}	A is a subset of B	$A \subseteq B$	A is a proper subset of B	$A \subset B$	A is not a subset of B	$A \not\subseteq B$	A is not a proper subset of	$A \not\subset B$
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Theme or topic	Curriculum objectives
2. Functions	<ul style="list-style-type: none"> • 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
3. Quadratic functions	<ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> (i) two real roots, (ii) two equal roots, (iii) no real roots and the related conditions for a given line to <ul style="list-style-type: none"> (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
4. Indices and surds	<ul style="list-style-type: none"> • perform simple operations with indices and with surds, including rationalising the denominator
5. Factors of polynomials	<ul style="list-style-type: none"> • know and use the remainder and factor theorems • find factors of polynomials • solve cubic equations
6. Simultaneous equations	<ul style="list-style-type: none"> • solve simultaneous equations in two unknowns with at least one linear equation
7. Logarithmic and exponential functions	<ul style="list-style-type: none"> • know simple properties and graphs of the logarithmic and exponential functions including $\ln x$ and e^x (series expansions are not required) • know and use the laws of logarithms (including change of base of logarithms) • solve equations of the form $a^x = b$

Theme or topic	Curriculum objectives
8. Straight line graphs	<ul style="list-style-type: none"> 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
9. Circular measure	<ul style="list-style-type: none"> solve problems involving the arc length and sector area of a circle, including knowledge and use of radian measure
10. Trigonometry	<ul style="list-style-type: none"> 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, 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 and b are positive integers and c is an integer use the relationships $\frac{\sin A}{\cos A} = \tan A, \frac{\cos A}{\sin A} = \cot A, \sin^2 A + \cos^2 A = 1,$ $\sec^2 A = 1 + \tan^2 A, \operatorname{cosec}^2 A = 1 + \cot^2 A$ and 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	<ul style="list-style-type: none"> 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. Binomial expansions	<ul style="list-style-type: none"> use the Binomial Theorem for expansion of $(a + b)^n$ for positive integral n use the general term $\binom{n}{r} a^{n-r} b^r, 0 < r \leq n$ (knowledge of the greatest term and properties of the coefficients is not required)

Theme or topic	Curriculum objectives
13. Vectors in 2 dimensions	<ul style="list-style-type: none"> • use vectors in any form, e.g. $\begin{pmatrix} a \\ b \end{pmatrix}$, \vec{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 • use relative velocity, including solving problems on interception (but not closest approach)
14. Matrices	<ul style="list-style-type: none"> • display information in the form of a matrix of any order and interpret the data in a given matrix • solve problems involving the calculation of the sum and product (where appropriate) of two matrices and interpret the results • calculate the product of a scalar quantity and a matrix • use the algebra of 2×2 matrices (including the zero and identity matrix) • calculate the determinant and inverse of a non-singular 2×2 matrix and solve simultaneous linear equations
15. Differentiation and integration	<ul style="list-style-type: none"> • 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 • discriminate between maxima and minima by any method • understand integration as the reverse process of differentiation • integrate sums of terms in powers of x, excluding $\frac{1}{x}$ • integrate functions of the form $(ax + b)^n$ (excluding $n = -1$), e^{ax+b}, $\sin(ax + b)$, $\cos(ax + b)$ • 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

6. Mathematical notation

The list which follows summarises the notation used in the Cambridge's Mathematics examinations. Although primarily directed towards Advanced/HSC (Principal) level, the list also applies, where relevant, to examinations at Cambridge O Level/S.C.

Mathematical Notation

1. Set Notation

\in	is an element of
\notin	is not an element of
$\{x_1, x_2, \dots\}$	the set with elements x_1, x_2, \dots
$\{x: \dots\}$	the set of all x such that...
$n(A)$	the number of elements in set A
\emptyset	the empty set
\mathcal{E}	universal set
A'	the complement of the set A
\mathbb{N}	the set of natural numbers, $\{1, 2, 3, \dots\}$
\mathbb{Z}	the set of integers $\{0, \pm 1, \pm 2, \pm 3, \dots\}$
\mathbb{Z}^+	the set of positive integers $\{1, 2, 3, \dots\}$
\mathbb{Z}_n	the set of integers modulo n , $\{0, 1, 2, \dots, n-1\}$
\mathbb{Q}	the set of rational numbers
\mathbb{Q}^+	the set of positive rational numbers, $\{x \in \mathbb{Q}: x > 0\}$
\mathbb{Q}_0^+	the set of positive rational numbers and zero, $\{x \in \mathbb{Q}: x \geq 0\}$
\mathbb{R}	the set of real numbers
\mathbb{R}^+	the set of positive real numbers $\{x \in \mathbb{R}: x > 0\}$
\mathbb{R}_0^+	the set of positive real numbers and zero $\{x \in \mathbb{R}: x \geq 0\}$
\mathbb{R}^n	the real n tuples
\mathbb{C}	the set of complex numbers
\subseteq	is a subset of
\subset	is a proper subset of
$\not\subseteq$	is not a subset of
$\not\subset$	is not a proper subset of
\cup	union
\cap	intersection
$[a, b]$	the closed interval $\{x \in \mathbb{R}: a \leq x \leq b\}$
$[a, b)$	the interval $\{x \in \mathbb{R}: a \leq x < b\}$
$(a, b]$	the interval $\{x \in \mathbb{R}: a < x \leq b\}$
(a, b)	the open interval $\{x \in \mathbb{R}: a < x < b\}$
yRx	y is related to x by the relation R
$y \sim x$	y is equivalent to x , in the context of some equivalence relation

2. Miscellaneous Symbols

$=$	is equal to
\neq	is not equal to
\equiv	is identical to or is congruent to
\approx	is approximately equal to
\cong	is isomorphic to
\propto	is proportional to
$<$; \ll	is less than, is much less than
\leq , \nlessgtr	is less than or equal to, is not greater than
$>$; \gg	is greater than, is much greater than
\geq , \nlessgtr	is greater than or equal to, is not less than
∞	infinity

3. Operations

$a + b$	a plus b
$a - b$	a minus b
$a \times b$, ab , $a.b$	a multiplied by b
$a \div b$, $\frac{a}{b}$, a/b	a divided by b
$a : b$	the ratio of a to b
$\sum_{i=1}^n a_i$	$a_1 + a_2 + \dots + a_n$
\sqrt{a}	the positive square root of the real number a
$ a $	the modulus of the real number a
$n!$	n factorial for $n \in \mathbb{N}$ ($0! = 1$)
$\binom{n}{r}$	the binomial coefficient $\frac{n!}{r!(n-r)!}$, for $n, r \in \mathbb{N}$, $0 \leq r \leq n$
	$\frac{n(n-1)\dots(n-r+1)}{r!}$, for $n \in \mathbb{Q}$, $r \in \mathbb{N}$

4. Functions

f	function f
$f(x)$	the value of the function f at x
$f: A \rightarrow B$	f is a function under which each element of set A has an image in set B
$f: x \mapsto y$	the function f maps the element x to the element y
f^{-1}	the inverse of the function f
$g \circ f, gf$	the composite function of f and g which is defined by $(g \circ f)(x)$ or $gf(x) = g(f(x))$
$\lim_{x \rightarrow a} f(x)$	the limit of $f(x)$ as x tends to a
$\Delta x; \delta x$	an increment of x
$\frac{dy}{dx}$	the derivative of y with respect to x
$\frac{d^n y}{dx^n}$	the n th derivative of y with respect to x
$f'(x), f''(x), \dots, f^{(n)}(x)$	the first, second, \dots , n th derivatives of $f(x)$ with respect to x
$\int y dx$	indefinite integral of y with respect to x
$\int_a^b y dx$	the definite integral of y with respect to x for values of x between a and b
$\frac{\partial y}{\partial x}$	the partial derivative of y with respect to x
\dot{x}, \ddot{x}, \dots	the first, second, \dots derivatives of x with respect to time

5. Exponential and Logarithmic Functions

e	base of natural logarithms
$e^x, \exp x$	exponential function of x
$\log_a x$	logarithm to the base a of x
$\ln x$	natural logarithm of x
$\lg x$	logarithm of x to base 10

6. Circular and Hyperbolic Functions and Relations

sin, cos, tan, cosec, sec, cot	}	the circular functions
\sin^{-1} , \cos^{-1} , \tan^{-1} , $\operatorname{cosec}^{-1}$, \sec^{-1} , \cot^{-1}	}	the inverse circular relations
sinh, cosh, tanh, cosech, sech, coth	}	the hyperbolic functions
\sinh^{-1} , \cosh^{-1} , \tanh^{-1} , $\operatorname{cosech}^{-1}$, sech^{-1} , coth^{-1}	}	the inverse hyperbolic relations

7. Complex Numbers

i	square root of -1
z	a complex number, $z = x + iy$ $= r(\cos \theta + i \sin \theta)$, $r \in \mathbb{R}_0^+$ $= re^{i\theta}$, $r \in \mathbb{R}_0^+$
$\operatorname{Re} z$	the real part of z , $\operatorname{Re}(x + iy) = x$
$\operatorname{Im} z$	the imaginary part of z , $\operatorname{Im}(x + iy) = y$
$ z $	the modulus of z , $ x + iy = \sqrt{x^2 + y^2}$, $ r(\cos \theta + i \sin \theta) = r$
$\arg z$	the argument of z , $\arg(r(\cos \theta + i \sin \theta)) = \theta$, $-\pi < \theta \leq \pi$
z^*	the complex conjugate of z , $(x + iy)^* = x - iy$

8. Matrices

\mathbf{M}	a matrix \mathbf{M}
\mathbf{M}^{-1}	the inverse of the square matrix \mathbf{M}
\mathbf{M}^T	the transpose of the matrix \mathbf{M}
$\det \mathbf{M}$	the determinant of the square matrix \mathbf{M}

9. Vectors

\mathbf{a}	the vector \mathbf{a}
\vec{AB}	the vector represented in magnitude and direction by the directed line segment AB
$\hat{\mathbf{a}}$	a unit vector in the direction of the vector \mathbf{a}
$\mathbf{i}, \mathbf{j}, \mathbf{k}$	unit vectors in the directions of the cartesian coordinate axes
$ \mathbf{a} $	the magnitude of \mathbf{a}
$ \vec{AB} $	the magnitude of \vec{AB}
$\mathbf{a} \cdot \mathbf{b}$	the scalar product of \mathbf{a} and \mathbf{b}
$\mathbf{a} \times \mathbf{b}$	the vector product of \mathbf{a} and \mathbf{b}

10. Probability and Statistics

A, B, C etc.	events
$A \cup B$	union of events A and B
$A \cap B$	intersection of the events A and B
$P(A)$	probability of the event A
A'	complement of the event A , the event 'not A '
$P(A B)$	probability of the event A given the event B
X, Y, R , etc.	random variables
x, y, r , etc.	values of the random variables X, Y, R , etc.
x_1, x_2, \dots	observations
f_1, f_2, \dots	frequencies with which the observations x_1, x_2, \dots occur
$p(x)$	the value of the probability function $P(X = x)$ of the discrete random variable X
p_1, p_2, \dots	probabilities of the values x_1, x_2, \dots of the discrete random variable X
$f(x), g(x), \dots$	the value of the probability density function of the continuous random variable X
$F(x), G(x), \dots$	the value of the (cumulative) distribution function $P(X \leq x)$ of the random variable X
$E(X)$	expectation of the random variable X
$E[g(X)]$	expectation of $g(X)$
$\text{Var}(X)$	variance of the random variable X
$G(t)$	the value of the probability generating function for a random variable which takes integer values
$B(n, p)$	binomial distribution, parameters n and p
$\text{Po}(\mu)$	Poisson distribution, mean μ
$N(\mu, \sigma^2)$	normal distribution, mean μ and variance σ^2
μ	population mean
σ^2	population variance
σ	population standard deviation
\bar{x}	sample mean
s^2	unbiased estimate of population variance from a sample, $s^2 = \frac{1}{n-1} \sum (x - \bar{x})^2$
ϕ	probability density function of the standardised normal variable with distribution $N(0, 1)$
Φ	corresponding cumulative distribution function
ρ	linear product-moment correlation coefficient for a population
r	linear product-moment correlation coefficient for a sample
$\text{Cov}(X, Y)$	covariance of X and Y

7. Resource list

The following titles represent some of the texts available in the UK at the time of printing this booklet. Teachers are encouraged to choose texts for class use which they feel will be of interest to their students and will support their own teaching style. ISBN numbers are provided wherever possible.

Author	Title	Date	Publisher	ISBN
Backhouse, J K & Houldsworth S P T	<i>Essential Pure Mathematics: A First Course</i>	1991	Longman	0582066581
Backhouse, J K & Houldsworth S P T	<i>Pure Mathematics: A First Course</i>	1985	Longman	0582353866
Bostock L & Chandler S	<i>Mathematics: Core Maths for Advanced Level</i>	2000	Nelson Thornes	0748755098
Bostock L & Chandler S	<i>Mathematics: Pure Mathematics 1</i>	1978	Nelson Thornes	0859500926
Emanuel, R	<i>Pure Mathematics 1</i>	2001	Longman	0582405505
Harwood Clarke, L	<i>Additional Pure Mathematics</i>	1980	Heinemann	0435511874
Talbert, J F	<i>Additional Maths Pure and Applied</i>	1995	Longman	0582265118

8. Other information

Equality and inclusion

Cambridge International Examinations has taken great care in the preparation of this syllabus and assessment materials to avoid bias of any kind. To comply with the UK Equality Act (2010), Cambridge has designed this qualification with the aim of avoiding direct and indirect discrimination.

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

Candidates who are unable to access the assessment of any component may be eligible to receive an award based on the parts of the assessment they have taken.

Information on access arrangements is found in the *Cambridge Handbook* which can be downloaded from the website **www.cie.org.uk**

Language

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

Grading and reporting

Cambridge O Level results are shown by one of the grades A*, A, B, C, D or E, indicating the standard achieved, A* being the highest and E the lowest. 'Ungraded' indicates that the candidate's performance fell short of the standard required for grade E. 'Ungraded' will be reported on the statement of results but not on the certificate. The letters Q (result pending); X (no results) and Y (to be issued) may also appear on the statement of results but not on the certificate.

Entry codes

To maintain the security of our examinations we produce question papers for different areas of the world, known as 'administrative zones'. Where the component entry code has two digits, the first digit is the component number given in the syllabus. The second digit is the location code, specific to an administrative zone. Information about entry codes, examination timetables and administrative instructions can be found in the *Cambridge Guide to Making Entries*.

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