UNIVERSITY of CAMBRIDGE
International Examinations

Cambridge IGCSE

SYLLABUS

Cambridge IGCSE®
Mathematics (US)
0444

For examination in June and November 2014

This syllabus is available only to Centers taking part in the Board Examination Systems (BES) Pilot.

If you have any questions about this syllabus, please contact Cambridge at international@cie.org.uk quoting syllabus code 0444.

Note

Administration materials appear in UK English and are standard for all our international customers. Please read the *Cambridge Glossary* alongside this syllabus. This is available from our website.

Contents

1. Introduction

1.1 Why Choose Cambridge?

University of Cambridge International Examinations is the world's largest provider of international education programs and qualifications for 5 to 19 year olds. We are part of the University of Cambridge, trusted for excellence in education. Our qualifications are recognized by the world's universities and employers.

Recognition

Every year, hundreds of thousands of learners gain the Cambridge qualifications they need to enter the world's universities.

Cambridge IGCSE® (International General Certificate of Secondary Education) is internationally recognized by schools, universities, and employers as equivalent to UK GCSE. Learn more at **www.cie.org.uk/recognition**

Excellence in Education

We understand education. We work with over 9,000 schools in over 160 countries that offer our programs and qualifications. Understanding learners' needs around the world means listening carefully to our community of schools, and we are pleased that 98% of Cambridge schools say they would recommend us to other schools.

Our mission is to provide excellence in education, and our vision is that Cambridge learners become confident, responsible, innovative, and engaged.

Cambridge programs and qualifications help Cambridge learners to become:

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

Support in the Classroom

We provide a world-class support service for Cambridge teachers and exams officers. We offer a wide range of teacher materials to Cambridge schools, plus teacher training (online and face-to-face), expert advice, and learner support materials. Exams officers can trust in reliable, efficient administration of exams entry and excellent, personal support from our customer services. Learn more at **www.cie.org.uk/teachers**

Nonprofit, Part of the University of Cambridge

We are a part of Cambridge Assessment, a department of the University of Cambridge and a nonprofit organization.

We invest constantly in research and development to improve our programs and qualifications.

1.2 Why Choose Cambridge IGCSE?

Cambridge IGCSE helps your school improve learners' performance. Learners develop not only knowledge and understanding, but also skills in creative thinking, inquiry, and problem solving, helping them perform well and prepare for the next stage of their education.

Cambridge IGCSE is the world's most popular international curriculum for 14 to 16 year olds, leading to globally recognized and valued Cambridge IGCSE qualifications. It is part of the Cambridge Secondary 2 stage.

Schools worldwide have helped develop Cambridge IGCSE, which provides an excellent preparation for Cambridge International AS and A Levels, Cambridge Pre-U, Cambridge AICE (Advanced International Certificate of Education), and other education programs, such as the US Advanced Placement Program and the International Baccalaureate Diploma. Cambridge IGCSE incorporates the best in international education for learners at this level. It develops in line with changing needs, and we update and extend it regularly.

1.3 Why Choose Cambridge IGCSE Mathematics?

Cambridge IGCSE Mathematics is accepted by universities and employers as proof of mathematical knowledge and understanding. Successful Cambridge IGCSE 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.

1.4 Cambridge International Certificate of Education (ICE)

Cambridge ICE is the group award of Cambridge IGCSE. It gives schools the opportunity to benefit from offering a broad and balanced curriculum by recognizing the achievements of learners who pass examinations in at least seven subjects. Learners take subjects from five subject groups, including two languages, and one subject from each of the other subject groups. The seventh subject can be taken from any of the five subject groups.

Mathematics (0444) falls in Group IV, Mathematics.

Learn more about Cambridge IGCSE and Cambridge ICE at **www.cie.org.uk/cambridgesecondary2**

1.5 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 **international@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 **international@cie.org.uk** to find out how your organization can become a Cambridge school.

2. Assessment at a Glance

This qualification is assessed via two components.

Candidates who have followed the Core curriculum take components 1 and 3.

Candidates who have followed the Extended curriculum take components 2 and 4.

Component	Weighting	Raw mark	Nature of assessment
1 Written paper **1 hour** Short-answer questions based on the Core curriculum. Calculators are **not** permitted. *Grades available: C–G*	35%	56	External
2 Written paper **1 hour, 30 minutes** Short-answer questions based on the Extended curriculum. Calculators are **not** permitted. *Grades available: A*–E*	35%	70	External
3 Written paper **2 hours** Structured questions based on the Core curriculum. Electronic calculators are required.† *Grades available: C–G*	65%	104	External
4 Written paper **2 hours, 30 minutes** Structured questions based on the Extended curriculum. Electronic calculators are required.† *Grades available: A*–E*	65%	130	External

† Algebraic or graphic calculators are **not** permitted.

The mathematical formulae provided in the written papers is given in the appendix.

Availability

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

Combining This with Other Syllabi

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

- syllabi with the same title (or the title Mathematics) at the same level

Candidates who follow the Extended Curriculum of the Cambridge IGCSE Mathematics (US) (0444) and the Cambridge IGCSE Additional Mathematics (US) (0459) syllabus content will cover the Common Core State Standards for Mathematics (CCSSM) for Grades 9–12.

3. Syllabus Goals and Objectives

3.1 Goals

Cambridge IGCSE Mathematics syllabus is designed as a two-year course for examination at age 16-plus. The goals of this syllabus should enable students to:

1. develop their mathematical knowledge and oral, written, and practical skills in a way that encourages confidence and provides satisfaction and enjoyment;
2. read mathematics, and write and talk about the subject in a variety of ways;
3. develop a feel for numbers, carry out calculations, and understand the significance of the results obtained;
4. apply mathematics in everyday situations and develop an understanding of the part that mathematics plays in the world around them;
5. solve problems, present the solutions clearly, check and interpret the results;
6. develop an understanding of mathematical principles;
7. recognize when and how a situation may be represented mathematically, identify and interpret relevant factors, and, where necessary, select an appropriate mathematical method to solve the problem;
8. use mathematics as a means of communication with emphasis on the use of clear expression;
9. develop an ability to apply mathematics in other subjects, particularly science and technology;
10. develop the abilities to reason logically, to classify, to generalize, and to prove;
11. appreciate patterns and relationships in mathematics;
12. produce and appreciate imaginative and creative work arising from mathematical ideas;
13. develop their mathematical abilities by considering problems and conducting individual and cooperative enquiry and experiment, including extended pieces of work of a practical and investigative kind;
14. appreciate the interdependence of different branches of mathematics;
15. acquire a foundation appropriate to their further study of mathematics and of other disciplines.

3.2 Assessment Objectives

The examination will test the ability of candidates to:

1. organize, interpret, and present information accurately in written, tabular, graphical, and diagrammatic forms;
2. perform calculations by suitable methods;
3. use an electronic calculator and also perform some straightforward calculations without a calculator;
4. understand systems of measurement in everyday use and make use of them in the solution of problems;
5. estimate, approximate, and work to degrees of accuracy appropriate to the context and convert between equivalent numerical forms;
6. use mathematical and other instruments to measure and to draw to an acceptable degree of accuracy;
7. interpret, transform, and make appropriate use of mathematical statements expressed in words or symbols;
8. recognize and use spatial relationships in two and three dimensions, particularly in solving problems;
9. recall, apply, and interpret mathematical knowledge in the context of everyday situations.
10. make logical deductions from given mathematical data;
11. recognize patterns and structures in a variety of situations, and form generalizations;
12. respond to a problem relating to a relatively unstructured situation by translating it into an appropriately structured form;
13. analyze a problem, select a suitable strategy, and apply an appropriate technique to obtain its solution;
14. apply combinations of mathematical skills and techniques in problem solving;
15. set out mathematical work, including the solution of problems, in a logical and clear form using appropriate symbols and terminology;
16. present concise reasoned arguments to justify solutions or generalizations, using symbols diagrams or graphs and related explanations.

4. Curriculum Content

Candidates may follow either the Core Curriculum or the Extended Curriculum. Candidates aiming for Grades A*–C should follow the Extended Curriculum.

1.	Number—Core curriculum	Notes / Examples
1.1	Knowledge of: natural numbers, integers (positive, negative, and zero), prime numbers, square numbers, rational and irrational numbers, real numbers. Use of symbols: $=, \neq, \leqslant, \geqslant, <, >$	
1.2	Use of the four operations and parentheses.	Applies to integers, fractions, and decimals. Choose mental or written methods appropriate to the number or context.
1.3	Multiples and factors, including greatest common factor, least common multiple.	GCF and LCM will be used and knowledge of prime factors is assumed.
1.4	Ratio and proportion.	
1.5	Language and notation of fractions, decimals, and percentages; recognize equivalences between decimals, fractions, ratios, and percentages and convert between them. Order quantities given in different forms by magnitude, by first converting into same form.	
1.6	Percentages, including applications such as interest and profit.	Excludes reverse percentages. Includes both simple and compound interest.
1.7	Meaning and calculation of exponents (powers, indices) including positive, negative, and zero exponents. Explain the definition of radical exponents as an extension to integral exponents. Explain the rules for exponents. Scientific notation (Standard Form) $a \times 10^n$ where $1 \leqslant a < 10$ and n is an integer.	e.g., work out 4^{-3} as a fraction. e.g., work out $2^4 \times 2^{-3}$ Convert numbers in and out of scientific notation. Calculate with values in scientific notation.

1.	Number—Extended curriculum	Notes / Examples
1.1	Knowledge of: natural numbers, integers (positive, negative, and zero), prime numbers, square numbers, rational and irrational numbers, real numbers. Use of symbols: $=, \neq, \leqslant, \geqslant, <, >$	Understand that the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a non-zero rational number and an irrational number is irrational.
1.2	Use of the four operations and parentheses.	Applies to integers, fractions, and decimals. Choose mental or written methods appropriate to the number or context.
1.3	Multiples and factors, including greatest common factor, least common multiple.	GCF and LCM will be used and knowledge of prime factors is assumed.
1.4	Ratio and proportion.	
1.5	Understand and use the language and notation of fractions, decimals, and percentages; recognize equivalences between decimals, fractions, ratios, and percentages and convert between them. Order quantities given in different forms by magnitude, by first converting into same form.	
1.6	Percentages, including applications such as interest and profit.	Includes reverse percentages. Includes both simple and compound interest. Includes percentiles.
1.7	Meaning and calculation of exponents (powers, indices) including positive, negative, zero and fractional exponents. Explain the definition of radical exponents as an extension to integral exponents. Explain the rules for exponents. Scientific notation (Standard Form) $a \times 10^n$ where $1 \leqslant a < 10$ and n is an integer.	e.g., $5^{\frac{1}{2}} = \sqrt{5}$ Evaluate 5^{-2}, $100^{\frac{1}{2}}$, $8^{-\frac{2}{3}}$ Work out $2^4 \times 2^{-3}$ Convert numbers in and out of scientific notation. Calculate with values in scientific notation.

1.	Number—Core curriculum	Notes / Examples
1.8	Radicals, calculation of square root and cube root expressions.	e.g., the area of a square is 54.76 cm^2. Work out the length of one side of the square. Find the value of the cube root of 64.
1.9	Use units to understand problems and guide the solution to multi-step problems. Quantities—choose and interpret units and scales, define appropriate quantities (including money). Estimating, rounding, decimal places, and significant figures—choose a level of accuracy appropriate for a problem.	Also relates to graphs and geometrical measurement topics. Includes converting between units, e.g., different currencies. Use estimation to check answers and consider whether the answer is reasonable in the context of the problem.
1.10	Calculations involving time: seconds (s), minutes (min), hours (h), days, months, years including the relation between consecutive units.	1 year = 365 days. Includes familiarity with both 24-hour and 12-hour clocks and extraction of data from dials and schedules.
1.11	Speed, distance, time problems.	

1.	Number—Extended curriculum	Notes / Examples
1.8	Radicals, calculation and simplification of square root and cube root expressions.	e.g., simplify $\sqrt{200} + \sqrt{18}$ Write $(2 + \sqrt{3})^2$ in the form $a + b\sqrt{3}$
1.9	Use units to understand problems and guide the solution to multi-step problems. Quantities—choose and interpret units and scales, define appropriate quantities (including money). Estimating, rounding, decimal places, and significant figures—choose a level of accuracy appropriate for a problem.	Also relates to graphs and geometrical measurement topics. Includes converting between units, e.g., different currencies. Use estimation to check answers and consider whether the answer is reasonable in the context of the problem.
1.10	Calculations involving time: seconds (s), minutes (min), hours (h), days, months, years including the relation between consecutive units.	1 year = 365 days. Includes familiarity with both 24-hour and 12-hour clocks and extraction of data from dials and schedules.
1.11	Speed, distance, time problems.	

2.	Algebra—Core curriculum	Notes / Examples
2.1	*Extended Curriculum only.*	
2.2	*Extended Curriculum only.*	
2.3	Create expressions and create and solve linear equations, including those with fractional expressions.	Explain each algebraic step of the solution. May be asked to interpret solutions to a problem given in context. Construct a viable argument to justify a solution method.
2.4	Exponents (indices).	Includes rules of indices with negative indices. Simple examples only, e.g., $q^3 \times q^{-4}$, $8x^5 \div 2x^2$
2.5	Rearrangement and evaluation of simple formulae.	e.g., make r the subject of: • $p = rt - q$ • $w = \frac{r-t}{y}$ e.g., when $x = -3$ and $y = 4$, find the value of xy^2.
2.6	Create and solve simultaneous linear equations in two variables algebraically.	
2.7	Identify terms, factors, and coefficients.	
2.8	Expansion of parentheses (simple examples only). Simplify expressions.	e.g., expand and simplify $4(5c - 3d) - 7c$

2.	Algebra—Extended curriculum	Notes / Examples
2.1	Writing, showing, and interpretation of inequalities on the real number line.	
2.2	Create and solve linear inequalities.	e.g., Solve $3x + 5 < 7$ Solve $-7 \leqslant 3n - 1 < 5$
2.3	Create expressions and create and solve linear equations, including those with fractional expressions.	Explain each algebraic step of the solution. May be asked to interpret solutions to a problem given in context. Construct a viable argument to justify a solution method.
2.4	Exponents (indices).	Includes rules of indices with negative and fractional indices. e.g., simplify $2x^{\frac{3}{2}} \times 5x^{-4}$
2.5	Rearrangement and evaluation of formulae.	Includes manipulation of algebraic expressions to prove identities. Formulae may include indices or cases where the subject appears twice. e.g., make r the subject of • $V = \frac{4}{3}\pi r^3$ • $p = \dfrac{2r - 3}{r + s}$ e.g., $y = m^2 - 4n^2$ Find the value of y when $m = 4.4$ and $n = 2.8$
2.6	Create and solve simultaneous linear equations in two variables algebraically and graphically.	*See functions 3.2*
2.7	Identify terms, factors, and coefficients. Interpret algebraic expressions in terms of a context.	e.g., interpret $P(1 + r)^n$ as the product of P and a factor not depending on P.
2.8	Expansion of parentheses, including the square of a binomial. Simplify expressions.	e.g., expand $(2x - 5)^2 = 4x^2 - 20x + 25$

2.	Algebra—Core curriculum	Notes / Examples
2.9	Factorization: common factor only.	e.g., $6x^2 + 9x = 3x(2x + 3)$
2.10	*Extended Curriculum only.*	
2.11	*Extended Curriculum only.*	
2.12	*Extended Curriculum only.*	
2.13	Continuation of a sequence of numbers or patterns; recognize patterns in sequences; generalize to simple algebraic statements, including determination of the n^{th} term.	e.g., find the n^{th} term of: • 5 9 13 17 21 • 2 4 8 16 32
2.14	*Extended Curriculum only.*	

2.	Algebra—Extended curriculum	Notes / Examples
2.9	Use equivalent forms of an expression or function to reveal and explain properties of the quantities or function represented. Factorization: common factor difference of squares trinomial four term.	 $6x^2 + 9x = 3x(2x + 3)$ $9x^2 - 16y^2 = (3x - 4y)(3x + 4y)$ $6x^2 + 11x - 10 = (3x - 2)(2x + 5)$ $xy - 3x + 2y - 6 = (x + 2)(y - 3)$ Use the structure of an expression to identify ways to rewrite it, for example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.
2.10	Algebraic fractions: simplification, including use of factorization addition or subtraction of fractions with linear denominators multiplication or division and simplification of two fractions.	e.g., simplify $\frac{4x^2 - 9}{8x^2 - 10x - 3}$, $\frac{3}{2x + 1} - \frac{4}{x}$, $\frac{7x}{4y^2} \div \frac{21x}{8}$
2.11	Create and solve quadratic equations by: inspection factorization using the quadratic formula completing the square.	 e.g., $x^2 = 49$ $2x^2 + 5x - 3 = 0$ $3x^2 - 2x - 7 = 0$ Write $x^2 - 6x + 9$ in the form $(x - a)^2 + b$ and state the minimum value of the function. Quadratic formula will be given.
2.12	Solve simple rational and radical equations in one variable and discount any extraneous solutions.	e.g., solve $\sqrt{x} + 2 = 6$, $x^{-3} = 27$, $2y^4 = 32$
2.13	Continuation of a sequence of numbers or patterns; recognize patterns in sequences; generalize to simple algebraic statements, including determination of the n^{th} term. Derive the formula for the sum of a finite geometric series, and use the formula to solve problems.	e.g., find the n^{th} term of: • 5 9 13 17 21 • 2 4 8 16 32 • 2 5 10 17 26 • 3 6 12 24 48 For a common ratio that is not 1. e.g., calculate mortgage payments.
2.14	Express direct and inverse variation in algebraic terms and use this form of expression to find unknown quantities.	e.g., $y \propto x$, $y \propto \sqrt{x}$ $y \propto \frac{1}{x}$, $y \propto \frac{1}{x^2}$

3.	Functions—Core curriculum	Notes / Examples
3.1	Use function notation. Knowledge of domain and range. Mapping diagrams.	Understand that a function assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain then f(x) denotes the output of f corresponding to the input of x.
3.2	Understand and explain that the graph of an equation in two variables is the set of all its solutions plotted in the co-ordinate plane. Construct tables of values for functions of the form $ax + b$, $\pm x^2 + ax + b$, $\frac{a}{x}$ ($x \neq 0$) where a and b are integral constants; draw and interpret such graphs. Solve associated equations approximately by graphical methods.	
3.3	Write a function that describes a relationship between two quantities.	e.g., $C(x) = 50{,}000 + 400x$ models the cost of producing x wheelchairs. Write a function that represents the cost of one wheelchair.
3.4	*Extended Curriculum only.*	
3.5	Recognition of the following function types from the shape of their graphs: linear $f(x) = ax + b$ quadratic $f(x) = ax^2 + bx + c$ reciprocal $f(x) = \frac{a}{x}$ Interpret the key features of the graphs—to include intercepts; intervals where the function is increasing, decreasing, positive, negative; relative maxima and minima; symmetries; end behavior.	Some of a, b, c may be 0

3.	Functions—Extended curriculum	Notes / Examples
3.1	Use function notation. Knowledge of domain and range. Mapping diagrams.	e.g., f(*x*); f:*x* Understand that a function assigns to each element of the domain exactly one element of the range. If f is a function and *x* is an element of its domain then f(*x*) denotes the output of f corresponding to the input of *x*.
3.2	Understand and explain that the graph of an equation in two variables is the set of all its solutions plotted in the co-ordinate plane. Construct tables of values and construct graphs of 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 type a^x where *a* is a positive integer. Solve associated equations approximately by graphical methods.	
3.3	Write a function that describes a relationship between two quantities.	e.g., C(*x*) = 50,000 + 400*x* models the cost of producing *x* wheelchairs. Write a function that represents the cost of one wheelchair.
3.4	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).	e.g., given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.
3.5	Recognition of the following function types from the shape of their graphs: linear $f(x) = ax + b$ quadratic $f(x) = ax^2 + bx + c$ cubic $f(x) = ax^3 + bx^2 + cx + d$ reciprocal $f(x)= \frac{a}{x}$ exponential $f(x) = a^x$ with $0 < a < 1$ or $a > 1$ trigonometric $f(x) = a\sin(bx)$; $a\cos(bx)$; $\tan x$ Interpret the key features of the graphs—to include intercepts; intervals where the function is increasing, decreasing, positive, negative; relative maxima and minima; symmetries; end behavior and periodicity.	Some of *a, b, c,* and *d* may be 0 Including period and amplitude.

3.	Functions—Core curriculum	Notes / Examples
3.6	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.	e.g., if the function h(*n*) gives the number of person-hours it takes to assemble *n* engines in a factory, then the positive integers would be an appropriate domain for the function.
3.7	*Extended Curriculum only.*	
3.8	*Extended Curriculum only.*	
3.9	*Extended Curriculum only.*	
3.10	*Extended Curriculum only.*	
3.11	*Extended Curriculum only.*	
3.12	Description and identification, using the language of transformations, of the changes to the graph of $y = \mathrm{f}(x)$ when $y = \mathrm{f}(x) + k$, $y = k\,\mathrm{f}(x)$, $y = \mathrm{f}(x + k)$ for $\mathrm{f}(x)$ given in section 3.5.	Where k is an integer.

<table>
<tr><th>3.</th><th>Functions—Extended curriculum</th><th>Notes / Examples</th></tr>
<tr><td>3.6</td><td>Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.</td><td>e.g., if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.</td></tr>
<tr><td>3.7</td><td>Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval.
Estimate the rate of change from a graph.</td><td>e.g., average speed between 2 points

e.g., use a tangent to the curve to find the slope</td></tr>
<tr><td>3.8</td><td>Behavior of linear, quadratic, and exponential functions:
linear $f(x) = ax + b$
quadratic $f(x) = ax^2 + bx + c$
exponential $f(x) = a^x$ with $0 < a < 1$ or $a > 1$</td><td>Observe, using graphs and tables, that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
Use the properties of exponents to interpret expressions for exponential functions, e.g., identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, and classify them as representing exponential growth or decay.</td></tr>
<tr><td>3.9</td><td>Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).</td><td>e.g., find the function or equation for the relationship between x and y
<table><tr><td>x</td><td>−2</td><td>0</td><td>2</td><td>4</td></tr><tr><td>y</td><td>3</td><td>5</td><td>7</td><td>9</td></tr></table></td></tr>
<tr><td>3.10</td><td>Simplification of formulae for composite functions such as f(g(x)) where g(x) is a linear expression.</td><td>e.g., $f(x) = 6 + 2x$, $g(x) = 7x$,
$f(g(x)) = 6 + 2(7x) = 6 + 14x$</td></tr>
<tr><td>3.11</td><td>Inverse function f^{-1}.</td><td>Find an inverse function.
Solve equation of form $f(x) = c$ for a simple function that has an inverse.
Read values of an inverse function from a graph or a table, given that the function has an inverse.</td></tr>
<tr><td>3.12</td><td>Description and identification, using the language of transformations, of the changes to the graph of $y = f(x)$ when $y = f(x) + k$, $y = k\,f(x)$, $y = f(x + k)$ for f(x) given in section 3.5.</td><td>Where k is an integer.</td></tr>
</table>

3.	Functions—Core curriculum	Notes / Examples
3.13	*Extended Curriculum only.*	

4.	Geometry—Core curriculum	Notes / Examples
4.1	Vocabulary: acute, obtuse, right angle, reflex, equilateral, isosceles, congruent, similar, regular, pentagon, hexagon, octagon, rectangle, square, kite, rhombus, parallelogram, trapezoid, and simple solid figures.	
4.2	Definitions: Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.	
4.3	Line and rotational symmetry in 2D.	e.g., know properties of triangles, quadrilaterals, and circles directly related to their symmetries.
4.4	Angles around a point. Angles on a straight line and intersecting straight lines. Vertically opposite angles. Alternate and corresponding angles on parallel lines. Angle properties of triangles, quadrilaterals, and polygons. Interior and exterior angles of a polygon.	Formal proof is not required, but candidates will be expected to use reasoned arguments, including justifications, to establish geometric results from given information.

3.	Functions—Extended curriculum	Notes / Examples
3.13	Graph the solutions to a linear inequality in two variables as a half-plane (region), excluding the boundary in the case of a strict inequality. Graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.	e.g., identify the region bounded by the inequalities $y > 3$, $2x + y < 12$, $y \leqslant x$.

4.	Geometry—Extended curriculum	Notes / Examples
4.1	Vocabulary: Know precise definitions of acute, obtuse, right angle, reflex, equilateral, isosceles, congruent, similar, regular, pentagon, hexagon, octagon, rectangle, square, kite, rhombus, parallelogram, trapezoid, and simple solid figures.	
4.2	Definitions: Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.	
4.3	Line and rotational symmetry in 2D and 3D.	e.g., know properties of triangles, quadrilaterals, and circles directly related to their symmetries. For example, given a rectangle, parallelogram, trapezoid or regular polygon, describe the rotations and reflections that carry it onto itself. Recognize symmetry properties of the prism and the pyramid.
4.4	Angles around a point. Angles on a straight line and intersecting straight lines. Vertically opposite angles. Alternate and corresponding angles on parallel lines. Angle properties of triangles, quadrilaterals, and polygons. Interior and exterior angles of a polygon.	Formal proof is not required, but candidates will be expected to use reasoned arguments, including justifications, to establish geometric results from given information.

4.	Geometry—Core curriculum	Notes / Examples
4.5	Construction. Make formal geometric constructions with compass and straight edge only. Copy a segment; copy an angle; bisect a segment; bisect an angle; construct perpendicular lines, including the perpendicular bisector of a line segment. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle. Construct the inscribed and circumscribed circles of a triangle. Construct a tangent line from a point outside a given circle to the circle. Angle measurement in degrees. Read and make scale drawings.	
4.6	Vocabulary of circles. Properties of circles: • tangent perpendicular to radius at the point of contact • angle in a semicircle	Formal proof is not required but candidates will be expected to use reasoned arguments, including justifications, to establish geometric results from given information.
4.7	Similarity. Calculation of lengths of similar figures.	Use scale factors and/or angles to check for similarity.
4.8	*Extended Curriculum only.*	

4.	Geometry—Extended curriculum	Notes / Examples
4.5	Construction. Make formal geometric constructions with compass and straight edge only. Copy a segment; copy an angle; bisect a segment; bisect an angle; construct perpendicular lines, including the perpendicular bisector of a line segment. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle. Construct the inscribed and circumscribed circles of a triangle. Construct a tangent line from a point outside a given circle to the circle. Angle measurement in degrees. Read and make scale drawings.	
4.6	Vocabulary of circles. Properties of circles: • tangent perpendicular to radius at the point of contact • tangents from a point • angle in a semicircle • angles at the center and at the circumference on the same arc • cyclic quadrilateral Use the following symmetry properties of a circle: • equal chords are equidistant from the center • the perpendicular bisector of a chord passes through the center • tangents from an external point are equal in length	Formal proof is not required but candidates will be expected to use reasoned arguments, including justifications, to establish geometric results from given information.
4.7	Similarity. Calculation of lengths of similar figures. Area and volume scale factors.	Use scale factors and/or angles to check for similarity. Use of the relationships between areas of similar figures and extension to volumes and surface areas of similar solids.
4.8	Congruence. Recognise that two shapes are congruent and use this to solve problems.	

5.	Transformations and vectors—Core curriculum	Notes / Examples
5.1	Vector notation: directed line segment $\overrightarrow{AB}$; component form $\begin{pmatrix} x \\ y \end{pmatrix}$	
5.2	*Extended Curriculum only.*	
5.3	*Extended Curriculum only.*	
5.4	*Extended Curriculum only.*	
5.5	*Extended Curriculum only.*	
5.6	Transformations on the cartesian plane: translation, reflection, rotation, enlargement (dilation). Description of a translation using column vectors.	Representing and describing transformations.
5.7	*Extended Curriculum only.*	
5.8	*Extended Curriculum only.*	

5.	Transformations and vectors—Extended curriculum	Notes / Examples
5.1	Vector notation: **a**; directed line segment $\overrightarrow{AB}$; component form $\begin{pmatrix} x \\ y \end{pmatrix}$ use appropriate symbols for vectors and their magnitudes	e.g., **v**, |**v**|
5.2	Find the components of a vector by subtracting the co-ordinates of an initial point from the co-ordinates of a terminal point. Use position vectors.	See also section 5.6, translations using column vectors.
5.3	Calculate the magnitude of a vector $\begin{pmatrix} x \\ y \end{pmatrix}$ as $\sqrt{(x^2 + y^2)}$.	
5.4	Add and subtract vectors.	Both algebraic (component) and geometric (parallelogram rule) addition/ subtraction. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. Understand vector subtraction **v** – **w** as **v** + (–**w**), where –**w** is the additive inverse of **w**, with the same magnitude as **w** and pointing in the opposite direction.
5.5	Multiply a vector by a scalar.	e.g., $\left\| 3\begin{pmatrix} -4 \\ 3 \end{pmatrix} \right\| = 3(5) = 15$ $c\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} cx \\ cy \end{pmatrix}$ If c|**v**| ≠ 0, the direction of c**v** is either along **v** (for c > 0) or against **v** (for c < 0).
5.6	Transformations on the cartesian plane: translation, reflection, rotation, enlargement (dilation), stretch. Description of a translation using column vectors.	Representing and describing transformations.
5.7	Inverse of a transformation.	
5.8	Combined transformations.	e.g., find the **single** transformation that can replace a rotation of 180° around the origin followed by a translation by vector $\begin{pmatrix} 4 \\ -2 \end{pmatrix}$.

6.	Geometrical measurement—Core curriculum	Notes / Examples
6.1	Units: mm, cm, m, km mm^2, cm^2, m^2, ha, km^2 mm^3, cm^3, ml, cl, l, m^3 g, kg	All units will be metric; conversion between units is expected. Units of time as given in section 1.10.
6.2	Perimeter and area of rectangle, triangle, and compound shapes derived from these. Area of trapezoid and parallelogram.	Formula will be given for area of triangle.
6.3	Circumference and area of a circle. Arc length and area of sector.	Formulae will be given for circumference and area of a circle. From sector angles in degrees and simple examples only.
6.4	Surface area and volume of a prism (in particular, cuboid, and cylinder). Surface area and volume of a sphere.	Formulae will be given for the lateral surface area of cylinder and the surface area of a sphere, and the volume of a prism, a cylinder, and a sphere.
6.5	*Extended Curriculum only.*	
6.6	Use geometric shapes, their measures, and their properties to describe objects.	e.g., modeling a tree trunk or a human torso as a cylinder.
6.7	*Extended Curriculum only.*	
6.8	*Extended Curriculum only.*	
6.9	*Extended Curriculum only.*	

6.	Geometrical measurement—Extended curriculum	Notes / Examples
6.1	Units: mm, cm, m, km mm^2, cm^2, m^2, ha, km^2 mm^3, cm^3, ml, cl, l, m^3 g, kg	All units will be metric; conversion between units expected. Units of time as given in section 1.10.
6.2	Perimeter and area of rectangle, triangle, and compound shapes derived from these. Area of trapezoid and parallelogram.	
6.3	Circumference and area of a circle. Arc length and area of sector.	From sector angles in degrees only.
6.4	Surface area and volume of a prism and a pyramid (in particular, cuboid, cylinder, and cone). Surface area and volume of a sphere.	Formulae will be given for the lateral surface area of a cylinder and a cone, the surface area of a sphere, and the volume of a pyramid, a cone, and a sphere.
6.5	Areas and volumes of compound shapes.	Involving combinations of the shapes in section 6.4.
6.6	Use geometric shapes, their measures, and their properties to describe objects.	e.g., modeling a tree trunk or a human torso as a cylinder.
6.7	Identify the shapes of two-dimensional cross sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.	
6.8	Apply concepts of density based on area and volume in modelling situations.	e.g. persons per square mile, BTUs per cubic foot.
6.9	Apply geometric methods to solve design problems.	e.g., design an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios.

7.	Co-ordinate geometry—Core curriculum	Notes / Examples
7.1	Plotting of points and reading from a graph in the cartesian plane.	
7.2	Distance between two points.	Questions on this topic would be structured via diagrams.
7.3	Midpoint of a line segment.	Questions on this topic would be structured via diagrams.
7.4	Slope of a line segment.	
7.5	Interpret and obtain the equation of a straight line as $y = mx + b$.	e.g., obtain the equation of a straight line graph given a pair of co-ordinates on the line.
7.6	Slope of parallel line. Find the equation of a line parallel to a given line that passes through a given point.	

8.	Trigonometry—Core curriculum	Notes / Examples
8.1	Use trigonometric ratios and the Pythagorean Theorem to solve right-angled triangles in applied problems.	Problems involving bearings may be included. Know angle of elevation and depression.
8.2	*Extended Curriculum only.*	
8.3	*Extended Curriculum only.*	
8.4	*Extended Curriculum only.*	
8.5	*Extended Curriculum only.*	

7.	Co-ordinate geometry—Extended curriculum	Notes / Examples
7.1	Plotting of points and reading from a graph in the cartesian plane.	
7.2	Distance between two points.	e.g., use co-ordinates to compute the perimeters of polygons and areas of triangles using the distance formula.
7.3	Midpoint of a line segment. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.	
7.4	Slope of a line segment.	
7.5	Interpret and obtain the equation of a straight line as $y = mx + b$. Interpret and obtain the equation of a straight line as $ax + by = d$ (a, b, and d are integers)	e.g., obtain the equation of a straight line graph given a pair of co-ordinates on the line.
7.6	Slope of parallel line. Find the equation of a line parallel to a given line that passes through a given point. Slope of perpendicular line. Find the equation of a line perpendicular to a given line that passes through a given point.	Understand and explain how the slopes of parallel and perpendicular lines are related.

8.	Trigonometry—Extended curriculum	Notes / Examples
8.1	Use trigonometric ratios and the Pythagorean Theorem to solve right-angled triangles in applied problems. Know the exact values for the trigonometric ratios of 0°, 30°, 45°, 60°, 90°.	Problems involving bearings may be included. Know angle of elevation and depression.
8.2	Extend sine and cosine values to angles between 0° and 360°. Explain and use the relationship between the sine and cosine of complementary angles. Graph and know the properties of trigonometric functions.	
8.3	Sine Rule.	Formula will be given. ASA, SSA (ambiguous case included where the angle is obtuse).
8.4	Cosine Rule.	Formula will be given. SAS, SSS.
8.5	Area of triangle.	Formula will be given.

9.	Probability—Core curriculum	Notes / Examples
9.1	Probability P(*A*) as a fraction, decimal, or percentage. Significance of its value, including using probabilities to make fair decisions.	Includes an understanding that the probability of an event occurring = 1 – the probability of the event not occurring. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not"). The knowledge and use of set notation is not expected.
9.2	Relative frequency as an estimate of probability.	Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation, e.g., a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?
9.3	Expected number of occurrences.	
9.4	*Extended Curriculum only.*	
9.5	Possibility diagrams. Tree diagrams including successive selection with or without replacement.	Simple cases only.

9.	Probability—Extended curriculum	Notes / Examples
9.1	Probability P(*A*) as a fraction, decimal, or percentage. Significance of its value, including using probabilities to make fair decisions.	Includes an understanding that the probability of an event occurring = 1 – the probability of the event not occurring. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not"). The knowledge and use of set notation is not expected.
9.2	Relative frequency as an estimate of probability.	Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation, e.g., a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?
9.3	Expected number of occurrences.	
9.4	Combining events: Apply the addition rule P(*A* or *B*) = P(*A*) + P(*B*) – P(*A* and *B*) Apply the multiplication rule P(*A* and *B*) = P(*A*) × P(*B*).	Understand that two events are independent if the probability of A and B occurring together is the product of their probabilities and use this characterization to determine if they are independent.
9.5	Possibility diagrams. Tree diagrams including successive selection with or without replacement.	

10.	Statistics—Core curriculum	Notes / Examples
10.1	Reading and interpretation of graphs or tables of data.	
10.2	Discrete and continuous data.	
10.3	Compound bar chart, dot plots, line graph, pie chart, simple frequency distributions, scatter diagram.	
10.4	Mean, mode, median, and range from lists of discrete data.	
10.5	*Extended Curriculum only.*	
10.6	*Extended Curriculum only.*	
10.7	*Extended Curriculum only.*	
10.8	Understanding and description of correlation (positive, negative, or zero) with reference to a scatter diagram. Straight line of best fit (by eye) through the mean on a scatter diagram.	

10.	Statistics—Extended curriculum	Notes / Examples
10.1	Reading and interpretation of graphs or tables of data.	Make inferences to support or cast doubt on initial conjectures; relate results and conclusions to the original question.
10.2	Discrete and continuous data.	
10.3	Compound bar chart, dot plots, line graph, pie chart, simple frequency distributions, scatter diagram.	
10.4	Mean, mode, median, and range from lists of discrete data. Mean, modal class, median, and range from grouped and continuous data.	The term *estimated mean* may be used in questions involving grouped continuous data.
10.5	Histograms with frequency density on the vertical axis.	Includes histograms with unequal class intervals.
10.6	Cumulative frequency table and curve and box plots. Median, quartiles, percentiles, and inter-quartile range.	
10.7	Use and interpret statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (inter-quartile range) of two or more different data sets.	
10.8	Understanding and description of correlation (positive, negative, or zero) with reference to a scatter diagram. Straight line of best fit (by eye) through the mean on a scatter diagram.	

5. Additional Information

5.1 Guided Learning Hours

Cambridge IGCSE syllabi are designed with 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 with the subject.

5.2 Recommended Prerequisites

We recommend that candidates who are beginning this course should have previously studied an appropriate Junior High School mathematics program.

5.3 Progression

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

Candidates who have followed IGCSE 0444 Mathematics (US) will have the prerequisite skills to progress to Cambridge IGCSE 0459 Additional Mathematics (US).

Candidates who are awarded grades C to A* in Cambridge IGCSE Mathematics are well prepared to follow courses leading to Cambridge International AS and A Level Mathematics or the equivalent. Candidates must study the extended curriculum to be able to progress on to Cambridge AS Level Mathematics.

5.4 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.

5.5 Grading and Reporting

Cambridge IGCSE results are shown by one of the grades A*, A, B, C, D, E, F, or G, indicating the standard achieved, Grade A* being the highest and Grade G the lowest. "Ungraded" indicates that the candidate's performance fell short of the standard required for Grade G. "Ungraded" will be reported on the statement of results but not on the certificate.

5.6 Access

Reasonable adjustments are made for disabled candidates in order to enable them to access the assessments and to demonstrate what they know and what they can do. For this reason, very few candidates will have a complete barrier to the assessment. Information on reasonable adjustments is found in the *Cambridge Handbook*, which can be downloaded from the website **www.cie.org.uk**

Candidates who are unable to access part of the assessment, even after exploring all possibilities through reasonable adjustments, may still be able to receive an award based on the parts of the assessment they have taken.

5.7 Support and Resources

Copies of syllabi, the most recent question papers, and Principal Examiners' reports for teachers are on the Syllabus and Support Materials CD-ROM, which we send to all Cambridge International Schools. They are also on our public website—go to **www.cie.org.uk/igcse**. Click the **Subjects** tab and choose your subject. For resources, click "Resource List."

You can use the "Filter by" list to show all resources or only resources categorized as "Endorsed by Cambridge." Endorsed resources are written to align closely with the syllabus they support. They have been through a detailed quality-assurance process. As new resources are published, we review them against the syllabus and publish their details on the relevant resource list section of the website.

Additional syllabus-specific support is available from our secure Teacher Support website **http://teachers.cie.org.uk**, which is available to teachers at registered Cambridge schools. It provides past question papers and examiner reports on previous examinations, as well as any extra resources such as schemes of work (unit lesson plans) or examples of candidate responses. You can also find a range of subject communities on the Teacher Support website, where Cambridge teachers can share their own materials and join discussion groups.

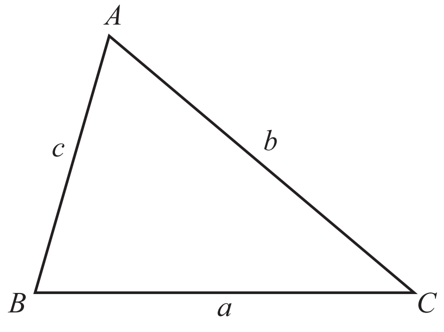
6. Appendix

6.1 Mathematical Formulae for Core Components 1 and 3

Area, A, of triangle, base b, height h.	$A = \frac{1}{2}bh$
Area, A, of circle, radius r.	$A = \pi r^2$
Circumference, C, of circle, radius r.	$C = 2\pi r$
Lateral surface area, A, of cylinder of radius r, height h.	$A = 2\pi rh$
Surface area, A, of sphere of radius r.	$A = 4\pi r^2$
Volume, V, of prism, cross-sectional area A, length l.	$V = Al$
Volume, V, of cylinder of radius r, height h.	$V = \pi r^2 h$
Volume, V, of sphere of radius r.	$V = \frac{4}{3}\pi r^3$

6.2 Mathematical Formulae for Extended Components 2 and 4

For the equation	$ax^2 + bx + c = 0$	$x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
Lateral surface area, A, of cylinder of radius r, height h.		$A = 2\pi rh$
Lateral surface area, A, of cone of radius r, sloping edge l.		$A = \pi rl$
Surface area, A, of sphere of radius r.		$A = 4\pi r^2$
Volume, V, of pyramid, base area A, height h.		$V = \frac{1}{3}Ah$
Volume, V, of cone of radius r, height h.		$V = \frac{1}{3}\pi r^2 h$
Volume, V, of sphere of radius r.		$V = \frac{4}{3}\pi r^3$



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

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

$$\text{Area} = \frac{1}{2}bc \sin A$$

University of Cambridge International Examinations
1 Hills Road, Cambridge, CB1 2EU, United Kingdom
Tel: +44 (0)1223 553554 Fax: +44 (0)1223 553558
Email: international@cie.org.uk www.cie.org.uk

* 1 0 6 2 2 1 8 6 3 8 *