

## Summary of Notations

The following list summarizes the notations that may be used in the Advanced level Mathematics examinations.

- **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
$\mathcal{E}$	universal set
$A'$	the complement of the set $A$
$\mathbb{Z}$	the set of integers, $\{0, \pm 1, \pm 2, \pm 3, \dots\}$
$\mathbb{Z}^+$	the set of positive integers, $\{1, 2, 3, \dots\}$
$\mathbb{Q}$	the set of rational numbers
$\mathbb{Q}^+$	the set of positive rational numbers, $\{x \in \mathbb{Q} : x > 0\}$
$\mathbb{Q}_0^+$	the set of positive rational numbers and zero, $\{x \in \mathbb{Q} : x \geq 0\}$
$\mathbb{R}$	the set of real numbers
$\mathbb{R}^+$	the set of positive real numbers, $\{x \in \mathbb{R} : x > 0\}$
$\mathbb{R}_0^+$	the set of positive real numbers and zero, $\{x \in \mathbb{R} : x \geq 0\}$
$\mathbb{R}^n$	the real $n$ tuples
$\mathbb{C}$	the set of complex numbers
$\subseteq$	is a subset of
$\subset$	is a proper subset of
$\not\subseteq$	is not a subset of
$\not\subset$	is not 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 $\{x \in \mathbb{R} : a < x < b\}$



- **Miscellaneous Symbols**

$=$	is equal to
$\neq$	is not equal to
$\equiv$	is identical to or is congruent to
$\approx$	is approximately equal to
$\propto$	is proportional to
$<$	is less than
$\leq$ ; $\nlessgtr$	is less than or equal to; is not greater than
$>$	is greater than
$\geq$ ; $\ngtr$	is greater than or equal to; or is not less than
$\infty$	infinity

- **Operations**

$a + b$	$a$ plus $b$
$a - b$	$a$ minus $b$
$a \times b$ , $ab$ , $a.b$	$a$ multiplied by $b$
$a \div b$ , $\frac{a}{b}$ , $a/b$	$a$ divided by $b$
$a : b$	the ratio of $a$ to $b$
$\sum_{i=1}^n a_i$	$a_1 + a_2 + \dots + a_n$
$\prod_{i=1}^n a_i$	$a_1 \times a_2 \times \dots \times a_n$
$\sqrt{a}$ , $\sqrt{a}$	the positive square root of the real number $a$
$ a $	the modulus of $a$
$n!$	$n$ factorial [for $n \in \mathbb{N}$ ( $0! = 1$ )]
$\binom{n}{r}$	the binomial coefficient $\frac{n!}{r!(n-r)!}$ for $n, r \in \mathbb{Z}^+$ , $0 \leq r \leq n$ $\frac{n(n-1)\dots(n-r+1)}{r!}$ for $n \in \mathbb{Q}$ , $r \in \mathbb{Z}^+ \cup \{0\}$

- Functions**

$f$	function $f$
$f(x)$	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 of the function $f$
$g \circ f$ or $gf$	the composite function of $f$ and $g$ which is defined by $(g \circ f)(x)$ or $gf(x) = g(f(x))$
$\lim_{x \rightarrow a} f(x)$	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 $n^{\text{th}}$ derivative of $y$ with respect to $x$
$f'(x), f''(x), \dots, f^{(n)}(x)$	the first, second, $\dots$ , $n^{\text{th}}$ derivatives of $f(x)$ with respect to $x$
$\int y \, dx$	indefinite integral of $y$ with respect to $x$
$\int_a^b y \, dx$	the definite integral of $y$ with respect to $x$ for values of $x$ between $a$ and $b$
$\dot{x}, \ddot{x}, \dots$	the first, second, $\dots$ derivatives of $x$ with respect to time

- 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 $x$
$\lg x$	logarithm of $x$ to base 10

- Circular Functions and Relations**

$\sin, \cos, \tan,$ $\operatorname{cosec}, \sec, \cot$	} the circular functions
$\sin^{-1}, \cos^{-1}, \tan^{-1}$ $\operatorname{cosec}^{-1}, \sec^{-1}, \cot^{-1}$	} the inverse circular functions



- **Complex Numbers**

$i$	square root of $-1$
$z$	a complex number, $z = x + iy$ $= r(\cos\theta + i \sin\theta)$ , $r \in \mathbb{R}_0^+$ $= r e^{i\theta}$ , $r \in \mathbb{R}_0^+$
$\operatorname{Re} z$	the real part of $z$ , $\operatorname{Re}(x + iy) = x$
$\operatorname{Im} z$	the imaginary part of $z$ , $\operatorname{Im}(x + iy) = y$
$ z $	the modulus of $z$ , $ x + iy  = \sqrt{x^2 + y^2}$ , $ r(\cos\theta + i \sin\theta)  = r$
$\arg z$	the argument of $z$ , $\arg(r(\cos\theta + i \sin\theta)) = \theta$ , $-\pi < \theta \leq \pi$
$z^*$	the complex conjugate of $z$ , $(x + iy)^* = x - iy$

- **Vectors.**

$\mathbf{a}$	the vector $\mathbf{a}$
$\overrightarrow{AB}$	the vector represented in magnitude and direction by the directed line segment $AB$
$\hat{\mathbf{a}}$	a unit vector in the direction of the vector $\mathbf{a}$
$\mathbf{i}, \mathbf{j}, \mathbf{k}$	unit vectors in the directions of the cartesian coordinate axes
$ \mathbf{a} $	the magnitude of $\mathbf{a}$
$ \overrightarrow{AB} $	the magnitude of $\overrightarrow{AB}$
$\mathbf{a} \cdot \mathbf{b}$	the scalar product (or dot product) of $\mathbf{a}$ and $\mathbf{b}$
$\mathbf{a} \times \mathbf{b}$	the vector product (or cross product) of $\mathbf{a}$ and $\mathbf{b}$

- **Probability and Statistics.**

$A, B, C, \text{ etc.}$	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 $A$ , the event "not $A$ "
$P(A B)$	probability of the event $A$ given the event $B$
$X, Y, R, \text{ etc.}$	random variables
$x, y, r, \text{ etc.}$	values of the random variables $X, Y, R, \text{ etc.}$
$x_1, x_2, \dots$	observations
$f_1, f_2, \dots$	frequencies with which the observations $x_1, x_2, \dots$ occur
$p(x)$	the value of the 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 $X$
$f(x), g(x), \dots$	the value of the probability density function of the continuous random variable $X$
$F(x), G(x), \dots$	the value of the (cumulative) distribution function $P(X \leq x)$ of the 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 $X$
$B(n, p)$	binomial distribution, parameters $n$ and $p$
$\text{Po}(\mu)$	Poisson distribution, mean $\mu$
$N(\mu, \sigma^2)$	normal distribution, mean $\mu$ and variance $\sigma^2$
$\mu$	population mean
$\sigma^2$	population variance
$\sigma$	population standard deviation
$\bar{x}$	sample mean
$s^2, \hat{\sigma}^2$	unbiased estimate of population variance from a sample, $s^2 = \frac{1}{n-1} \sum (x - \bar{x})^2$
$\phi$	probability density function of the standardised normal variable with distribution $N(0, 1)$
$\Phi$	corresponding cumulative distribution function
$\rho$	linear product-moment correlation coefficient for a population
$r$	linear product-moment correlation coefficient for a sample

≡≡≡



## The Greek Alphabet

A	$\alpha$	alpha	I	$\iota$	iota	P	$\rho$	rho
B	$\beta$	beta	K	$\kappa$	kappa	$\Sigma$	$\sigma$	sigma
$\Gamma$	$\gamma$	gamma	$\Lambda$	$\lambda$	lambda	T	$\tau$	tau
$\Delta$	$\delta$	delta	M	$\mu$	mu	Y	$\upsilon$	upsilon
E	$\varepsilon$	epsilon	N	$\nu$	nu	$\Phi$	$\phi$	phi
Z	$\zeta$	zeta	$\Xi$	$\xi$	xi	X	$\chi$	chi
H	$\eta$	eta	O	$o$	omicron	$\Psi$	$\psi$	psi
$\Theta$	$\theta$	theta	$\Pi$	$\pi$	pi	$\Omega$	$\omega$	omega

≡≡≡