Syllabus

Cambridge O Level Mathematics (Syllabus D)
Syllabus code 4024
For examination in June and November 2012

Cambridge O Level Mathematics (Syllabus D)
For Centres in Mauritius
Syllabus code 4029
For examination in November 2012

UNIVERSITY of CAMBRIDGE
International Examinations

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1. Introduction

1.1 Why choose Cambridge?

University of Cambridge International Examinations (CIE) is the world's largest provider of international qualifications. Around 1.5 million students from 150 countries enter Cambridge examinations every year. What makes educators around the world choose Cambridge?

Developed for an international audience

International O Levels have been designed specially 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 curriculum also allows teaching to be placed in a localised context, making it relevant in varying regions.

Recognition

Cambridge O Levels are internationally recognised by schools, universities and employers as equivalent to UK GCSE. They are excellent preparation for A/AS Level, the Advanced International Certificate of Education (AICE), US Advanced Placement Programme and the International Baccalaureate (IB) Diploma. CIE is accredited by the UK Government regulator, the Office of the Qualifications and Examinations Regulator (Ofqual). Learn more at **www.cie.org.uk/recognition**.

Support

CIE provides a world-class support service for teachers and exams officers. We offer a wide range of teacher materials to Centres, plus teacher training (online and face-to-face) and student support materials. Exams officers can trust in reliable, efficient administration of exams entry and excellent, personal support from CIE Customer Services. Learn more at **www.cie.org.uk/teachers**.

Excellence in education

Cambridge qualifications develop successful students. They not only build understanding and knowledge required for progression, but also learning and thinking skills that help students become independent learners and equip them for life.

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

CIE is part of Cambridge Assessment, a not-for-profit organisation and part of the University of Cambridge. The needs of teachers and learners are at the core of what we do. CIE invests constantly in improving its qualifications and services. We draw upon education research in developing our qualifications.

1. Introduction

1.2 Why choose Cambridge O Level Mathematics?

International O Levels are established qualifications that keep pace with educational developments and trends. The International 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 Mathematics is recognised by universities and employers throughout the world as proof of mathematical knowledge and understanding. Successful Cambridge O Level Mathematics candidates gain lifelong skills, including:

- the development of their mathematical knowledge;
- confidence by developing a feel for numbers, patterns and relationships;
- an ability to consider and solve problems and present and interpret results;
- communication and reason using mathematical concepts;
- a solid foundation for further study.

Students may also study for a Cambridge O Level in Additional Mathematics and Statistics. In addition to Cambridge O Levels, CIE also offers Cambridge IGCSE and International A & AS 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.

1.3 How can I find out more?

If you are already a Cambridge Centre

You can make entries for this qualification through your usual channels, e.g. your regional representative, the British Council or CIE Direct. If you have any queries, please contact us at **international@cie.org.uk**.

If you are not a Cambridge Centre

You can find out how your organisation can become a Cambridge Centre. Email either your local British Council representative or CIE at **international@cie.org.uk**. Learn more about the benefits of becoming a Cambridge Centre at **www.cie.org.uk**.

2. Assessment at a glance

Cambridge O Level Mathematics (Syllabus D)
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All candidates take two papers.
Each paper may contain questions on any part of the syllabus and questions will not necessarily be restricted to a single topic.

Paper 1	**2 hours**
Paper 1 has approximately 25 short answer questions. Candidates should show all working in the spaces provided on the question paper. Omission of essential working will result in loss of marks. **No calculators are allowed for this paper.** 80 marks weighted at 50% of the total	

Paper 2	**2½ hours**
Paper 2 has structured questions across two sections. **Section A (52 marks):** approximately six questions. Candidates should answer all questions. **Section B (48 marks):** five questions. Candidates should answer four. **Electronic calculators may be used.** Candidates should show all working in the spaces provided on the question paper. Omission of essential working will result in loss of marks. 100 marks weighted at 50% of the total	

Availability

4024 is examined in the May/June examination session and the October/November examination session.

4029 is examined in the October/November examination session.

These syllabuses are available to private candidates.

2. Assessment at a glance

Combining this with other syllabuses

Candidates can combine syllabus **4024** in an examination session with any other CIE syllabus, except:

- syllabuses with the same title at the same level
- 0580 IGCSE Mathematics
- 0581 IGCSE Mathematics (with Coursework)
- 0694 Cambridge International Level 1/Level 2 Certificate Mathematics
- 4021 O Level Mathematics A (Mauritius)
- 4026 O Level Mathematics E (Brunei)
- 4029 O Level Mathematics (Syllabus D) (Mauritius)

Candidates can combine syllabus **4029** in an examination session with any other CIE syllabus, except:

- syllabuses with the same title at the same level
- 0580 IGCSE Mathematics
- 0581 IGCSE Mathematics (with Coursework)
- 0694 Cambridge International Level 1/Level 2 Certificate Mathematics
- 4021 O Level Mathematics A (Mauritius)
- 4024 O Level Mathematics (Syllabus D)

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

Calculating aids:

Paper 1 – the use of all calculating aids is prohibited.

Paper 2 – all candidates should have a **silent** electronic calculator. A scientific calculator with trigonometric functions is strongly recommended.

The General Regulations concerning the use of electronic calculators are contained in the *Handbook for Centres.*

Unless stated otherwise within an individual question, three figure accuracy will be required. This means that four figure accuracy should be shown throughout the working, including cases where answers are used in subsequent parts of the question. Premature approximation will be penalised, where appropriate.

In Paper 2, candidates with suitable calculators are encouraged to use the value of π from their calculators. The value of π will be given as 3.142 to 3 decimal places for use by other candidates. This value will be given on the front page of the question paper only.

2. Assessment at a glance

Units

SI units will be used in questions involving mass and measures: the use of the centimetre will continue.
Both the 12-hour clock and the 24-hour clock may be used for quoting times of the day. In the 24-hour clock, for example, 3.15 a.m. will be denoted by 03 15; 3.15 p.m. by 15 15, noon by 12 00 and midnight by 24 00.
Candidates will be expected to be familiar with the solidus notation for the expression of compound units, e.g. 5 cm/s for 5 centimetres per second, 13.6 g/cm^3 for 13.6 grams per cubic centimetre.

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.

3. Syllabus aims and objectives

The syllabus demands understanding of basic mathematical concepts and their applications, together with an ability to show this by clear expression and careful reasoning.

In the examination, importance will be attached to skills in algebraic manipulation and to numerical accuracy in calculations.

3.1 Aims

The course should enable students to:

- increase intellectual curiosity, develop mathematical language as a means of communication and investigation and explore mathematical ways of reasoning;
- acquire and apply skills and knowledge relating to number, measure and space in mathematical situations that they will meet in life;
- acquire a foundation appropriate to a further study of Mathematics and skills and knowledge pertinent to other disciplines;
- appreciate the pattern, structure and power of Mathematics and derive satisfaction, enjoyment and confidence from the understanding of concepts and the mastery of skills.

3.2 Assessment objectives

The examination tests the ability of candidates to:

1. recognise the appropriate mathematical procedures for a given situation;
2. perform calculations by suitable methods, with and without a calculating aid;
3. use the common systems of units;
4. estimate, approximate and use appropriate degrees of accuracy;
5. interpret, use and present information in written, graphical, diagrammatic and tabular forms;
6. use geometrical instruments;
7. recognise and apply spatial relationships in two and three dimensions;
8. recognise patterns and structures in a variety of situations and form and justify generalisations;
9. understand and use mathematical language and symbols and present mathematical arguments in a logical and clear fashion;
10. apply and interpret Mathematics in a variety of situations, including daily life;
11. formulate problems into mathematical terms, select, apply and communicate appropriate techniques of solution and interpret the solutions in terms of the problems.

4. Syllabus content

Theme or topic	Subject content
1. Number	*Candidates should be able to:* • use natural numbers, integers (positive, negative and zero), prime numbers, common factors and common multiples, rational and irrational numbers, real numbers; • continue given number sequences, recognise patterns within and across different sequences and generalise to simple algebraic statements (including expressions for the nth term) relating to such sequences.
2. Set language and notation	• use set language and set notation, and Venn diagrams, to describe sets and represent relationships between sets as follows: Definition of sets, e.g. $A = \{x : x \text{ is a natural number}\}$ $B = \{(x, y): y = mx + c\}$ $C = \{x : a \leqslant x \leqslant b\}$ $D = \{a, b, c\ldots\}$ Notation: Union of A and B — $A \cup B$ Intersection of A and B — $A \cap B$ Number of elements in set A — $\mathrm{n}(A)$ "…is an element of…" — $\in$ "…is not an element of…" — $\notin$ Complement of set A — A' The empty set — $\varnothing$ Universal set — $\mathscr{E}$ 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 — $A \nsubseteq B$ A is not a proper subset of B — $A \not\subset B$
3. Function notation	• use function notation, e.g. $\mathrm{f}(x) = 3x - 5$, $\mathrm{f}: x \mapsto 3x - 5$ to describe simple functions, and the notation $\mathrm{f}^{-1}(x) = \dfrac{x+5}{3}$ and $\mathrm{f}^{-1}: x \mapsto \dfrac{x+5}{3}$ to describe their inverses.
4. Squares, square roots, cubes and cube roots	• calculate squares, square roots, cubes and cube roots of numbers.

4. Syllabus content

5. Directed numbers	• use directed numbers in practical situations (e.g. temperature change, tide levels).
6. Vulgar and decimal fractions and percentages	• use the language and notation of simple vulgar and decimal fractions and percentages in appropriate contexts; • recognise equivalence and convert between these forms.
7. Ordering	• order quantities by magnitude and demonstrate familiarity with the symbols $=, \neq, >, <, \geqslant, \leqslant$.
8. Standard form	• use the standard form $A \times 10^n$ where n is a positive or negative integer, and $1 \leqslant A < 10$.
9. The four operations	• use the four operations for calculations with whole numbers, decimal fractions and vulgar (and mixed) fractions, including correct ordering of operations and use of brackets.
10. Estimation	• make estimates of numbers, quantities and lengths, give approximations to specified numbers of significant figures and decimal places and round off answers to reasonable accuracy in the context of a given problem.
11. Limits of accuracy	• give appropriate upper and lower bounds for data given to a specified accuracy (e.g. measured lengths); • obtain appropriate upper and lower bounds to solutions of simple problems (e.g. the calculation of the perimeter or the area of a rectangle) given data to a specified accuracy.
12. Ratio, proportion, rate	• demonstrate an understanding of the elementary ideas and notation of ratio, direct and inverse proportion and common measures of rate; • divide a quantity in a given ratio; • use scales in practical situations, calculate average speed; • express direct and inverse variation in algebraic terms and use this form of expression to find unknown quantities.
13. Percentages	• calculate a given percentage of a quantity; • express one quantity as a percentage of another, calculate percentage increase or decrease; • carry out calculations involving reverse percentages, e.g. finding the cost price given the selling price and the percentage profit.

4. Syllabus content

14. Use of an electronic calculator	• use an electronic calculator efficiently; • apply appropriate checks of accuracy.
15. Measures	• use current units of mass, length, area, volume and capacity in practical situations and express quantities in terms of larger or smaller units.
16. Time	• calculate times in terms of the 12-hour and 24-hour clock; • read clocks, dials and timetables.
17. Money	• solve problems involving money and convert from one currency to another.
18. Personal and household finance	• use given data to solve problems on personal and household finance involving earnings, simple interest, discount, profit and loss; • extract data from tables and charts.
19. Graphs in practical situations	• demonstrate familiarity with cartesian coordinates in two dimensions; • interpret and use graphs in practical situations including travel graphs and conversion graphs; • draw graphs from given data; • apply the idea of rate of change to easy kinematics involving distance-time and speed-time graphs, acceleration and retardation; • calculate distance travelled as area under a linear speed-time graph.
20. Graphs of functions	• construct tables of values and draw graphs for functions of the form $y = ax^n$ where $n = -2, -1, 0, 1, 2, 3$, and simple sums of not more than three of these and for functions of the form $y = ka^x$ where a is a positive integer; • interpret graphs of linear, quadratic, reciprocal and exponential functions; • find the gradient of a straight line graph; • solve equations approximately by graphical methods; • estimate gradients of curves by drawing tangents.
21. Straight line graphs	• calculate the gradient of a straight line from the coordinates of two points on it; • interpret and obtain the equation of a straight line graph in the form $y = mx + c$; • calculate the length and the coordinates of the midpoint of a line segment from the coordinates of its end points.

4. Syllabus content

22. Algebraic representation and formulae	• use letters to express generalised numbers and express basic arithmetic processes algebraically, substitute numbers for words and letters in formulae; • transform simple and more complicated formulae; • construct equations from given situations.
23. Algebraic manipulation	• manipulate directed numbers; • use brackets and extract common factors; • expand products of algebraic expressions; • factorise expressions of the form $ax + ay$ $ax + bx + kay + kby$ $a^2x^2 - b^2y^2$ $a^2 + 2ab + b^2$ $ax^2 + bx + c$ • manipulate simple algebraic fractions.
24. Indices	• use and interpret positive, negative, zero and fractional indices.
25. Solutions of equations and inequalities	• solve simple linear equations in one unknown; • solve fractional equations with numerical and linear algebraic denominators; • solve simultaneous linear equations in two unknowns; • solve quadratic equations by factorisation and either by use of the formula or by completing the square; • solve simple linear inequalities.
26. Graphical representation of inequalities	• represent linear inequalities in one or two variables graphically. (Linear Programming problems are not included.)

27. Geometrical terms and relationships	• use and interpret the geometrical terms: point, line, plane, parallel, perpendicular, right angle, acute, obtuse and reflex angles, interior and exterior angles, regular and irregular polygons, pentagons, hexagons, octagons, decagons; • use and interpret vocabulary of triangles, circles, special quadrilaterals; • solve problems and give simple explanations involving similarity and congruence; • use and interpret vocabulary of simple solid figures: cube, cuboid, prism, cylinder, pyramid, cone, sphere; • use the relationships between areas of similar triangles, with corresponding results for similar figures, and extension to volumes of similar solids.
28. Geometrical constructions	• measure lines and angles; • construct simple geometrical figures from given data, angle bisectors and perpendicular bisectors using protractors or set squares as necessary; • read and make scale drawings. (Where it is necessary to construct a triangle given the three sides, ruler and compasses only must be used.)
29. Bearings	• interpret and use three-figure bearings measured clockwise from the north (i.e. 000°–360°).
30. Symmetry	• recognise line and rotational symmetry (including order of rotational symmetry) in two dimensions, and properties of triangles, quadrilaterals and circles directly related to their symmetries; • recognise symmetry properties of the prism (including cylinder) and the pyramid (including cone); • use the following symmetry properties of circles: (a) equal chords are equidistant from the centre; (b) the perpendicular bisector of a chord passes through the centre; (c) tangents from an external point are equal in length.

31. Angle	• calculate unknown angles and give simple explanations using the following geometrical properties: (a) angles on a straight line; (b) angles at a point; (c) vertically opposite angles; (d) angles formed by parallel lines; (e) angle properties of triangles and quadrilaterals; (f) angle properties of polygons including angle sum; (g) angle in a semi-circle; (h) angle between tangent and radius of a circle; (i) angle at the centre of a circle is twice the angle at the circumference; (j) angles in the same segment are equal; (k) angles in opposite segments are supplementary.
32. Locus	• use the following loci and the method of intersecting loci: (a) sets of points in two or three dimensions (i) which are at a given distance from a given point, (ii) which are at a given distance from a given straight line, (iii) which are equidistant from two given points; (b) sets of points in two dimensions which are equidistant from two given intersecting straight lines.
33. Mensuration	• solve problems involving (i) the perimeter and area of a rectangle and triangle, (ii) the circumference and area of a circle, (iii) the area of a parallelogram and a trapezium, (iv) the surface area and volume of a cuboid, cylinder, prism, sphere, pyramid and cone (formulae will be given for the sphere, pyramid and cone), (v) arc length and sector area as fractions of the circumference and area of a circle.

34. Trigonometry	• apply Pythagoras Theorem and the sine, cosine and tangent ratios for acute angles to the calculation of a side or of an angle of a right-angled triangle (angles will be quoted in, and answers required in, degrees and decimals of a degree to one decimal place); • solve trigonometrical problems in two dimensions including those involving angles of elevation and depression and bearings; • extend sine and cosine functions to angles between 90° and 180°; solve problems using the sine and cosine rules for any triangle and the formula $\frac{1}{2}ab \sin C$ for the area of a triangle; • solve simple trigonometrical problems in three dimensions. (Calculations of the angle between two planes or of the angle between a straight line and plane will not be required.)
35. Statistics	• collect, classify and tabulate statistical data; read, interpret and draw simple inferences from tables and statistical diagrams; • construct and use bar charts, pie charts, pictograms, simple frequency distributions and frequency polygons; • use frequency density to construct and read histograms with equal and unequal intervals; • calculate the mean, median and mode for individual data and distinguish between the purposes for which they are used; • construct and use cumulative frequency diagrams; estimate the median, percentiles, quartiles and interquartile range; • calculate the mean for grouped data; identify the modal class from a grouped frequency distribution.
36. Probability	• calculate the probability of a single event as either a fraction or a decimal (not a ratio); • calculate the probability of simple combined events using possibility diagrams and tree diagrams where appropriate. (In possibility diagrams outcomes will be represented by points on a grid and in tree diagrams outcomes will be written at the end of branches and probabilities by the side of the branches.)

37. Matrices	• display information in the form of a matrix of any order; • 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 2×2 matrices; • calculate the determinant and inverse of a non-singular matrix. ($\mathbf{A}^{-1}$ denotes the inverse of **A**.)
38. Transformations	• use the following transformations of the plane: reflection (M), rotation (R), translation (T), enlargement (E), shear (H), stretching (S) and their combinations (If M(a) = b and R(b) = c the notation RM(a) = c will be used; invariants under these transformations may be assumed.); • identify and give precise descriptions of transformations connecting given figures; describe transformations using coordinates and matrices. (Singular matrices are excluded.)
39. Vectors in two dimensions	• describe a translation by using a vector represented by $\begin{pmatrix} x \\ y \end{pmatrix}$, $\overrightarrow{AB}$ or **a**; • add vectors and multiply a vector by a scalar; • calculate the magnitude of a vector $\begin{pmatrix} x \\ y \end{pmatrix}$ as $\sqrt{x^2 + y^2}$. (Vectors will be printed as $\overrightarrow{AB}$ or **a** and their magnitudes denoted by modulus signs, e.g. $\lvert \overrightarrow{AB} \rvert$ or $\lvert \mathbf{a} \rvert$. In all their answers to questions candidates are expected to indicate **a** in some definite way, e.g. by an arrow or by underlining, thus $\overrightarrow{AB}$ or $\underline{a}$); • represent vectors by directed line segments; use the sum and difference of two vectors to express given vectors in terms of two coplanar vectors; use position vectors.

5. Mathematical notation

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

1. Set Notation

$\in$	is an element of
$\notin$	is not an element of
$\{x_1, x_2, \ldots\}$	the set with elements $x_1, x_2, \ldots$
$\{x: \ldots\}$	the set of all x such that…
$\mathrm{n}(A)$	the number of elements in set A
$\varnothing$	the empty set
$\mathscr{E}$	universal set
A'	the complement of the set A
$\mathbb{N}$	the set of positive integers, {1, 2, 3, …}
$\mathbb{Z}$	the set of integers {0, ±1, ±2, ±3, …}
$\mathbb{Z}^+$	the set of positive integers {1, 2, 3, …}
$\mathbb{Z}_n$	the set of integers modulo n, $\{0, 1, 2, \ldots, n-1\}$
$\mathbb{Q}$	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, $\{x \in \mathbb{Q}: x \geqslant 0\}$
$\mathbb{R}$	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 $\{x \in \mathbb{R}: x \geqslant 0\}$
$\mathbb{R}^n$	the real n tuples
$\mathbb{C}$	the set of complex numbers
$\subseteq$	is a subset of
$\subset$	is a proper subset of
$\nsubseteq$	is not a subset of
$\not\subset$	is not a proper subset of
$\cup$	union
$\cap$	intersection
$[a, b]$	the closed interval $\{x \in \mathbb{R}: a \leqslant x \leqslant b\}$
$[a, b)$	the interval $\{x \in \mathbb{R}: a \leqslant x < b\}$
$(a, b]$	the interval $\{x \in \mathbb{R}: a < x \leqslant b\}$
(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
$\leqslant$, $\ngtr$	is less than or equal to, is not greater than
$>$; $\gg$	is greater than, is much greater than
$\geqslant$, $\nless$	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
$\sum_{i=1}^{n} a_i$	$a_1 + a_2 + \ldots + a_n$
$\sqrt{a}$	the positive square root of the real number a
$\lvert a \rvert$	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 $n, r \in \mathbb{N}$, $0 \leqslant r \leqslant n$ $\frac{n(n-1)...(n-r+1)}{r!}$, for $n \in \mathbb{Q}$, $r \in \mathbb{N}$

4. Functions

f	function f
$\mathrm{f}(x)$	the value of the function f at x
$\mathrm{f}: A \to B$	f is a function under which each element of set A has an image in set B
$\mathrm{f}: x \mapsto y$	the function f maps the element x to the element y
f^{-1}	the inverse of the function f
$\mathrm{g} \circ \mathrm{f}$, gf	the composite function of f and g which is defined by $(\mathrm{g} \circ \mathrm{f})(x)$ or $\mathrm{gf}(x) = \mathrm{g}(\mathrm{f}(x))$
$\lim_{x \to a} \mathrm{f}(x)$	the limit of $\mathrm{f}(x)$ as x tends to a
$\Delta x; \delta x$	an increment of x
$\frac{\mathrm{d}y}{\mathrm{d}x}$	the derivative of y with respect to x
$\frac{\mathrm{d}^n y}{\mathrm{d}x^n}$	the nth derivative of y with respect to x
$\mathrm{f}'(x)$, $\mathrm{f}''(x)$, …, $\mathrm{f}^{(n)}(x)$	the first, second, …, nth derivatives of $\mathrm{f}(x)$ with respect to x
$\int y \, \mathrm{d}x$	indefinite integral of y with respect to x
$\int_a^b y \, \mathrm{d}x$	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
$\dot{x}$, $\ddot{x}$, …	the first, second, … 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
$\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, cosec^{-1}, $\sec^{-1}$, $\cot^{-1}$	the inverse circular relations
sinh, cosh, tanh, cosech, sech, coth	the hyperbolic functions
$\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, cosech^{-1}, sech^{-1}, $\coth^{-1}$	the inverse hyperbolic relations

7. Complex Numbers

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

8. Matrices

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

9. Vectors

$\mathbf{a}$	the vector $\mathbf{a}$
$\overrightarrow{AB}$	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
$\lvert \mathbf{a} \rvert$	the magnitude of $\mathbf{a}$
$\lvert \overrightarrow{AB} \rvert$	the magnitude of $\overrightarrow{AB}$
$\mathbf{a} . \mathbf{b}$	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
$\mathrm{P}(A)$	probability of the event A
A'	complement of the event A, the event 'not A'
$\mathrm{P}(A \vert B)$	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.
$x_1, x_2, \ldots$	observations
$f_1, f_2, \ldots$	frequencies with which the observations $x_1, x_2, \ldots$ occur

5. Mathematical notation

$\mathrm{p}(x)$	the value of the probability function $\mathrm{P}(X = x)$ of the discrete random variable X
$p_1, p_2, \ldots$	probabilities of the values $x_1, x_2, \ldots$ of the discrete random variable X
$\mathrm{f}(x), \mathrm{g}(x), \ldots$	the value of the probability density function of the continuous random variable X
$\mathrm{F}(x), \mathrm{G}(x), \ldots$	the value of the (cumulative) distribution function $\mathrm{P}(X \leqslant x)$ of the random variable X
$\mathrm{E}(X)$	expectation of the random variable X
$\mathrm{E}[\mathrm{g}(X)]$	expectation of $\mathrm{g}(X)$
$\mathrm{Var}(X)$	variance of the random variable X
$\mathrm{G}(t)$	the value of the probability generating function for a random variable which takes integer values
$\mathrm{B}(n, p)$	binomial distribution, parameters n and p
$\mathrm{N}(\mu,\sigma^2)$	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 $\mathrm{N}(0, 1)$
Φ	corresponding cumulative distribution function
ρ	linear product-moment correlation coefficient for a population
r	linear product-moment correlation coefficient for a sample
$\mathrm{Cov}(X, Y)$	covariance of X and Y

6. Additional information

6.1 Guided learning hours

O Level syllabuses are designed on the assumption that candidates have about 130 guided learning hours per subject over the duration of the course. ('Guided learning hours' include direct teaching and any other supervised or directed study time. They do not include private study by the candidate.)

However, this figure is for guidance only, and the number of hours required may vary according to local curricular practice and the candidates' prior experience of the subject.

6.2 Recommended prior learning

We recommend that candidates who are beginning this course should have previously studied an appropriate lower secondary Mathematics programme.

6.3 Progression

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 O Level Mathematics are well prepared to follow courses leading to AS and A Level Mathematics, or the equivalent.

6.4 Component codes

Because of local variations, in some cases component codes will be different in instructions about making entries for examinations and timetables from those printed in this syllabus, but the component names will be unchanged to make identification straightforward.

6.5 Grading and reporting

Ordinary Level (O Level) results are shown by one of the grades A*, A, B, C, D or E indicating the standard achieved, Grade A* being the highest and Grade 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.

6. Additional information

Percentage uniform marks are also provided on each candidate's Statement of Results to supplement their grade for a syllabus. They are determined in this way:

- A candidate who obtains…

  … the minimum mark necessary for a Grade A* obtains a percentage uniform mark of 90%.

  … the minimum mark necessary for a Grade A obtains a percentage uniform mark of 80%.

  … the minimum mark necessary for a Grade B obtains a percentage uniform mark of 70%.

  … the minimum mark necessary for a Grade C obtains a percentage uniform mark of 60%.

  … the minimum mark necessary for a Grade D obtains a percentage uniform mark of 50%.

  … the minimum mark necessary for a Grade E obtains a percentage uniform mark of 40%.

  … no marks receives a percentage uniform mark of 0%.

Candidates whose mark is none of the above receive a percentage mark in between those stated according to the position of their mark in relation to the grade 'thresholds' (i.e. the minimum mark for obtaining a grade). For example, a candidate whose mark is halfway between the minimum for a Grade C and the minimum for a Grade D (and whose grade is therefore D) receives a percentage uniform mark of 55%.

The uniform percentage mark is stated at syllabus level only. It is not the same as the 'raw' mark obtained by the candidate, since it depends on the position of the grade thresholds (which may vary from one session to another and from one subject to another) and it has been turned into a percentage.

6.6 Resources

Copies of syllabuses, the most recent question papers and Principal Examiners' reports are available on the Syllabus and Support Materials CD-ROM, which is sent to all CIE Centres.

Resources are also listed on CIE's public website at **www.cie.org.uk**. Please visit this site on a regular basis as the Resource lists are updated through the year.

Access to teachers' email discussion groups, suggested schemes of work and regularly updated resource lists may be found on the CIE Teacher Support website at **http://teachers.cie.org.uk**. This website is available to teachers at registered CIE Centres.

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