Glossary of command terms

Command terms for Mathematics: analysis and approaches

Students should be familiar with the following key terms and phrases used in examination questions, which are to be understood as described below. Although these terms will be used frequently in examination questions, other terms may be used to direct students to present an argument in a specific way.

Command term	Definition
Calculate	Obtain a numerical answer showing the relevant stages in the working.
Comment	Give a judgment based on a given statement or result of a calculation.
Compare	Give an account of the similarities between two (or more) items or situations, referring to both (all) of them throughout.
Compare and contrast	Give an account of similarities and differences between two (or more) items or situations, referring to both (all) of them throughout.
Construct	Display information in a diagrammatic or logical form.
Contrast	Give an account of the differences between two (or more) items or situations, referring to both (all) of them throughout.
Deduce	Reach a conclusion from the information given.
Demonstrate	Make clear by reasoning or evidence, illustrating with examples or practical application.
Describe	Give a detailed account.
Determine	Obtain the only possible answer.
Differentiate	Obtain the derivative of a function.
Distinguish	Make clear the differences between two or more concepts or items.
Draw	Represent by means of a labelled, accurate diagram or graph, using a pencil. A ruler (straight edge) should be used for straight lines. Diagrams should be drawn to scale. Graphs should have points correctly plotted (if appropriate) and joined in a straight line or smooth curve.
Estimate	Obtain an approximate value.
Explain	Give a detailed account including reasons or causes.
Find	Obtain an answer showing relevant stages in the working.
Hence	Use the preceding work to obtain the required result.
Hence or otherwise	It is suggested that the preceding work is used, but other methods could also receive credit.
Identify	Provide an answer from a number of possibilities.
Integrate	Obtain the integral of a function.

Command term	Definition
Interpret	Use knowledge and understanding to recognize trends and draw conclusions from given information.
Investigate	Observe, study, or make a detailed and systematic examination, in order to establish facts and reach new conclusions.
Justify	Give valid reasons or evidence to support an answer or conclusion.
Label	Add labels to a diagram.
List	Give a sequence of brief answers with no explanation.
Plot	Mark the position of points on a diagram.
Predict	Give an expected result.
Prove	Use a sequence of logical steps to obtain the required result in a formal way.
Show	Give the steps in a calculation or derivation.
Show that	Obtain the required result (possibly using information given) without the formality of proof. "Show that" questions do not generally require the use of a calculator.
Sketch	Represent by means of a diagram or graph (labelled as appropriate). The sketch should give a general idea of the required shape or relationship, and should include relevant features.
Solve	Obtain the answer(s) using algebraic and/or numerical and/or graphical methods.
State	Give a specific name, value or other brief answer without explanation or calculation.
Suggest	Propose a solution, hypothesis or other possible answer.
Verify	Provide evidence that validates the result.
Write down	Obtain the answer(s), usually by extracting information. Little or no calculation is required. Working does not need to be shown.

Notation list

There are various systems of notation in use, and the IB has chosen to adopt a system based on the recommendations of the International Organization for Standardization (ISO). This notation is used in the examination papers for this course without explanation. If forms of notation other than those listed in this guide are used on a particular examination paper, they are defined within the question in which they appear.

Because students are required to recognize, though not necessarily use, IB notation in examinations, it is recommended that teachers introduce students to this notation at the earliest opportunity. Students are **not** allowed access to information about this notation in the examinations.

Students must always use correct mathematical notation, not calculator notation.

SL and HL

$\mathbb{N}$	the set of positive integers and zero, $\{0,\ 1,\ 2,\ 3,\ ...\}$
$\mathbb{Z}$	the set of integers, $\{0,\ \pm 1,\ \pm 2,\ \pm 3,\ ...\}$
$\mathbb{Z}^+$	the set of positive integers, $\{1,\ 2,\ 3,\ ...\}$
$\mathbb{Q}$	the set of rational numbers
$\mathbb{Q}^+$	the set of positive rational numbers, $\{x \mid x \in \mathbb{Q},\ x > 0\}$
$\mathbb{R}$	the set of real numbers
$\mathbb{R}^+$	the set of positive real numbers, $\{x \mid x \in \mathbb{R},\ x > 0\}$
$\{x_1,\ \ x_2,\ \ \ldots\}$	the set with elements $x_1,\ x_2,\ ...$
$n(A)$	the number of elements in the finite set A
$\{x \mid \quad\}$	the set of all x such that
$\in$	is an element of
$\notin$	is not an element of
$\varnothing$	the empty (null) set
U	the universal set
$\cup$	union
$\cap$	intersection
A'	the complement of the set A
$a^{1/2}, \sqrt{a}$	a to the power $\frac{1}{2}$, square root of a (if $a \geq 0$ then $\sqrt{a} \geq 0$)
$a^{1/n}, \sqrt[n]{a}$	a to the power of $\frac{1}{n}$, n^{th} root of a (if $a \geq 0$ then $\sqrt[n]{a} \geq 0$)
$a^{-n} = \frac{1}{a^n}$	a to the power of $-n$, reciprocal of a^n
$\lvert x \rvert$	the modulus or absolute value of x, that is $\begin{cases} x & \text{for } x \geq 0,\ x \in \mathbb{R} \\ -x & \text{for } x < 0,\ x \in \mathbb{R} \end{cases}$

$\equiv$	identity
$\approx$	is approximately equal to
$>$	is greater than
$\geq$	is greater than or equal to
$<$	is less than
$\leq$	is less than or equal to
$\not>$	is not greater than
$\not<$	is not less than
$\Rightarrow$	implies
$\Leftrightarrow$	implies and is implied by
u_n	the n^{th} term of a sequence or series
d	the common difference of an arithmetic sequence
r	the common ratio of a geometric sequence
S_n	the sum of the first n terms of a sequence, $u_1 + u_2 + \ldots + u_n$
S_∞	the sum to infinity of a sequence, $u_1 + u_2 + \ldots$
$\sum_{i=1}^{n} u_i$	$u_1 + u_2 + \ldots + u_n$
$n!$	$n(n-1)(n-2)\ldots 3 \times 2 \times 1$
${}^nC_r$	$\frac{n!}{r!(n-r)!}$
Δ	the discriminant of a quadratic equation, $\Delta = b^2 - 4ac$
$f(x)$	the image of x under the function f
f^{-1}	the inverse function of the function f
$f \circ g$	the composite function of f and g
$\frac{dy}{dx}$	the derivative of y with respect to x
$f'(x)$	the derivative of $f(x)$ with respect to x
$\frac{d^2y}{dx^2}$	the second derivative of y with respect to x
$f''(x)$	the second derivative 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 $x = b$
e^x	the exponential function of x
$\log_a x$	the logarithm to the base a of x
$\ln x$	the natural logarithm of x, $\log_e x$
$\sin, \cos, \tan$	the circular functions
$A(x, y)$	the point A in the plane with Cartesian coordinates x and y

[AB]	the line segment with end points A and B
AB	the length of [AB]
(AB)	the line containing points A and B
$\hat{A}$	the angle at A
C$\hat{A}$B	the angle between [CA] and [AB]
Δ ABC	the triangle whose vertices are A, B and C
P(A)	probability of event A
P(A')	probability of the event "not A"
P($A \mid B$)	probability of the event A given B
$x_1, \quad x_2, \quad \ldots$	observations
$f_1, \quad f_2, \quad \ldots$	frequencies with which the observations $x_1, \ x_2, \ \ldots$ occur
E(X)	the expected value of the random variable X
μ	population mean
σ^2	population variance
σ	population standard deviation
$\bar{x}$	the sample mean of a set $\{x_1, x_2, \ldots, x_n\}$ of observations
P($X = x$)	the probability that the random variable X takes the value x
B(n, p)	binomial distribution with parameters n and p
N(μ, σ^2)	normal distribution with mean μ and variance σ^2
X~B(n, p)	the random variable X has a binomial distribution with parameters n and p
X~N(μ, σ^2)	the random variable X has a normal distribution with mean μ and variance σ^2
r	Pearson's product-moment correlation coefficient

AHL only

$\mathbb{C}$	the set of complex numbers, $\{a + b\mathrm{i} \mid a, \ b \in \mathbb{R}\}$
i	$\sqrt{-1}$ where $\mathrm{i}^2 = -1$
z	a complex number
z^*	the complex conjugate of z
$\lvert z \rvert$	the modulus of z
arg$z$	the argument of z
Rez	the real part of z
Imz	the imaginary part of z
cisθ	$\cos\theta + \mathrm{i}\sin\theta$
$\mathrm{e}^{\mathrm{i}\theta}$	Euler/exponential form of a complex number

${}^{n}\mathrm{P}_{r}$	$\frac{n!}{(n-r)!}$
$\Leftarrow$	is implied by
$[a, b]$	the closed interval $a \leq x \leq b$
$]a, b[$	the open interval $a < x < b$
$f: A \to B$	f is a function under which each element of a set A has an image in set B.
$\lim_{x \to a} f(x)$	the limit of $f(x)$ as x tends to a
$\frac{d^n y}{\mathrm{d}x^n}$	the n^{th} derivative of y with respect to x
$f^{(n)}(x)$	the n^{th} derivative of $f(x)$ with respect to x
$\left.\begin{matrix}\arcsin, & \sin^{-1} \\ \arccos, & \cos^{-1} \\ \arctan, & \tan^{-1}\end{matrix}\right\}$	the inverse circular functions
cosec, sec, cot	the reciprocal circular functions
$\boldsymbol{v}$	the vector $\boldsymbol{v}$
$\overrightarrow{\mathrm{AB}}$	the vector represented in magnitude and direction by the directed line segment from A to B
$\boldsymbol{a}$	the position vector $\overrightarrow{\mathrm{OA}}$
$\boldsymbol{i}, \quad \boldsymbol{j}, \quad \boldsymbol{k}$	unit vectors in the directions of the Cartesian coordinate axes
$\lvert\boldsymbol{a}\rvert$	the magnitude of $\boldsymbol{a}$
$\lvert\overrightarrow{\mathrm{AB}}\rvert$	the magnitude of $\overrightarrow{\mathrm{AB}}$
$\boldsymbol{v} \cdot \boldsymbol{w}$	the scalar product of v and $\boldsymbol{w}$
$\boldsymbol{v} \times \boldsymbol{w}$	the vector product of v and w
$f(x)$	the probability density function of the continuous random variable X
$\mathrm{Var}(X)$	the variance of the random variable X