Content overview

All candidates will study the following topics:

1 Functions
2 Quadratic functions
3 Equations, inequalities and graphs
4 Indices and surds
5 Factors of polynomials
6 Simultaneous equations
7 Logarithmic and exponential functions
8 Straight line graphs
9 Circular measure
10 Trigonometry
11 Permutations and combinations
12 Series
13 Vectors in two dimensions
14 Differentiation and integration

The content of Cambridge O Level Mathematics is assumed as prerequisite knowledge for this qualification.

Calculators

The syllabus assumes that candidates will be in possession of a scientific calculator for both papers.

Candidates must show all necessary working; no marks will be given to unsupported answers from a calculator.

Non-exact numerical answers will be required to be given correct to three significant figures, or one decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

Mathematical notation

The list of mathematical notation that may be used in examinations for this syllabus is available on our website at **www.cambridgeinternational.org/4037**

Support for Cambridge O Level Additional Mathematics

Our School Support Hub **www.cambridgeinternational.org/support** provides Cambridge schools with a secure site for downloading specimen and past question papers, mark schemes, grade thresholds and other curriculum resources specific to this syllabus. The School Support Hub community offers teachers the opportunity to connect with each other and to ask questions related to the syllabus.

3 Subject content

Knowledge of the content of Cambridge O Level Mathematics (or an equivalent syllabus) is assumed.

Cambridge O Level material which is not included in the subject content will not be tested directly but it may be required in response to questions on other topics.

Proofs of results will not be required unless specifically mentioned in the syllabus.

Candidates will be expected to be familiar with the scientific notation for the expression of compound units, e.g. $5\,\text{ms}^{-1}$ for 5 metres per second.

1 Functions

- understand the terms: function, domain, range (image set), one-one function, inverse function and composition of functions
- use the notation $\text{f}(x) = \sin x$, $\text{f}: x \mapsto \lg x$, $(x > 0)$, $\text{f}^{-1}(x)$ and $\text{f}^2(x)$ $[= \text{f}(\text{f}(x))]$
- understand the relationship between $y = \text{f}(x)$ and $y = |\text{f}(x)|$, where $\text{f}(x)$ may be linear, quadratic or trigonometric
- explain in words why a given function is a function or why it does not have an inverse
- find the inverse of a one-one function and form composite functions
- use sketch graphs to show the relationship between a function and its inverse

2 Quadratic functions

- find the maximum or minimum value of the quadratic function $\text{f}: x \mapsto ax^2 + bx + c$ by any method
- use the maximum or minimum value of $\text{f}(x)$ to sketch the graph or determine the range for a given domain
- know the conditions for $\text{f}(x) = 0$ to have:
  (i) two real roots, (ii) two equal roots, (iii) no real roots
  and the related conditions for a given line to
  (i) intersect a given curve, (ii) be a tangent to a given curve, (iii) not intersect a given curve
- solve quadratic equations for real roots and find the solution set for quadratic inequalities

3 Equations, inequalities and graphs

- solve graphically or algebraically equations of the type $|ax + b| = c$ $(c \geqslant 0)$ and $|ax + b| = |cx + d|$
- solve graphically or algebraically inequalities of the type $|ax + b| > c$ $(c \geqslant 0)$, $|ax + b| \leqslant c$ $(c > 0)$ and $|ax + b| \leqslant |cx + d|$
- use substitution to form and solve a quadratic equation in order to solve a related equation
- sketch the graphs of cubic polynomials and their moduli, when given in factorised form $y = k(x - a)(x - b)(x - c)$
- solve cubic inequalities in the form $k(x - a)(x - b)(x - c) \leqslant d$ graphically

4 Indices and surds

- perform simple operations with indices and with surds, including rationalising the denominator

5 Factors of polynomials

- know and use the remainder and factor theorems
- find factors of polynomials
- solve cubic equations

6 Simultaneous equations

- solve simple simultaneous equations in two unknowns by elimination or substitution

7 Logarithmic and exponential functions

- know simple properties and graphs of the logarithmic and exponential functions including $\ln x$ and e^x (series expansions are not required) and graphs of $ke^{nx} + a$ and $k\ln(ax + b)$ where n, k, a and b are integers
- know and use the laws of logarithms (including change of base of logarithms)
- solve equations of the form $a^x = b$

8 Straight line graphs

- interpret the equation of a straight line graph in the form $y = mx + c$
- transform given relationships, including $y = ax^n$ and $y = Ab^x$, to straight line form and hence determine unknown constants by calculating the gradient or intercept of the transformed graph
- solve questions involving mid-point and length of a line
- know and use the condition for two lines to be parallel or perpendicular, including finding the equation of perpendicular bisectors

9 Circular measure

- solve problems involving the arc length and sector area of a circle, including knowledge and use of radian measure

10 Trigonometry

- know the six trigonometric functions of angles of any magnitude (sine, cosine, tangent, secant, cosecant, cotangent)
- understand amplitude and periodicity and the relationship between graphs of related trigonometric functions, e.g. $\sin x$ and $\sin 2x$
- draw and use the graphs of

  $y = a\sin bx + c$

  $y = a\cos bx + c$

  $y = a\tan bx + c$

  where a is a positive integer, b is a simple fraction or integer (fractions will have a denominator of 2, 3, 4, 6 or 8 only), and c is an integer
- use the relationships

  $\sin^2 A + \cos^2 A = 1$

  $\sec^2 A = 1 + \tan^2 A$, $\operatorname{cosec}^2 A = 1 + \cot^2 A$

  $\frac{\sin A}{\cos A} = \tan A$, $\frac{\cos A}{\sin A} = \cot A$
- solve simple trigonometric equations involving the six trigonometric functions and the above relationships (not including general solution of trigonometric equations)
- prove simple trigonometric identities

11 Permutations and combinations

- recognise and distinguish between a permutation case and a combination case
- know and use the notation $n!$ (with $0! = 1$), and the expressions for permutations and combinations of n items taken r at a time
- answer simple problems on arrangement and selection (cases with repetition of objects, or with objects arranged in a circle, or involving both permutations and combinations, are excluded)

12 Series

- use the Binomial Theorem for expansion of $(a + b)^n$ for positive integer n
- use the general term $\binom{n}{r}a^{n-r}b^r$, $0 \leqslant r \leqslant n$ (knowledge of the greatest term and properties of the coefficients is not required)
- recognise arithmetic and geometric progressions
- use the formulae for the nth term and for the sum of the first n terms to solve problems involving arithmetic or geometric progressions
- use the condition for the convergence of a geometric progression, and the formula for the sum to infinity of a convergent geometric progression

13 Vectors in two dimensions

- use vectors in any form, e.g. $\begin{pmatrix} a \\ b \end{pmatrix}$, $\overrightarrow{AB}$, $\mathbf{p}$, $a\mathbf{i} - b\mathbf{j}$
- know and use position vectors and unit vectors
- find the magnitude of a vector; add and subtract vectors and multiply vectors by scalars
- compose and resolve velocities

14 Differentiation and integration

- understand the idea of a derived function
- use the notations $\mathrm{f}'(x)$, $\mathrm{f}''(x)$, $\frac{\mathrm{d}y}{\mathrm{d}x}$, $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$ $\left[= \frac{\mathrm{d}}{\mathrm{d}x}\left(\frac{\mathrm{d}y}{\mathrm{d}x}\right)\right]$
- use the derivatives of the standard functions x^n (for any rational n), $\sin x$, $\cos x$, $\tan x$, e^x, $\ln x$, together with constant multiples, sums and composite functions of these
- differentiate products and quotients of functions
- apply differentiation to gradients, tangents and normals, stationary points, connected rates of change, small increments and approximations and practical maxima and minima problems
- use the first and second derivative tests to discriminate between maxima and minima
- understand integration as the reverse process of differentiation
- integrate sums of terms in powers of x including $\frac{1}{x}$ and $\frac{1}{ax+b}$
- integrate functions of the form $(ax+b)^n$ for any rational n, $\sin(ax+b)$, $\cos(ax+b)$, e^{ax+b}
- evaluate definite integrals and apply integration to the evaluation of plane areas
- apply differentiation and integration to kinematics problems that involve displacement, velocity and acceleration of a particle moving in a straight line with variable or constant acceleration, and the use of x–t and v–t graphs

4 Details of the assessment

All candidates will take **two** written papers.

Candidates must show all necessary working; no marks will be given to unsupported answers from a calculator.

Paper 1

2 hours, 80 marks
Candidates answer **all** questions.
This paper consists of questions of various lengths.
Electronic calculators are required.
This is a compulsory component for all candidates.
This written paper is an externally set assessment, marked by Cambridge International.

Paper 2

2 hours, 80 marks
Candidates answer **all** questions.
This paper consists of questions of various lengths.
Electronic calculators are required.
This is a compulsory component for all candidates.
This written paper is an externally set assessment, marked by Cambridge International.

Each paper includes the formulae list.

List of formulae

1. ALGEBRA

Quadratic Equation

For the equation $ax^2 + bx + c = 0$,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Binomial Theorem

$$(a+b)^n = a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \ldots + \binom{n}{r}a^{n-r}b^r + \ldots + b^n$$

where n is a positive integer and $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series

$$u_n = a + (n-1)d$$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series

$$u_n = ar^{n-1}$$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$
$$\sec^2 A = 1 + \tan^2 A$$
$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

Formulae for ΔABC

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

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

$$\Delta = \frac{1}{2}bc\sin A$$

Command words

This glossary should help candidates understand what is expected when responding to questions in the assessment. The number of marks allocated for any part of a question is a guide to the depth required for the answer.

Command word	What it means
Calculate	work out from given facts, figures or information, generally using a calculator
Describe	state the points of a topic/give characteristics and main features
Determine	establish with certainty
Explain	set out purposes or reasons/ make the relationships between things evident/provide why and/or how and support with relevant evidence
Give	produce an answer from a given source or recall/memory
Plot	mark point(s) on a graph
Show (that)	provide structured evidence that leads to a given result
Sketch	make a simple freehand drawing showing the key features
State	express in clear terms
Verify	confirm a given statement/result is true
Work out	calculate from given facts, figures or information with or without the use of a calculator
Write	give an answer in a specific form
Write down	give an answer without significant working