Cambridge Assessment International Education

Syllabus

Cambridge O Level Mathematics (Syllabus D) 4024

Use this syllabus for exams in 2022, 2023 and 2024.
Exams are available in the June and November series.

For centres in Mauritius Mathematics (Syllabus D) 4029

Use this syllabus for exams in 2022, 2023 and 2024.
Exams are available in the November series.

Version 1

Please check the syllabus page at www.cambridg
to see if this syllabus is available in your administrative zone.

Cambridge Pathway

Changes to the syllabus for 2022, 2023 and 2024

The latest syllabus is version 1, published September 2019.

There are no significant changes which affect teaching.

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

Any textbooks endorsed to support the syllabus for examination from 2018 are still suitable for use with this syllabus.

Contents

1. Introduction

1.1 Why choose Cambridge International?

Cambridge International 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 Cambridge Pathway gives students a clear path for educational success from age 5 to 19. Schools can shape the curriculum around how they want students to learn – with a wide range of subjects and flexible ways to offer them. It helps students discover new abilities and a wider world, and gives them the skills they need for life, so they can achieve at school, university and work.

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 students to progress from one stage to the next, and are well supported by teaching and learning resources.

Every year, nearly a million Cambridge learners from 10000 schools in 160 countries prepare for their future with the Cambridge Pathway.

Cambridge learners

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** 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.

Recognition

Our expertise in curriculum, teaching and learning, and assessment is the basis for the recognition of our programmes and qualifications around the world.

Cambridge O Level is internationally recognised by schools, universities and employers as equivalent in demand to Cambridge IGCSE™ (International General Certificate of Secondary Education). There are over 700000 entries a year in nearly 70 countries. Learn more at **www.cambridgeinternational.org/recognition**

Cambridge Assessment International Education is an education organisation and politically neutral. The content of this syllabus, examination papers and associated materials do not endorse any political view. We endeavour to treat all aspects of the exam process neutrally.

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.cambridgeinternational.org/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.cambridgeinternational.org/eoguide**

Quality management

Cambridge International is committed to providing exceptional quality. In line with this commitment, our quality management system for the provision of international qualifications and education programmes for students aged 5 to 19 is independently certified as meeting the internationally recognised standard, ISO 9001:2015. Learn more at **www.cambridgeinternational.org/ISO9001**

1.2 Why choose Cambridge O Level?

Cambridge O Level is typically for 14 to 16 year olds and is an internationally recognised qualification. It has been designed especially for an international market and is sensitive to the needs of different countries. Cambridge O Level is designed for learners whose first language may not be English, and this is acknowledged throughout the examination process.

Our aim is to balance knowledge, understanding and skills in our programmes and qualifications to enable students 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 & A Levels, the Cambridge AICE (Advanced International Certificate of Education) Diploma, 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.cambridgeinternational.org/olevel**

Guided learning hours

Cambridge O Level syllabuses are designed on the assumption that learners 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 students' prior experience of the subject.

1.3 Why choose Cambridge O Level 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 learners 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. Cambridge O Level Mathematics allows learners to gain lifelong benefits, including:

- confidence in their mathematical knowledge, and the ability to apply it in different contexts
- skills in communication and reasoning using mathematical concepts
- a solid foundation for further study
- the ability to be reflective when considering, presenting and interpreting mathematical results
- the ability to be engaged intellectually by developing a feel for numbers, patterns and relationships
- the ability to be innovative when applying their knowledge and understanding to solve problems in their future work.

Learners may also study for a Cambridge O Level in Additional Mathematics and for a Cambridge O Level 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. See **www.cambridgeinternational.org** for a full list of the qualifications you can take.

Prior learning

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

Progression

Cambridge O Levels 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 Mathematics are well prepared to follow courses leading to Cambridge International AS & 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@cambridgeinternational.org**

If you are not yet a Cambridge school

Learn about the benefits of becoming a Cambridge school at **www.cambridgeinternational.org/startcambridge**

Email us at **info@cambridgeinternational.org** to find out how your organisation can register to become a Cambridge school.

2. Teacher support

2.1 Support materials

You can go to our public website at **www.cambridgeinternational.org/olevel** to download current and future syllabuses together with specimen papers or past question papers, examiner reports and grade threshold tables from one series.

For teachers at registered Cambridge schools a range of additional support materials for specific syllabuses is available online from the School Support Hub. Go to **www.cambridgeinternational.org/support** (username and password required). If you do not have access, speak to the School Support coordinator at your school.

2.2 Endorsed resources

We work with publishers who provide a range of resources for our syllabuses including print and digital materials. Resources endorsed by Cambridge International go through a detailed quality assurance process to make sure they provide a high level of support for teachers and learners.

We have resource lists which can be filtered to show all resources, or just those which are endorsed by Cambridge International. The resource lists include further suggestions for resources to support teaching. See **www.cambridgeinternational.org/i-want-to/resource-centre** for further information.

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.cambridgeinternational.org/events** for further information.

3. Syllabus content at a glance

All candidates will study the following themes or topics:

Theme or topic	Theme or topic
1. Number	22. Sequences
2. Set language and notation	23. Variation
3. Squares, square roots, cubes and cube roots	24. Graphs in practical situations
4. Directed numbers	25. Graphs of functions
5. Vulgar and decimal fractions and percentages	26. Function notation
6. Ordering	27. Coordinate geometry
7. Standard form	28. Geometrical terms
8. The four operations	29. Geometrical constructions
9. Estimation	30. Similarity and congruence
10. Limits of accuracy	31. Symmetry
11. Ratio, proportion, rate	32. Angles
12. Percentages	33. Loci
13. Use of an electronic calculator	34. Measures
14. Time	35. Mensuration
15. Money	36. Trigonometry
16. Personal and small business finance	37. Vectors in two dimensions
17. Algebraic representation and formulae	38. Matrices
18. Algebraic manipulation	39. Transformations
19. Indices	40. Probability
20. Solutions of equations and inequalities	41. Categorical, numerical and grouped data
21. Graphical representation of inequalities	42. Statistical diagrams

4. Assessment at a glance

All candidates take two papers: Paper 1 and Paper 2.

Each paper may contain questions on any part of the syllabus and questions may assess more than one 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. Essential working must be shown for full marks to be awarded. **No calculators are allowed for this paper.** 80 marks This paper will be weighted at 50% of the total qualification.	

Paper 2	2 hours 30 minutes
Paper 2 has approximately 11 structured questions. Candidates should answer **all** questions. **Electronic calculators may be used and candidates should have access to a calculator for this paper.** Candidates should show all working in the spaces provided on the question paper. Essential working must be shown for full marks to be awarded. 100 marks This paper will be weighted at 50% of the total qualification.	

Availability

4024 is examined in the June and November examination series.

4029 is examined in the November examination series.

This syllabus is available to private candidates.

Detailed timetables are available from **www.cambridgeinternational.org/timetables**

Cambridge O Levels are available to centres in administrative zones 3, 4 and 5.

Combining this with other syllabuses

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

Candidates can combine syllabus **4024** in an examination series with any other Cambridge syllabus, except:

- syllabuses at the same level with the same title ('Mathematics', including 'International Mathematics')

Candidates can combine syllabus **4029** in an examination series with any other Cambridge syllabus, except:

- syllabuses at the same level with the same title ('Mathematics', including 'International Mathematics')

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

Additional materials for examinations:

For both Paper 1 and Paper 2, candidates should have these geometrical instruments:

- a pair of compasses
- a protractor
- a ruler.

Tracing paper may be used as an additional material for both of the written papers.

For Paper 2, candidates should have an electronic calculator – see below for details.

Use of calculators:

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. Algebraic or graphical calculators are not permitted.

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

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. To earn accuracy marks, premature approximation should be avoided.

In Paper 2, candidates are encouraged to use the value of π from their calculators. Otherwise, they should use the value of π given on the front page of the question paper as 3.142 to three decimal places.

Units

SI units will be used in questions involving mass and measures, including use of centimetres.

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 expression of compound units in the following form: e.g. 5 cm/s for 5 centimetres per second; 13.6 g/cm^3 for 13.6 grams per cubic centimetre.

Mathematical Notation

Please use the list of mathematical no

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5. Syllabus aims and assessment objectives

5.1 Syllabus aims

The aims are to enable candidates 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 their further study of mathematics and of 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.

5.2 Assessment objectives

The two assessment objectives in Cambridge O Level Mathematics are:

AO1 Mathematical techniques

AO2 Applying mathematical techniques to solve problems

AO1: Mathematical techniques

Candidates should be able to:

- recognise the appropriate mathematical procedures for a given situation
- perform calculations by suitable methods, with and without a calculator
- understand systems of measurement in everyday use and make use of them in the solution of problems
- estimate, approximate and work to degrees of accuracy appropriate to the context and convert between equivalent numerical forms
- organise, interpret and present information accurately in written, tabular, graphical and diagrammatic forms
- use mathematical and other instruments to measure and to draw to an acceptable degree of accuracy
- recognise and use spatial relationships in two and three dimensions, particularly when solving problems
- interpret, transform and make appropriate use of mathematical statements expressed in words or symbols
- recall, apply and interpret mathematical knowledge in the context of everyday situations.

AO2: Applying mathematical techniques to solve problems

In questions which are set in context and/or which require a sequence of steps to solve, candidates should be able to:

- recognise patterns and structures in a variety of situations and form and justify generalisations
- make logical deductions from given mathematical data
- respond to a problem relating to a relatively unstructured situation by translating it into an appropriately structured form
- analyse a problem, select a suitable strategy and apply an appropriate technique to obtain its solution
- apply combinations of mathematical skills and techniques in problem solving
- set out mathematical work, including the solution of problems, in a logical and clear form using appropriate symbols and terminology.

5.3 Relationship between assessment objectives and components

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

The table shows the assessment objectives as an approximate percentage of each component and as an approximate percentage of the overall Cambridge O Level Mathematics qualification.

Component	AO1 (%)	AO2 (%)	Weighting of component in overall qualification (%)
Paper 1	55–65	35–45	50
Paper 2	28–38	62–72	50
Weighting of AO in overall qualification	40–50	50–60	

6. Syllabus content

Theme or topic	Subject content	Notes/examples
1. Number	*Candidates should be able to:* • identify and use natural numbers, integers (positive, negative and zero), prime numbers, square numbers, cube numbers, common factors and common multiples, rational and irrational numbers (e.g. π, $\sqrt{2}$), real numbers	Includes expressing numbers as a product of prime factors, finding the Lowest Common Multiple (LCM) and Highest Common Factor (HCF) of two or more numbers.
2. Set language and notation	• use language, notation and Venn diagrams to describe sets and represent relationships between sets Definition of sets: e.g. $A = \{x : x \text{ is a natural number}\}$ $B = \{(x, y): y = mx + c\}$ $C = \{x : a \bullet \ x \bullet \ b\}$ $D = \{a, b, c...\}$	Includes using Venn diagrams to solve problems. Notation: 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 — $\varnothing$ 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 — $A \not\subset B$ Union of A and B — $A \cup B$ Intersection of A and B — $A \cap B$
3. Squares, square roots, cubes and cube roots	• calculate squares, square roots, cubes and cube roots of numbers	Includes recall of squares and their corresponding roots from 1 to 15 and cubes and their corresponding roots from 1 to 10.
4. Directed numbers	• use directed numbers in practical situations	e.g. temperature changes or flood levels
5. 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	
6. Ordering	• order quantities by magnitude and demonstrate familiarity with the symbols $=, \neq, \bullet, \bullet, \bullet, \bullet$	

Theme or topic	Subject content	Notes/examples
7. Standard form	• use the standard form $A \times 10^n$ where n is a positive or negative integer, and $1 \bullet \ A < 10$	Convert numbers into and out of standard form. Calculate with values in standard form.
8. The four operations	• use the four operations for calculations with whole numbers, decimals and vulgar (and mixed) fractions, including correct ordering of operations and use of brackets	
9. 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	e.g. by writing each number correct to one significant figure, estimate the value of $\frac{41.3}{9.79 \times 0.765}$
10. Limits of accuracy	• give appropriate upper and lower bounds for data given to a specified accuracy • obtain appropriate upper and lower bounds to solutions of simple problems given data to a specified accuracy	e.g. measured lengths e.g. the calculation of the perimeter or the area of a rectangle
11. Ratio, proportion, rate	• demonstrate an understanding of ratio and proportion • increase and decrease a quantity by a given ratio • use common measures of rate • solve problems involving average speed	Divide a quantity in a given ratio. Direct and inverse proportion. Use scales in practical situations. Interpreting the ratio as old quantity : new quantity, e.g. decrease $240 in the ratio 5 : 3. e.g. hourly rate of pay or flow rates
12. 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
13. Use of an electronic calculator	• use a calculator efficiently • apply appropriate checks of accuracy • enter a range of measures including 'time' • interpret the calculator display appropri	e.g. enter 2 hours 30 minutes as 2.5 hours e.g. in money 4.8 means $4.80; in time 3.25 means 3 hours 15 minutes

Theme or topic	Subject content	Notes/examples
14. Time	• calculate times in terms of the 24-hour and 12-hour clock • read clocks, dials and timetables	Includes problems involving time zones.
15. Money	• solve problems involving money and convert from one currency to another	
16. Personal and small business finance	• use given data to solve problems on personal and small business finance involving earnings, simple interest and compound interest • extract data from tables and charts	Includes discount, and profit and loss (as an amount or a percentage). Knowledge of compound interest formula given below is required: Value of investment = $P\left(1+\frac{r}{100}\right)^n$ where P is the amount invested, r is the percentage rate of interest and n is the number of years of compound interest.
17. Algebraic representation and formulae	• use letters to express generalised numbers and express arithmetic processes algebraically • substitute numbers for words and letters in formulae • construct and transform formulae and equations	e.g. transform formulae where the subject appears twice or where a power of the subject appears e.g. construct equations from numerical and geometrical problems.
18. Algebraic manipulation	• manipulate directed numbers • use brackets and extract common factors • expand products of algebraic expressions • factorise where possible expressions of the form: $ax + bx + kay + kby$ $a^2x^2 - b^2y^2$ $a^2 + 2ab + b^2$ $ax^2 + bx + c$ • manipulate algebraic fractions • factorise and simplify rational expressions	e.g. factorise $9x^2 + 15xy$ e.g. expand $3x(2x - 4y)$, $(x + 4)(x - 7)$ e.g. $\frac{x}{3}+\frac{x-4}{2}$, $\frac{2x}{3}-\frac{3(x-5)}{2}$, $\frac{3a}{4}\times\frac{9a}{10}$ $\frac{3a}{4}\div\frac{9a}{10}$, $\frac{1}{x-2}+\frac{2}{x-3}$ e.g. $\frac{x^2-2x}{x^2-5x+6}$

Theme or topic	Subject content	Notes/examples
19. Indices	• understand and use the rules of indices	e.g. work out $2^{-3} \times 2^4$ e.g. simplify $3x^{-4} \times \frac{2}{3}x^{\frac{1}{2}}$, $\frac{2}{5}x^{\frac{1}{2}} \div 2x^{-2}$ and $\left(\frac{2x^5}{3}\right)^3$
	• use and interpret positive, negative, fractional and zero indices	e.g. $5^{\frac{1}{2}} = \sqrt{5}$ e.g. evaluate 2^5, 4^0, 5^{-2}, $100^{\frac{1}{2}}$, $8^{-\frac{2}{3}}$ e.g. solve $32^x = 2$
20. 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, completing the square or by use of the formula • solve simple linear inequalities	Includes writing a quadratic expression in completed square form.
21. Graphical representation of inequalities	• represent linear inequalities graphically	Linear programming problems are not included.
22. Sequences	• continue a given number sequence • recognise patterns in sequences and relationships between different sequences • generalise sequences as simple algebraic statements	Includes linear sequences, quadratic and cubic sequences, exponential sequences and simple combinations of these. Including expressions for the *n*th term.
23. Variation	• express direct and inverse variation in algebraic terms and use this form of expression to find unknown quantities	Includes linear, square, square root and cubic variation (direct and inverse). e.g. y is inversely proportional to the square of x. Given that $y = 2$ when $x = 6$, find the value of y when $x = 2$
24. Graphs in practical situations	• 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 deceleration • calculate distance travelled as area under a linear speed–time graph	

Theme or topic	Subject content	Notes/examples
25. Graphs of functions	• construct tables of values and draw graphs for functions of the form ax^n where a is a rational constant, and $n = -2, -1, 0, 1, 2, 3$, and simple sums of not more than three of these and for functions of the form ka^x where a is a positive integer • interpret graphs of linear, quadratic, cubic, reciprocal and exponential functions • solve associated equations approximately by graphical methods • estimate gradients of curves by drawing tangents	
26. Function notation	• use function notation, e.g. $f(x) = 3x - 5$, $f: x \longmapsto 3x - 5$, to describe simple functions • find inverse functions $f^{-1}(x)$	
27. Coordinate geometry	• demonstrate familiarity with Cartesian coordinates in two dimensions • find the gradient of a straight line • calculate the gradient of a straight line from the coordinates of two points on it • calculate the length and the coordinates of the midpoint of a line segment from the coordinates of its end points • interpret and obtain the equation of a straight line graph in the form $y = mx + c$ • determine the equation of a straight line parallel to a given line • find the gradient of parallel and perpendicular lines	e.g. find the equation of a line parallel to $y = 4x - 1$ that passes through $(0, -3)$ e.g. find the gradient of a line perpendicular to $y = 3x + 1$ e.g. find the equation of a line perpendicular to one passing through the coordinates $(1, 3)$ and $(-2, -9)$

Theme or topic	Subject content	Notes/examples
28. Geometrical terms	• use and interpret the geometrical terms: point; line; plane; parallel; perpendicular; bearing; right angle, acute, obtuse and reflex angles; interior and exterior angles; similarity and congruence • use and interpret vocabulary of triangles, special quadrilaterals, circles, polygons and simple solid figures • understand and use the terms: centre, radius, chord, diameter, circumference, tangent, arc, sector and segment	Includes the following terms: Triangles: equilateral, isosceles and scalene (including right-angled triangles). Quadrilaterals: square, rectangle, kite, rhombus, parallelogram, trapezium. Polygons: Regular and irregular polygons; pentagon, hexagon, octagon, decagon. Simple solid figures: cube, cuboid, prism, cylinder, pyramid, cone, sphere; face, surface, edge, vertex and net.
29. Geometrical constructions	• measure lines and angles • construct a triangle, given the three sides, using a ruler and pair of compasses only • construct other simple geometrical figures from given data, using a ruler and protractor as necessary • construct angle bisectors and perpendicular bisectors using a pair of compasses as necessary • read and make scale drawings • use and interpret nets	
30. Similarity and congruence	• solve problems and give simple explanations involving similarity and congruence • calculate lengths of similar figures • use the relationships between areas of similar triangles, with corresponding results for similar figures, and extension to volumes and surface areas of similar solids	Includes showing that two triangles are similar or showing that two triangles are congruent (using correct congruence condition SSS, SAS, ASA, RHS). Includes use of scale factor.

Theme or topic	Subject content	Notes/examples
31. Symmetry	• recognise rotational and line symmetry (including order of rotational symmetry) in two dimensions • 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	Includes properties of triangles, quadrilaterals and circles directly related to their symmetries.
32. Angles	• calculate unknown angles and give simple explanations using the following geometrical properties: (a) angles at a point (b) angles at a point on a straight line and intersecting straight lines (c) angles formed within parallel lines (d) angle properties of triangles and quadrilaterals (e) angle properties of regular and irregular polygons (f) angle in a semi-circle (g) angle between tangent and radius of a circle (h) angle at the centre of a circle is twice the angle at the circumference (i) angles in the same segment are equal (j) angles in opposite segments are supplementary	Candidates will be expected to use the correct geometrical terminology when giving reasons for answers. Angle properties of polygons includes angle sum.

Theme or topic	Subject content	Notes/examples
33. Loci	• use the following loci and the method of intersecting loci for sets of points in two dimensions which are: (a) at a given distance from a given point (b) at a given distance from a given straight line (c) equidistant from two given points (d) equidistant from two given intersecting straight lines	
34. Measures	• use current units of mass, length, area, volume and capacity in practical situations and express quantities in terms of larger or smaller units	Convert between units including units of area and volume. e.g. between mm^2 and cm^2 or between cm^3, m^3 and litres
35. Mensuration	• solve problems involving: (a) the perimeter and area of a rectangle and triangle (b) the perimeter and area of a parallelogram and a trapezium (c) the circumference and area of a circle (d) arc length and sector area as fractions of the circumference and area of a circle (e) the surface area and volume of a cuboid, cylinder, prism, sphere, pyramid and cone (f) the areas and volumes of compound shapes	Formulae will be given for the surface area and volume of the sphere, pyramid and cone.

Theme or topic	Subject content	Notes/examples
36. Trigonometry	• interpret and use three-figure bearings	Measured clockwise from the north, i.e. 000•–360•. e.g. Find the bearing of *A* from *B* if the bearing of *B* from *A* is 125•
	• 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 • solve trigonometrical problems in two dimensions involving angles of elevation and depression • 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 area of triangle = $\frac{1}{2}ab\sin C$ • solve simple trigonometrical problems in three dimensions	Angles will be quoted in, and answers required in, degrees and decimals of a degree to one decimal place. Calculations of the angle between two planes or of the angle between a straight line and plane will not be required.
37. Vectors in two dimensions	• describe a translation by using a vector represented by $\begin{pmatrix} x \\ y \end{pmatrix}$, $\overrightarrow{AB}$ or **a** • add and subtract vectors • multiply a vector by a scalar • calculate the magnitude of a vector $\begin{pmatrix} x \\ y \end{pmatrix}$ as $\sqrt{x^2+y^2}$ • 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	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 their answers to questions candidates are expected to indicate **a** in some definite way, e.g. by an arrow $\overrightarrow{AB}$ or by underlining as follows a.

Theme or topic	Subject content	Notes/examples
38. 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 matrix and a scalar quantity • use the algebra of 2 × 2 matrices including the zero and identity 2 × 2 matrices • calculate the determinant $\lvert\mathbf{A}\rvert$ and inverse $\mathbf{A}^{-1}$ of a non-singular matrix **A**	
39. Transformations	• use the following transformations of the plane: reflection (M), rotation (R), translation (T), enlargement (E) and their combinations • identify and give precise descriptions of transformations connecting given figures • describe transformations using coordinates and matrices	If M(a) = b and R(b) = c the notation RM(a) = c will be used. Invariants under these transformations may be assumed. Singular matrices are excluded.
40. Probability	• calculate the probability of a single event as either a fraction or a decimal • understand that the probability of an event occurring = 1 – the probability of the event not occurring • understand relative frequency as an estimate of probability • calculate the probability of simple combined events using possibility diagrams and tree diagrams where appropriate	Probabilities should not be given as ratios. Problems could be set involving extracting information from tables or graphs. e.g. P(blue) = 0.8, find P(not blue) e.g. use results of experiments with a spinner to estimate the probability of a given outcome e.g. use probability to estimate from a population 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.

Theme or topic	Subject content	Notes/examples
41. Categorical, numerical and grouped data	• collect, classify and tabulate statistical data • read, interpret and draw simple inferences from tables and statistical diagrams • calculate the mean, median, mode and range for individual and discrete data and distinguish between the purposes for which they are used • calculate an estimate of the mean for grouped and continuous data • identify the modal class from a grouped frequency distribution	
42. Statistical diagrams	• construct and interpret bar charts, pie charts, pictograms, simple frequency distributions, frequency polygons, histograms with equal and unequal intervals and scatter diagrams • construct and use cumulative frequency diagrams • estimate and interpret the median, percentiles, quartiles and interquartile range for cumulative frequency diagrams • calculate with frequency density • understand what is meant by positive, negative and zero correlation with reference to a scatter diagram • draw a straight line of best fit by eye.	For unequal intervals on histograms, areas are proportional to frequencies and the vertical axis is labelled 'Frequency density'.

7. Mathematical notation

The list which follows summarises the notation used in Cambridge's mathematics examinations. Although primarily directed towards Advanced Level, the list also applies, where relevant, to examinations at Cambridge O Level.

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, …
$\{x: \ldots\}$	the set of all x such that …
$\mathrm{n}(A)$	the number of elements in set A
$\varnothing$	the empty set
$\mathbb{E}$	the universal set
A'	the complement of the set A
$\mathbb{N}$	the set of natural numbers, {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, …, n – 1}
$\mathbb{Q}$	the set of rational numbers
$\mathbb{Q}^+$	the set of positive rational numbers, $\{x \in \mathbb{Q}: x \bullet 0\}$
$\mathbb{Q}_0^+$	the set of positive rational numbers and zero, $\{x \in \mathbb{Q}: x \bullet 0\}$
$\mathbb{R}$	the set of real numbers
$\mathbb{R}^+$	the set of positive real numbers $\{x \in \mathbb{R}: x \bullet 0\}$
$\mathbb{R}_0^+$	the set of positive real numbers and zero $\{x \in \mathbb{R}: x \bullet 0\}$
$\mathbb{R}^n$	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 $\{x \in \mathbb{R}: a \bullet x \bullet b\}$
$[a, b)$	the interval $\{x \in \mathbb{R}: a \bullet x \bullet b\}$
$(a, b]$	the interval $\{x \in \mathbb{R}: a \bullet x \bullet b\}$
(a, b)	the open interval $\{x \in \mathbb{R}: a \bullet x \bullet b\}$
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
$<$, $<<$	is less than, is much less than
$\leqslant$, $\leqslant$	is less than or equal to, is not greater than
$>$, $>>$	is greater than, is much greater than
$\geqslant$, $\geqslant$	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 $n \in \mathbb{N}$, $0 \leqslant r \leqslant n$
	the binomial coefficient $\frac{n(n-1)\ldots(n-r+1)}{r!}$, 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, $z = x + \mathrm{i}y$ $= r(\cos\theta + \mathrm{i}\sin\theta)$, $r \in \mathbb{R}_0^+$ $= re^{i\theta}$, $r \in \mathbb{R}_0^+$
$\mathrm{Re}\, z$	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 $\overrightarrow{AB}$
$\mathbf{a} \cdot \mathbf{b}$	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
$\mathrm{P}(A)$	probability of the event A
A'	complement of the event A, the event 'not A'
$\mathrm{P}(A \mid B)$	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
$p(x)$	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

8. Other information

Equality and inclusion

We have 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), we have 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 in the *Cambridge Handbook* at
www.cambridgeinternational.org/eoguide

Language

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

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.

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.

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 (pending), X (no result) and Y (to be issued) may also appear on the statement of results but not 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.

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