## **Appendix 2: Notation**

The tables below set out the notation that must be used in A Level Mathematics examinations. Students will be expected to understand this notation without need for further explanation.

1		Set notation
1.1	€	is an element of
1.2	∉	is not an element of
1.3	⊆	is a subset of
1.4	<b>C</b>	is a proper subset of
1.5	$\{x_1, x_2, \ldots\}$	the set with elements $x_1, x_2, \dots$
1.6	{ x:}	the set of all $x$ such that
1.7	n(A)	the number of elements in set A
1.8	Ø	the empty set
1.9	3	the universal set
1.10	A'	the complement of the set $A$
1.11	N	the set of natural numbers, {1, 2, 3,}
1.12	Z	the set of integers, $\{0, \pm 1, \pm 2, \pm 3,\}$
1.13	$\mathbb{Z}^+$	the set of positive integers, $\{1, 2, 3,\}$
1.14	Z + 0	the set of non-negative integers, {0, 1, 2, 3,}
1.15	R	the set of real numbers
1.16	Q	the set of rational numbers, $\left\{\frac{p}{q}: p \in \mathbb{Z}, q \in \mathbb{Z}^+\right\}$
1.17	U	union
1.18	$\cap$	intersection
1.19	(x, y)	the ordered pair x, y
1.20	[a, b]	the closed interval $\{x \in \mathbb{R} : a \le x \le b\}$
1.21	[a, b)	the interval $\{x \in \mathbb{R} : a \le x < b\}$
1.22	(a, b]	the interval $\{\{x \in \mathbb{R} : a < x \le b\}$
1.23	(a,b)	the open interval $\{x \in \mathbb{R} : a < x < b\}$

2		Miscellaneous symbols
2.1	=	is equal to
2.2	≠	is not equal to
2.3	=	is identical to or is congruent to
2.4	≈	is approximately equal to
2.5	∞	infinity
2.6	∝	is proportional to
2.7	··.	therefore
2.8	···	because
2.9	<	is less than
2.10	<b>≼</b> ,≤	is less than or equal to, is not greater than
2.11	>	is greater than
2.12	<b>&gt;</b> ,≥	is greater than or equal to, is not less than
2.13	$p \Rightarrow q$	p implies $q$ (if $p$ then $q$ )
2.14	$p \Leftarrow q$	p is implied by $q$ (if $q$ then $p$ )
2.15	$p \Leftrightarrow q$	p implies and is implied by $q$ ( $p$ is equivalent to $q$ )
2.16	a	first term for an arithmetic or geometric sequence
2.17	l	last term for an arithmetic sequence
2.18	d	common difference for an arithmetic sequence
2.19	r	common ratio for a geometric sequence
2.20	$S_n$	sum to <i>n</i> terms of a sequence
2.21	$S_{\infty}$	sum to infinity of a sequence

3		Operations
3.1	a + b	a plus b
3.2	a-b	a minus b
3.3	$a \times b$ , $ab$ , $a \cdot b$	a multiplied by b
3.4	$a \div b, \frac{a}{b}$	a divided by b
3.5	$\sum_{i=1}^{n} a_i$	$a_1 + a_2 + \ldots + a_n$
3.6	$\prod_{i=1}^{n} a_{i}$	$a_1 \times a_2 \times \ldots \times a_n$
3.7	$\sqrt{a}$	the non-negative square root of a
3.8	a	the modulus of a
3.9	n!	<i>n</i> factorial: $n! = n \times (n-1) \times \times 2 \times 1$ , $n \in \mathbb{N}$ ; $0! = 1$
3.10	$\binom{n}{r}$ , ${}^{n}C_{r}$ , ${}_{n}C_{r}$	the binomial coefficient $\frac{n!}{r!(n-r)!}$ for $n, r \in \mathbb{Z}_0^+$ , $r \le n$
		or $\frac{n(n-1)(n-r+1)}{r!}$ for $n \in \mathbb{Q}$ , $r \in \mathbb{Z}_0^+$

4		Functions
4.1	f(x)	the value of the function f at x
4.2	$f: x \mapsto y$	the function f maps the element $x$ to the element $y$
4.3	$f^{-1}$	the inverse function of the function f
4.4	gf	the composite function of f and g which is defined by $gf(x) = g(f(x))$
4.5	$\lim_{x \to a} f(x)$	the limit of $f(x)$ as $x$ tends to $a$
4.6	$\Delta x$ , $\delta x$	an increment of x
4.7	$\frac{\mathrm{d}y}{\mathrm{d}x}$	the derivative of $y$ with respect to $x$
4.8	$\frac{\mathrm{d}^n y}{\mathrm{d} x^n}$	the $n$ th derivative of $y$ with respect to $x$
4.9	$f'(x), f''(x),, f^{(n)}(x)$	the first, second,, $n^{th}$ derivatives of $f(x)$ with respect to $x$

4	Functions	
4.10	$\dot{x}, \ddot{x}, \ldots$	the first, second, derivatives of $x$ with respect to $t$
4.11	$\int y  dx$	the indefinite integral of $y$ with respect to $x$
4.12	$\int_{a}^{b} y  dx$	the definite integral of $y$ with respect to $x$ between the limits $x = a$ and $x = b$

5	Exponential and Logarithmic Functions	
5.1	e	base of natural logarithms
5.2	$e^x$ , $exp x$	exponential function of x
5.3	$\log_a x$	logarithm to the base $a$ of $x$
5.4	$\ln x$ , $\log_{\mathrm{e}} x$	natural logarithm of x

6	Trigonometric Functions	
6.1	sin, cos, tan,	the trigonometric functions
	cosec, sec, cot	
6.2	sin <sup>-1</sup> , cos <sup>-1</sup> , tan <sup>-1</sup> arcsin, arccos, arctan	the inverse trigonometric functions
6.3	0	degrees
6.4	rad	radians

7	Vectors	
7.1	<b>a</b> , <u>a</u> , <u>a</u>	the vector $\mathbf{a}$ , $\underline{\mathbf{a}}$ , $\underline{\mathbf{a}}$ ; these alternatives apply throughout section 9
7.2	$\overrightarrow{\mathrm{AB}}$	the vector represented in magnitude and direction by the directed line segment <b>AB</b>
7.3	â	a unit vector in the direction of a
7.4	i, j, k	unit vectors in the directions of the cartesian coordinate axes
7.5	$ \mathbf{a} , a$	the magnitude of <b>a</b>
7.6	$\overrightarrow{AB}$  , $\overrightarrow{AB}$	the magnitude of $\overrightarrow{AB}$

7	Vectors	
7.7	$\binom{a}{b}$ , $a\mathbf{i} + b\mathbf{j}$	column vector and corresponding unit vector notation
7.8	r	position vector
7.9	s	displacement vector
7.10	v	velocity vector
7.11	a	acceleration vector

8		Probability and Statistics
8.1	A, B, C, etc.	events
8.2	$A \cup B$	union of the events A and B
8.3	$A \cap B$	intersection of the events A and B
8.4	P(A)	probability of the event A
8.5	A'	complement of the event A
8.6	P(A B)	probability of the event $A$ conditional on the event $B$
8.7	X, Y, R, etc.	random variables
8.8	<i>x</i> , <i>y</i> , <i>r</i> , etc.	values of the random variables <i>X</i> , <i>Y</i> , <i>R</i> etc.
8.9	$x_1, x_2, \ldots$	observations
8.10	$f_1, f_2, \ldots$	frequencies with which the observations $x_1, x_2, \dots$ occur
8.11	p(x), P(X = x)	probability function of the discrete random variable $X$
8.12	$p_1, p_2, \ldots$	probabilities of the values $x_1, x_2, \dots$ of the discrete random variable $X$
8.13	E(X)	expectation of the random variable $X$
8.14	Var(X)	variance of the random variable $X$
8.15	~	has the distribution
8.16	B(n, p)	binomial distribution with parameters $n$ and $p$ , where $n$ is the number of trials and $p$ is the probability of success in a trial
8.17	q	q = 1 - p for binomial distribution
8.18	$N(\mu, \sigma^2)$	Normal distribution with mean $\mu$ and variance $\sigma^2$

8		Probability and Statistics
8.19	$Z \sim N(0,1)$	standard Normal distribution
8.20	φ	probability density function of the standardised Normal variable with distribution $N(0, 1)$
8.21	Ф	corresponding cumulative distribution function
8.22	$\mu$	population mean
8.23	$\sigma^2$	population variance
8.24	σ	population standard deviation
8.25	$\overline{x}$	sample mean
8.26	$s^2$	sample variance
8.27	S	sample standard deviation
8.28	$H_0$	Null hypothesis
8.29	$H_1$	Alternative hypothesis
8.30	r	product moment correlation coefficient for a sample
8.31	ρ	product moment correlation coefficient for a population

9		Mechanics
9.1	kg	kilograms
9.2	m	metres
9.3	km	kilometres
9.4	m/s, m s <sup>-1</sup>	metres per second (velocity)
9.5	m/s <sup>2</sup> , m s <sup>-2</sup>	metres per second per second (acceleration)
9.6	F	Force or resultant force
9.7	N	Newton
9.8	N m	Newton metre (moment of a force)
9.9	t	time
9.10	S	displacement
9.11	и	initial velocity
9.12	ν	velocity or final velocity
9.13	a	acceleration
9.14	g	acceleration due to gravity
9.15	μ	coefficient of friction