

SYLLABUS

Cambridge IGCSE[®]
Mathematics (US)

0444

For examination in June and November 2019

Changes to syllabus for 2019

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

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

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.

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1. Introduction

1.1 Why Choose Cambridge?

Cambridge International Examinations is part of the University of Cambridge. We prepare school students for life, helping them develop an informed curiosity and a lasting passion for learning. Our international qualifications are recognized by the world's best universities and employers, giving students a wide range of options in their education and career. As a nonprofit organization, we devote our resources to delivering high-quality educational programs that can unlock students' potential.

Our programs set the global standard for international education. They are created by subject experts, are rooted in academic rigor, and provide a strong platform for progression to employment or to other qualifications. Over 10,000 schools in 160 countries work with us to prepare nearly a million students for their future with an international education from Cambridge.

Cambridge Students

Cambridge programs and qualifications develop not only subject knowledge but also skills. We encourage Cambridge students to be:

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

Recognition

Cambridge IGCSE® is recognized by leading universities and employers worldwide, and is an international passport to progression and success. It provides a solid foundation for moving on to higher-level studies. Learn more at www.cie.org.uk/recognition

Support for Teachers

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

Support for Exams Officers

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

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

1.2 Why Choose Cambridge IGCSE?

Cambridge IGCSEs are international in outlook but retain a local relevance. The syllabi provide opportunities for contextualized learning, and the content has been created to suit a wide variety of schools, avoid cultural bias, and develop essential lifelong skills, including creative thinking and problem solving.

Our goal is to balance knowledge, understanding, and skills in our programs 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 IGCSEs, 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 IGCSEs are considered to be an excellent preparation for Cambridge International AS and A Levels, the Cambridge AICE (Advanced International Certificate of Education) Group Award, Cambridge Pre-U, and other education programs, such as the US Advanced Placement program and the International Baccalaureate Diploma program. Learn more about Cambridge IGCSEs at www.cie.org.uk/cambridgesecondary2

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, but this is for guidance only. The number of hours required to gain the qualification may vary according to local curricular practice and the candidates' prior experience with the subject.

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 benefits, 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
- skills in communication and reasoning using mathematical concepts
- a solid foundation for further study.

Prerequisites

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

Progression

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

Candidates who are awarded grades C to A* in Cambridge 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.

1.4 Cambridge ICE (International Certificate of Education)

Cambridge ICE is a group award for Cambridge IGCSE. It gives schools the opportunity to benefit from offering a broad and balanced curriculum by recognizing the achievements of candidates who pass examinations in a number of different subjects.

Learn more about Cambridge ICE at www.cie.org.uk/cambridgesecundary2

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 info@cie.org.uk

If You Are Not Yet a Cambridge School

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

2. Teacher Support

2.1 Support Materials

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

For teachers at registered Cambridge schools a range of additional support materials for specific syllabi is available from Teacher Support, our secure online support for Cambridge teachers. Go to **<https://teachers.cie.org.uk>** (username and password required). If you do not have access, speak to the Teacher Support coordinator at your school.

2.2 Resource Lists

We work with publishers providing a range of resources for our syllabi including print and digital materials. Resources endorsed by Cambridge go through a detailed quality assurance process to ensure they provide a high level of support for teachers and students.

We have resource lists that can be filtered to show all resources, or just those that are endorsed by Cambridge. The resource lists include further suggestions for resources to support teaching. See **www.cie.org.uk/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.cie.org.uk/events** for further information.

3. 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. <i>Grades available: C–G</i>	35%	56	External
2 Written paper 1 hour, 30 minutes Short-answer questions based on the Extended curriculum. Calculators are not permitted. <i>Grades available: A*–E</i>	35%	70	External
3 Written paper 2 hours Structured questions based on the Core curriculum. Electronic calculators are required. [†] <i>Grades available: C–G</i>	65%	104	External
4 Written paper 2 hours, 30 minutes Structured questions based on the Extended curriculum. Electronic calculators are required. [†] <i>Grades available: A*–E</i>	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 June and November examination series.

All Cambridge schools are allocated to one of six administrative zones. Each zone has a specific timetable. This syllabus is not available in all administrative zones. To find out about the availability visit the syllabus page at www.cie.org.uk/igcse

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

4. Syllabus Goals and Assessment Objectives

4.1 Syllabus 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.

4.2 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.

4.3 Grade Descriptions

Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by candidates awarded particular grades. The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of a candidate's performance in the examination may be balanced by a better performance in others.

Grade F

At this level, candidates are expected to identify and obtain necessary information. They would be expected to recognize if their solutions to problems are sensible. An understanding of simple situations should enable candidates to describe them, using symbols, words, and diagrams. They draw simple, basic conclusions with explanations where appropriate.

- With an understanding of place value, candidates should be able to perform calculations using the four rules on positive integers and decimal fractions (one operation only), using a calculator where necessary. They should be able to convert between fractions, decimals, and percentages for the purpose of comparing quantities between 0 and 1 in a variety of forms, and reduce a fraction to its simplest form. Candidates should appreciate the idea of direct proportion, and the solution of simple problems involving ratio should be expected. Basic knowledge of percentage is needed to apply to simple problems involving percentage parts of quantities. They need to understand and apply metric units of length, mass, and capacity, together with conversion between units in these areas of measure. The ability to

recognize and continue a straightforward pattern in sequences and understand the terms multiples, factors, and squares is needed as a foundation to higher grade levels of applications in the areas of number and algebra.

- At this level, the algebra is very basic, involving the construction of simple algebraic expressions, substituting numbers for letters, and evaluating simple formulae. Candidates should appreciate how a simple linear equation can represent a practical situation and be able to solve such equations.
- Knowledge of names and recognition of simple plane figures and common solids is basic to an understanding of shape and space. This will be applied to the perimeter and area of a rectangle and other rectilinear shapes. The skill of using geometrical instruments, ruler, protractor, and compasses is required for applying to measuring lengths and angles and drawing a triangle given three sides.
- Candidates should be familiar with reading data from a variety of sources and be able to extract data from them, in particular timetables. The tabulation of the data is expected in order to form frequency tables and draw a bar chart. They will need the skill of plotting given points on a graph. From a set of numbers, they should be able to calculate the mean.

Grade C

At this level, candidates are expected to show some insight into the mathematical structures of problems, which enables them to justify generalizations, arguments, or solutions. Mathematical presentation and stages of derivations should be more extensive in order to generate fuller solutions. They should appreciate the difference between mathematical explanation and experimental evidence.

- Candidates should now apply the four rules of number to positive and negative integers, fractions, and decimal fractions, in order to solve problems. Percentage should be extended to problems involving calculating one quantity as a percentage of another and its application to percentage change. Calculations would now involve several operations and allow candidates to demonstrate fluent and efficient use of calculators, as well as giving reasonable approximations. The relationship between decimal and standard form of a number should be appreciated and applied to positive and negative powers of 10. They should be familiar with the differences between simple and compound interest and apply this to calculating both.
- Candidates now need to extend their basic knowledge of sequences to recognize, and in simple cases formulate, rules for generating a pattern or sequence. While extending the level of difficulty of solving linear equations by involving appropriate algebraic manipulation, candidates are also expected to solve simple systems of equations in two unknowns. Work with formulae extends into harder substitution and evaluating the remaining term, as well as transforming simple formulae. The knowledge of basic algebra is extended to the use of parentheses and common factor factorization. On graph work, candidates should be able to plot points from given values and use them to draw and interpret algebraic graphs of linear and quadratic functions.
- Candidates are expected to extend perimeter and area beyond rectilinear shapes to circles. They are expected to appreciate and use area and volume units in relation to finding the volume and surface area of a prism and cylinder. The basic construction work, with appropriate geometrical instruments, should now be extended and applied to accurate scale diagrams to solve a two-dimensional problem. The Pythagorean Theorem and trigonometry of right-angled triangles should be understood and applied to solving, by calculation, problems in a variety of contexts. The calculation of angles in a variety of geometrical figures, including polygons and to some extent circles, should be expected from straightforward diagrams.
- Candidates should be able to use a frequency table to construct a pie chart. They need to understand and construct a scatter diagram and apply this to a judgment of the correlation existing between two quantities.

Grade A

At this level, candidates should make clear, concise, and accurate statements, demonstrating ease and confidence in the use of symbolic forms and accuracy of arithmetic manipulation. They should apply the mathematics they know in familiar and unfamiliar contexts.

- Candidates should understand and use direct and inverse proportion. A further understanding of percentages should be evident by relating percentage change to change to a multiplying factor and vice versa, e.g., multiplication by 1.03 results in a 3% increase.
- Knowledge of the four rules for fractions should be applied to the simplification of algebraic fractions. Building on their knowledge of algebraic manipulation, candidates should be able to manipulate linear and quadratic equations and systems of linear equations. They should be able to use positive, negative, and fractional exponents in both numerical and algebraic work, and interpret the description of a situation in terms of algebraic formulae and equations. Their knowledge of graphs of algebraic functions should be extended to the intersections and slopes of these graphs.
- The basic knowledge of scale factors should be extended to two and three dimensions and applied to calculating lengths, areas, and volumes between actual values and scale models. The basic right-angled trigonometry knowledge should be extended to an understanding of and solving problems on non-right-angled triangles.
- At this level, candidates should be able to process data, discriminating between necessary and redundant information.

5. 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	<p>Knowledge of: natural numbers, integers (positive, negative, and zero), prime numbers, square numbers, rational and irrational numbers, real numbers.</p> <p>Use of symbols: =, ≠, ≤, ≥, <, ></p>	
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	<p>Understand and use the language and notation of fractions, decimals, and percentages; recognize equivalences between decimals, fractions, ratios, and percentages and convert between them.</p> <p>Order quantities given in different forms by magnitude, by first converting into same form.</p>	
1.6	Percentages, including applications such as interest and profit.	Excludes reverse percentages. Includes both simple and compound interest.
1.7	<p>Meaning and calculation of exponents (powers, indices) including positive, negative, and zero exponents.</p> <p>Explain the definition of radical exponents as an extension to integral exponents.</p> <p>Explain the rules for exponents.</p> <p>Scientific notation (Standard Form) $a \times 10^n$ where $1 \leq a < 10$ and n is an integer.</p>	<p>e.g., work out 4^{-3} as a fraction.</p> <p>e.g., work out $2^4 \times 2^{-3}$</p> <p>Convert numbers in and out of scientific notation. Calculate with values in scientific notation.</p>

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: =, ≠, ≤, ≥, <, >	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 $1 \leq a < 10$ 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	<p>Use units to understand problems and guide the solution to multi-step problems.</p> <p>Quantities—choose and interpret units and scales, define appropriate quantities (including money).</p> <p>Estimating, rounding, decimal places, and significant figures—choose a level of accuracy appropriate for a problem.</p>	<p>Also relates to graphs and geometrical measurement topics.</p> <p>Includes converting between units, e.g., different currencies.</p> <p>Use estimation to check answers and consider whether the answer is reasonable in the context of the problem.</p>
1.10	Calculations involving time: seconds (s), minutes (min), hours (h), days, months, years including the relation between consecutive units.	<p>1 year = 365 days.</p> <p>Includes familiarity with both 24-hour and 12-hour clocks and extraction of data from dials and schedules.</p>
1.11	Speed, distance, time problems.	

2.	Algebra – Core curriculum	Notes / Examples
2.1	<i>Extended Curriculum only.</i>	
2.2	<i>Extended Curriculum only.</i>	
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 exponents with negative exponents. 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: <ul style="list-style-type: none"> • $p = rt - q$ • $w = \frac{r-t}{y}$ e.g., when $x = -3$ and $y = 4$, find the value of xy^2 .
2.6	Create and solve systems of 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 $-7 \leq 3n - 1 < 5$
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 exponents with negative and fractional exponents. 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 exponents or cases where the subject appears twice. e.g., make r the subject of <ul style="list-style-type: none"> • $V = \frac{4}{3}\pi r^3$ • $p = \frac{2r-3}{r+s}$ 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 systems of 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	<i>Extended Curriculum only.</i>	
2.11	<i>Extended Curriculum only.</i>	
2.12	<i>Extended Curriculum only.</i>	
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: <ul style="list-style-type: none"> • 5 9 13 17 21 • 2 4 8 16 32
2.14	<i>Extended Curriculum only.</i>	

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: <ul style="list-style-type: none"> • 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	<i>Extended Curriculum only.</i>	
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—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	<i>Extended Curriculum only.</i>	
3.8	<i>Extended Curriculum only.</i>	
3.9	<i>Extended Curriculum only.</i>	
3.10	<i>Extended Curriculum only.</i>	
3.11	<i>Extended Curriculum only.</i>	
3.12	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.	Where k is an integer.
3.13	<i>Extended Curriculum only.</i>	

3.	Functions—Extended 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	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.	e.g., average speed between 2 points e.g., use a tangent to the curve to find the slope										
3.8	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 $a > 1$	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.										
3.9	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).	e.g., find the function or equation for the relationship between x and y <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td style="padding: 0 5px;">x</td><td style="border-left: 1px solid black; padding: 0 5px;">-2</td><td style="border-left: 1px solid black; padding: 0 5px;">0</td><td style="border-left: 1px solid black; padding: 0 5px;">2</td><td style="border-left: 1px solid black; padding: 0 5px;">4</td></tr><tr><td style="padding: 0 5px;">y</td><td style="border-left: 1px solid black; padding: 0 5px;">3</td><td style="border-left: 1px solid black; padding: 0 5px;">5</td><td style="border-left: 1px solid black; padding: 0 5px;">7</td><td style="border-left: 1px solid black; padding: 0 5px;">9</td></tr></table>	x	-2	0	2	4	y	3	5	7	9
x	-2	0	2	4								
y	3	5	7	9								
3.10	Simplification of formulae for composite functions such as $f(g(x))$ where $g(x)$ is a linear expression.	e.g., $f(x) = 6 + 2x$, $g(x) = 7x$, $f(g(x)) = 6 + 2(7x) = 6 + 14x$										
3.11	Inverse function f^{-1} .	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.										
3.12	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.	Where k is an integer.										
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 $y > 3$, $2x + y < 12$, $y \leq x$.										

4.	Geometry – Core 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.	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.
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.	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.
4.5	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.	Geometry – Core curriculum	Notes / Examples
4.6	Vocabulary of circles. Properties of circles: <ul style="list-style-type: none">• 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	<i>Extended Curriculum only.</i>	

4.	Geometry – Extended curriculum	Notes / Examples
4.6	Vocabulary of circles. Properties of circles: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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. Recognize 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 \overline{AB} ; component form $\begin{pmatrix} x \\ y \end{pmatrix}$	
5.2	<i>Extended Curriculum only.</i>	
5.3	<i>Extended Curriculum only.</i>	
5.4	<i>Extended Curriculum only.</i>	
5.5	<i>Extended Curriculum only.</i>	
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	<i>Extended Curriculum only.</i>	
5.8	<i>Extended Curriculum only.</i>	

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., \mathbf{v} , $ \mathbf{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 $\mathbf{v} - \mathbf{w}$ as $\mathbf{v} + (-\mathbf{w})$, where $-\mathbf{w}$ is the additive inverse of \mathbf{w} , with the same magnitude as \mathbf{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 $c \mathbf{v} \neq 0$, the direction of $c\mathbf{v}$ is either along \mathbf{v} (for $c > 0$) or against \mathbf{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	<i>Extended Curriculum only.</i>	
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	<i>Extended Curriculum only.</i>	
6.8	<i>Extended Curriculum only.</i>	
6.9	<i>Extended Curriculum only.</i>	

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 modeling 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	<i>Extended Curriculum only.</i>	
8.3	<i>Extended Curriculum only.</i>	
8.4	<i>Extended Curriculum only.</i>	
8.5	<i>Extended Curriculum only.</i>	

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 (Law of Sines).	Formula will be given. ASA, SSA (ambiguous case included where the angle is obtuse).
8.4	Cosine Rule (Law of Cosines).	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	<i>Extended Curriculum only.</i>	
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 $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$ Apply the multiplication rule $P(A \text{ and } B) = P(A) \times P(B)$.	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	<i>Extended Curriculum only.</i>	
10.6	<i>Extended Curriculum only.</i>	
10.7	<i>Extended Curriculum only.</i>	
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 <i>estimated mean</i> 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.	

6. Other Information

Equality and Inclusion

Cambridge International Examinations has taken great care in the preparation of this syllabus and assessment materials to avoid bias of any kind. To comply with the UK Equality Act (2010), Cambridge has designed this qualification with the goal 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 to if they give candidates an unfair advantage over others or if they compromise the standards being assessed.

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

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

Language

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

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, A* being the highest and 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. The letters Q (result pending), X (no results), and Y (to be issued) may also appear on the statement of results but not on the certificate.

Entry Codes

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

7. Appendix

7.1 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 $ax^2 + bx + c = 0$ $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Lateral surface area, A , of cylinder of radius r , height h . $A = 2\pi rh$

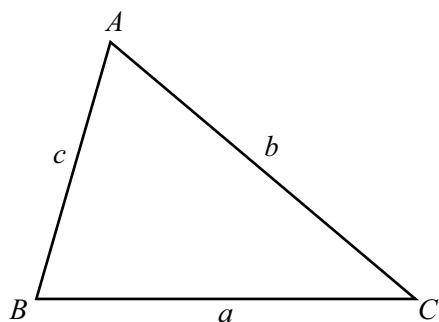
Lateral surface area, A , of cone of radius r , sloping edge l . $A = \pi rl$

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 . $V = \frac{4}{3}\pi r^3$



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

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

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

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