



Cambridge Assessment
International Education

Notation List

**For Cambridge International Mathematics
Qualifications**

For use from 2020

Mathematical notation

Examinations for CIE syllabuses may use relevant notation from the following list.

1 Set notation

\in	is an element of
\notin	is not an element of
$\{x_1, x_2, \dots\}$	the set with elements x_1, x_2, \dots
$\{x : \dots\}$	the set of all x such that ...
$n(A)$	the number of elements in set A
\emptyset	the empty set
\mathcal{E}	the universal set
\cup	the universal set (for 0607 IGCSE International Mathematics)
A'	the complement of the set A
\mathbb{N}	the set of natural numbers, $\{1, 2, 3, \dots\}$
\mathbb{Z}	the set of integers, $\{0, \pm 1, \pm 2, \pm 3, \dots\}$
\mathbb{Q}	the set of rational numbers, $\left\{\frac{p}{q} : p, q \in \mathbb{Z}, q \neq 0\right\}$
\mathbb{R}	the set of real numbers
\mathbb{C}	the set of complex numbers
(x, y)	the ordered pair x, y
\subseteq	is a subset of
\subset	is a proper subset of
\cup	union
\cap	intersection
$[a, b]$	the closed interval $\{x \in \mathbb{R} : a \leq x \leq b\}$
$[a, b)$	the interval $\{x \in \mathbb{R} : a \leq x < b\}$
$(a, b]$	the interval $\{x \in \mathbb{R} : a < x \leq b\}$
(a, b)	the open interval $\{x \in \mathbb{R} : a < x < b\}$
(S, \circ)	the group consisting of the set S with binary operation \circ

2 Miscellaneous symbols

$=$	is equal to
\neq	is not equal to
\equiv	is identical to or is congruent to
\approx	is approximately equal to
\sim	is distributed as
\cong	is isomorphic to
\propto	is proportional to
$<$	is less than
\leq	is less than or equal to
$>$	is greater than
\geq	is greater than or equal to
∞	infinity
\Rightarrow	implies
\Leftarrow	is implied by
\Leftrightarrow	implies and is implied by (is equivalent to)

3 Operations

$a + b$	a plus b
$a - b$	a minus b
$a \times b, ab$	a multiplied by b
$a \div b, \frac{a}{b}$	a divided by b
$\sum_{i=1}^n a_i$	$a_1 + a_2 + \dots + a_n$
\sqrt{a}	the non-negative square root of a , for $a \in \mathbb{R}, a \geq 0$
$\sqrt[n]{a}$	the (real) n th root of a , for $a \in \mathbb{R}$, where $\sqrt[n]{a} \geq 0$ for $a \geq 0$
$ a $	the modulus of a
$n!$	n factorial
$\binom{n}{r}$	the binomial coefficient $\frac{n!}{r!(n-r)!}$ for $n, r \in \mathbb{Z}$ and $0 \leq r \leq n$

4 Functions

$f(x)$	the value of the function f at x
$f: A \rightarrow B$	f is a function under which each element of set A has an image in set B
$f: x \mapsto y$	the function f maps the element x to the element y
f^{-1}	the inverse function of the one-one function f
gf	the composite function of f and g which is defined by $gf(x) = g(f(x))$
$\lim_{x \rightarrow a} f(x)$	the limit of $f(x)$ as x tends to a
$\Delta x, \delta x$	an increment of x
$\frac{dy}{dx}$	the derivative of y with respect to x
$\frac{d^n y}{dx^n}$	the n th derivative of y with respect to x
$f'(x), f''(x), \dots, f^{(n)}(x)$	the first, second, \dots , n th derivatives of $f(x)$ with respect to x
$\int y \, dx$	the indefinite integral of y with respect to x
$\int_a^b y \, dx$	the definite integral of y with respect to x between the limits $x = a$ and $x = b$
\dot{x}, \ddot{x}, \dots	the first, second, \dots derivatives of x with respect to t

5 Exponential and logarithmic functions

e	base of natural logarithms
$e^x, \exp(x)$	exponential function of x
$\log_a x$	logarithm to the base a of x
$\ln x$	natural logarithm of x
$\lg x, \log_{10} x$	logarithm of x to base 10

6 Circular and hyperbolic functions

$\left. \begin{array}{l} \sin, \cos, \tan \\ \operatorname{cosec}, \sec, \cot \end{array} \right\}$	the circular functions
$\left. \begin{array}{l} \sin^{-1}, \cos^{-1}, \tan^{-1} \\ \operatorname{cosec}^{-1}, \sec^{-1}, \cot^{-1} \end{array} \right\}$	the inverse circular functions
$\left. \begin{array}{l} \sinh, \cosh, \tanh \\ \operatorname{cosech}, \operatorname{sech}, \operatorname{coth} \end{array} \right\}$	the hyperbolic functions
$\left. \begin{array}{l} \sinh^{-1}, \cosh^{-1}, \tanh^{-1} \\ \operatorname{cosech}^{-1}, \operatorname{sech}^{-1}, \operatorname{coth}^{-1} \end{array} \right\}$	the inverse hyperbolic functions

7 Complex numbers

i	the imaginary unit, $i^2 = -1$
z	a complex number, $z = x + iy = r(\cos \theta + i \sin \theta)$
$\operatorname{Re} z$	the real part of z , $\operatorname{Re} z = x$
$\operatorname{Im} z$	the imaginary part of z , $\operatorname{Im} z = y$
$ z $	the modulus of z , $ z = \sqrt{x^2 + y^2}$
$\arg z$	the argument of z , $\arg z = \theta$ where $-\pi < \theta \leq \pi$
z^*	the complex conjugate of z , $x - iy$

8 Matrices

\mathbf{M}	a matrix \mathbf{M}
\mathbf{M}^{-1}	the inverse of the non-singular square matrix \mathbf{M}
$\det \mathbf{M}$, $ \mathbf{M} $	the determinant of the square matrix \mathbf{M}
\mathbf{I}	an identity (or unit) matrix

9 Vectors

\mathbf{a}	the vector \mathbf{a}
\overline{AB}	the vector represented in magnitude and direction by the directed line segment AB
$\hat{\mathbf{a}}$	a unit vector in the direction of \mathbf{a}
$\mathbf{i}, \mathbf{j}, \mathbf{k}$	unit vectors in the directions of the Cartesian coordinate axes
$\begin{pmatrix} x \\ y \end{pmatrix}, \begin{pmatrix} x \\ y \\ z \end{pmatrix}$	the vectors $x\mathbf{i} + y\mathbf{j}$ (in 2 dimensions) and $x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$ (in 3 dimensions)
$ \mathbf{a} , a$	the magnitude of \mathbf{a}
$ \overline{AB} , AB$	the magnitude of \overline{AB}
$\mathbf{a} \cdot \mathbf{b}$	the scalar product of \mathbf{a} and \mathbf{b}
$\mathbf{a} \times \mathbf{b}$	the vector product of \mathbf{a} and \mathbf{b}

10 Probability and statistics

A, B, C, \dots	events
$A \cup B$	union of the events A and B
$A \cap B$	intersection of the events A and B
$P(A)$	probability of the event A
A'	complement of the event A
$P(A B)$	probability of the event A conditional on the event B
${}^n C_r$	the number of combinations of r objects from n , ${}^n C_r = \binom{n}{r} = \frac{n!}{r!(n-r)!}$
${}^n P_r$	the number of permutations of r objects from n , ${}^n P_r = \frac{n!}{(n-r)!}$
X, Y, R, \dots	random variables
x, y, r, \dots	values of the random variables X, Y, R, \dots
x_1, x_2, \dots	observations
f_1, f_2, \dots	frequencies with which the observations x_1, x_2, \dots occur
$p(x)$	probability function $P(X = x)$ of the discrete random variable X
p_1, p_2, \dots	probabilities of the values x_1, x_2, \dots of the discrete random variable X
$f(x)$	value of the probability density function of a continuous random variable X
$F(x)$	value of the cumulative distribution function of a continuous random variable X
$E(X)$	expectation of the random variable X
$E(g(X))$	expectation of $g(X)$
$\text{Var}(X)$	variance of the random variable X
$G_X(t)$	probability generating function for the discrete random variable X
$M_X(t)$	moment generating function for the random variable X
$B(n, p)$	binomial distribution with parameters n and p
$\text{Geo}(p)$	geometric distribution with parameter p
$\text{Po}(\lambda)$	Poisson distribution with parameter λ
$N(\mu, \sigma^2)$	normal distribution with mean μ and variance σ^2
μ	population mean
σ^2	population variance
σ	population standard deviation
\bar{x}	sample mean, $\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i$
s^2	unbiased estimate of population variance from a sample, $s^2 = \frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2$
ρ	product moment correlation coefficient for a population
r	product moment correlation coefficient for a sample
ϕ	probability density function of the standardised normal variable $Z \sim N(0, 1)$
Φ	cumulative distribution function of the standardised normal variable $Z \sim N(0, 1)$
H_0, H_1	null and alternative hypotheses for a hypothesis test