SUBJECT CONTENT

Topic/Sub-topics		Content
NUMBER AND ALGEBRA		
N1	**Numbers and their operations**	- primes and prime factorisation - finding highest common factor (HCF) and lowest common multiple (LCM), squares, cubes, square roots and cube roots by prime factorisation - negative numbers, integers, rational numbers, real numbers, and their four operations - calculations with calculator - representation and ordering of numbers on the number line - use of the symbols $<$, $>$, $\leqslant$, $\geqslant$ - approximation and estimation (including rounding off numbers to a required number of decimal places or significant figures and estimating the results of computation) - use of standard form $A \times 10^n$, where n is an integer, and $1 \leqslant A < 10$ - positive, negative, zero and fractional indices - laws of indices
N2	**Ratio and proportion**	- ratios involving rational numbers - writing a ratio in its simplest form - map scales (distance and area) - direct and inverse proportion
N3	**Percentage**	- expressing one quantity as a percentage of another - comparing two quantities by percentage - percentages greater than 100% - increasing/decreasing a quantity by a given percentage - reverse percentages
N4	**Rate and speed**	- average rate and average speed - conversion of units (e.g. km/h to m/s)

Topic/Sub-topics		Content
N5	Algebraic expressions and formulae	- using letters to represent numbers - interpreting notations: ab as $a \times b$ $\dfrac{a}{b}$ as $a \div b$ or $a \times \dfrac{1}{b}$ a^2 as $a \times a$, a^3 as $a \times a \times a$, a^2b as $a \times a \times b$, … $3y$ as $y + y + y$ or $3 \times y$ $3(x + y)$ as $3 \times (x + y)$ $\dfrac{3+y}{5}$ as $(3 + y) \div 5$ or $\dfrac{1}{5} \times (3 + y)$ - evaluation of algebraic expressions and formulae - translation of simple real-world situations into algebraic expressions - recognising and representing patterns/relationships by finding an algebraic expression for the nth term - addition and subtraction of linear expressions - simplification of linear expressions such as: $-2(3x - 5) + 4x$ $\dfrac{2x}{3} - \dfrac{3(x-5)}{2}$ - use brackets and extract common factors - factorisation of linear expressions of the form $ax + bx + kay + kby$ - expansion of the product of algebraic expressions - changing the subject of a formula - finding the value of an unknown quantity in a given formula - use of: $(a + b)^2 = a^2 + 2ab + b^2$ $(a - b)^2 = a^2 - 2ab + b^2$ $a^2 - b^2 = (a + b)(a - b)$ - factorisation of quadratic expressions $ax^2 + bx + c$ - multiplication and division of simple algebraic fractions such as: $\left(\dfrac{3a}{4b^2}\right)\left(\dfrac{5ab}{3}\right)$ $\dfrac{3a}{4} \div \dfrac{9a^2}{10}$ - addition and subtraction of algebraic fractions with linear or quadratic denominator such as: $\dfrac{1}{x-2} + \dfrac{2}{x-3}$ $\dfrac{1}{x^2-9} + \dfrac{2}{x-3}$ $\dfrac{1}{x-3} + \dfrac{2}{(x-3)^2}$

	Topic/Sub-topics	Content

N6	**Functions and graphs**	• Cartesian coordinates in two dimensions
		• graph of a set of ordered pairs as a representation of a relationship between two variables
		• linear functions ($y = ax + b$) and quadratic functions ($y = ax^2 + bx + c$)
		• graphs of linear functions
		• the gradient of a linear graph as the ratio of the vertical change to the horizontal change (positive and negative gradients)
		• graphs of quadratic functions and their properties:
		   ∗ positive or negative coefficient of x^2
		   ∗ maximum and minimum points
		   ∗ symmetry
		• sketching the graphs of quadratic functions given in the form:
		   ∗ $y = (x - p)^2 + q$
		   ∗ $y = -(x - p)^2 + q$
		   ∗ $y = (x - a)(x - b)$
		   ∗ $y = -(x - a)(x - b)$
		• graphs of power functions of the form $y = ax^n$, where $n = -2, -1, 0, 1, 2, 3$, and simple sums of not more than three of these
		• graphs of exponential functions $y = ka^x$, where a is a positive integer
		• estimation of the gradient of a curve by drawing a tangent

N7	**Equations and inequalities**	• solving linear equations in one variable
		• solving simple fractional equations that can be reduced to linear equations such as:
		$$\frac{x}{3} + \frac{x-2}{4} = 3$$
		$$\frac{3}{x-2} = 6$$
		• solving simultaneous linear equations in two variables by
		   ∗ substitution and elimination methods
		   ∗ graphical method
		• solving quadratic equations in one unknown by
		   ∗ factorisation
		   ∗ use of formula
		   ∗ completing the square for $y = x^2 + px + q$
		   ∗ graphical methods
		• solving fractional equations that can be reduced to quadratic equations such as:
		$$\frac{6}{x+4} = x + 3$$
		$$\frac{1}{x-2} + \frac{2}{x-3} = 5$$
		• formulating equations to solve problems
		• solving linear inequalities in one variable, and representing the solution on the number line

Topic/Sub-topics		Content
N8	Set language and notation	- use of set language and the following notation: <table><tr><td>Union of *A* and *B*</td><td>$A \cup B$</td></tr><tr><td>Intersection of *A* and *B*</td><td>$A \cap B$</td></tr><tr><td>'… is an element of …'</td><td>$\in$</td></tr><tr><td>'… is not an element of …'</td><td>$\notin$</td></tr><tr><td>Complement of set *A*</td><td>A'</td></tr><tr><td>The empty set</td><td>$\varnothing$</td></tr><tr><td>Universal set</td><td>$\mathscr{E}$</td></tr><tr><td>*A* is a (proper) subset of *B*</td><td>$A \subset B$</td></tr><tr><td>*A* is not a (proper) subset of *B*</td><td>$A \not\subset B$</td></tr></table> - union and intersection of two sets - Venn diagrams
N9	Matrices	- display of information in the form of a matrix of any order - interpreting the data in a given matrix - product of a scalar quantity and a matrix - problems involving the calculation of the sum and product (where appropriate) of two matrices
N10	Problems in real-world contexts	- solving problems based on real-world contexts: - in everyday life (including travel plans, transport schedules, sports and games, recipes, etc.) - involving personal and household finance (including simple and compound interest, taxation, instalments, utilities bills, money exchange, etc.) - interpreting and analysing data from tables and graphs, including distance–time and speed–time graphs - interpreting the solution in the context of the problem
GEOMETRY AND MEASUREMENT		
G1	Angles, triangles and polygons	- right, acute, obtuse and reflex angles - vertically opposite angles, angles on a straight line and angles at a point - angles formed by two parallel lines and a transversal: corresponding angles, alternate angles, interior angles - properties of triangles, special quadrilaterals and regular polygons (pentagon, hexagon, octagon and decagon), including symmetry properties - classifying special quadrilaterals on the basis of their properties - angle sum of interior and exterior angles of any convex polygon - properties of perpendicular bisectors of line segments and angle bisectors - construction of simple geometrical figures from given data (including perpendicular bisectors and angle bisectors) using compasses, ruler, set squares and protractors, where appropriate

Topic/Sub-topics		Content

G2	**Congruence and similarity**	• congruent figures and similar figures
		• properties of similar triangles and polygons:
		  ∗ corresponding angles are equal
		  ∗ corresponding sides are proportional
		• enlargement and reduction of a plane figure
		• scale drawings
		• determining whether two triangles are
		  ∗ congruent
		  ∗ similar
		• ratio of areas of similar plane figures
		• ratio of volumes of similar solids
		• solving simple problems involving similarity and congruence

G3	**Properties of circles**	• symmetry properties of circles:
		  ∗ equal chords are equidistant from the centre
		  ∗ the perpendicular bisector of a chord passes through the centre
		  ∗ tangents from an external point are equal in length
		  ∗ the line joining an external point to the centre of the circle bisects the angle between the tangents
		• angle properties of circles:
		  ∗ angle in a semicircle is a right angle
		  ∗ angle between tangent and radius of a circle is a right angle
		  ∗ angle at the centre is twice the angle at the circumference
		  ∗ angles in the same segment are equal
		  ∗ angles in opposite segments are supplementary

G4	**Pythagoras' theorem and trigonometry**	• use of Pythagoras' theorem • determining whether a triangle is right-angled given the lengths of three sides • use of trigonometric ratios (sine, cosine and tangent) of acute angles to calculate unknown sides and angles in right-angled triangles • extending sine and cosine to obtuse angles • use of the formula $\frac{1}{2}\,ab\sin C$ for the area of a triangle • use of sine rule and cosine rule for any triangle • problems in two and three dimensions including those involving angles of elevation and depression and bearings
G5	**Mensuration**	• area of parallelogram and trapezium • problems involving perimeter and area of composite plane figures • volume and surface area of cube, cuboid, prism, cylinder, pyramid, cone and sphere • conversion between cm^2 and m^2, and between cm^3 and m^3 • problems involving volume and surface area of composite solids • arc length, sector area and area of a segment of a circle • use of radian measure of angle (including conversion between radians and degrees)

Topic/Sub-topics		Content
G6	**Coordinate geometry**	- finding the gradient of a straight line given the coordinates of two points on it - finding the length of a line segment given the coordinates of its end points - interpreting and finding the equation of a straight line graph in the form $y = mx + c$ - geometric problems involving the use of coordinates
G7	**Vectors in two dimensions**	- use of notations: $\begin{pmatrix} x \\ y \end{pmatrix}$, $\overrightarrow{AB}$, **a**, $\left\|\overrightarrow{AB}\right\|$ and $\|\mathbf{a}\|$ - representing a vector as a directed line segment - translation by a vector - position vectors - magnitude of a vector $\begin{pmatrix} x \\ y \end{pmatrix}$ as $\sqrt{x^2 + y^2}$ - use of sum and difference of two vectors to express given vectors in terms of two coplanar vectors - multiplication of a vector by a scalar - geometric problems involving the use of vectors
G8	**Problems in real-world contexts**	- solving problems in real-world contexts (including floor plans, surveying, navigation, etc.) using geometry - interpreting the solution in the context of the problem

Topic/Sub-topics	Content
STATISTICS AND PROBABILITY	

S1 **Data analysis**	• analysis and interpretation of:
	  ∗ tables
	  ∗ bar graphs
	  ∗ pictograms
	  ∗ line graphs
	  ∗ pie charts
	  ∗ dot diagrams
	  ∗ histograms with equal class intervals
	  ∗ stem-and-leaf diagrams
	  ∗ cumulative frequency diagrams
	  ∗ box-and-whisker plots
	• purposes and uses, advantages and disadvantages of the different forms of statistical representations
	• explaining why a given statistical diagram leads to misinterpretation of data
	• mean, mode and median as measures of central tendency for a set of data
	• purposes and use of mean, mode and median
	• calculation of the mean for grouped data
	• quartiles and percentiles
	• range, interquartile range and standard deviation as measures of spread for a set of data
	• calculation of the standard deviation for a set of data (grouped and ungrouped)
	• using the mean and standard deviation to compare two sets of data

S2 **Probability**	• probability as a measure of chance • probability of single events (including listing all the possible outcomes in a simple chance situation to calculate the probability) • probability of simple combined events (including using possibility diagrams and tree diagrams, where appropriate) • addition and multiplication of probabilities (mutually exclusive events and independent events)

MATHEMATICAL FORMULAE

Compound interest

$$\text{Total amount} = P\left(1 + \frac{r}{100}\right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi r l$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2}r^2\theta, \text{ where } \theta \text{ is in radians}$$

Trigonometry

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

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

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

MATHEMATICAL NOTATION

The list which follows summarises the notation used in Cambridge's Mathematics examinations. Although primarily directed towards A-Level, the list also applies, where relevant, to examinations at all other levels.

1. *Set Notation*

$\in$	is an element of
$\notin$	is not an element of
$\{x_1, x_2, \ldots\}$	the set with elements $x_1, x_2, \ldots$
$\{x: \ldots\}$	the set of all x such that
$n(A)$	the number of elements in set A
$\varnothing$	the empty set
$\mathscr{E}$	universal set
A'	the complement of the set A
$\mathbb{Z}$	the set of integers, $\{0, \pm 1, \pm 2, \pm 3, \ldots\}$
$\mathbb{Z}^+$	the set of positive integers, $\{1, 2, 3, \ldots\}$
$\mathbb{Q}$	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, $\{x \in \mathbb{Q}: x \geqslant 0\}$
$\mathbb{R}$	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, $\{x \in \mathbb{R}: x \geqslant 0\}$
$\mathbb{R}^n$	the real n-tuples
$\mathbb{C}$	the set of complex numbers
$\subseteq$	is a subset of
$\subset$	is a proper subset of
$\nsubseteq$	is not a subset of
$\not\subset$	is not a proper subset of
$\cup$	union
$\cap$	intersection
$[a, b]$	the closed interval $\{x \in \mathbb{R}: a \leqslant x \leqslant b\}$
$[a, b)$	the interval $\{x \in \mathbb{R}: a \leqslant x < b\}$
$(a, b]$	the interval $\{x \in \mathbb{R}: a < x \leqslant b\}$
(a, b)	the open interval $\{x \in \mathbb{R}: a < x < b\}$

2. *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
$\leqslant$; $\ngtr$	is less than or equal to; is not greater than
$>$	is greater than
$\geqslant$; $\nless$	is greater than or equal to; is not less than
∞	infinity

3. *Operations*

$a + b$	a plus b
$a - b$	a minus b
$a \times b, ab, a.b$	a multiplied by b
$a \div b, \dfrac{a}{b}, a/b$	a divided by b
$a : b$	the ratio of a to b
$\displaystyle\sum_{i=1}^{n} a_i$	$a_1 + a_2 + ... + a_n$
$\sqrt{a}$	the positive square root of the real number a
$\lvert a \rvert$	the modulus of the real number a
$n!$	n factorial for $n \in \mathbb{Z}^+ \cup \{0\}, (0! = 1)$
$\dbinom{n}{r}$	the binomial coefficient $\dfrac{n!}{r!(n-r)!}$, for $n, r \in \mathbb{Z}^+ \cup \{0\}, 0 \leqslant r \leqslant n$
	$\dfrac{n(n-1)...(n-r+1)}{r!}$, for $n \in \mathbb{Q}, r \in \mathbb{Z}^+ \cup \{0\}$

4. *Functions*

f	the function f
f(x)	the value of the function f at x
f: $A \to B$	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 ∘ f, gf	the composite function of f and g which is defined by $(g \circ f)(x)$ or gf(x) = g(f(x))
$\lim\limits_{x \to a}$ f(x)	the limit of f(x) as x tends to a
Δx ; δx	an increment of x
$\dfrac{dy}{dx}$	the derivative of y with respect to x
$\dfrac{d^n y}{dx^n}$	the nth derivative of y with respect to x
f'(x), f''(x), ..., f$^{(n)}$(x)	the first, second, ... nth 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
$\dot{x}, \ddot{x}, ...$	the first, second, ...derivatives of x with respect to time

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	logarithm of x to base 10

6. *Circular Functions and Relations*

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

7. *Complex Numbers*

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

8. *Matrices*

$\mathbf{M}$	a matrix $\mathbf{M}$
$\mathbf{M}^{-1}$	the inverse of the square matrix $\mathbf{M}$
$\mathbf{M}^{\mathrm{T}}$	the transpose of the matrix $\mathbf{M}$
$\det \mathbf{M}$	the determinant of the square matrix $\mathbf{M}$

9. *Vectors*

$\mathbf{a}$	the vector $\mathbf{a}$
$\overrightarrow{AB}$	the vector represented in magnitude and direction by the directed line segment AB
$\mathbf{\hat{a}}$	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
$\lvert \mathbf{a} \rvert$	the magnitude of $\mathbf{a}$
$\lvert \overrightarrow{AB} \rvert$	the magnitude of $\overrightarrow{AB}$
$\mathbf{a} \cdot \mathbf{b}$	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, etc.	events
$A \cup B$	union of 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'
$P(A \mid B)$	probability of the event A given the event B
X, Y, R, etc.	random variables
x, y, r, etc.	value of the random variables X, Y, R, etc.
$x_1, x_2, \ldots$	observations
$f_1, f_2, \ldots$	frequencies with which the observations, $x_1, x_2, \ldots$occur
$p(x)$	the value of the probability function $P(X = x)$ of the discrete random variable X
$p_1, p_2, \ldots$	probabilities of the values $x_1, x_2, \ldots$of the discrete random variable X
$f(x), g(x)\ldots$	the value of the probability density function of the continuous random variable X
$F(x), G(x)\ldots$	the value of the (cumulative) distribution function $P(X \leqslant x)$ 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 μ
$N(\mu, \sigma^2)$	normal distribution, mean μ and variance σ^2
μ	population mean
σ^2	population variance
σ	population standard deviation
$\overline{x}$	sample mean
s^2	unbiased estimate of population variance from a sample, $$s^2 = \frac{1}{n-1}\Sigma\left(x - \overline{x}\right)^2$$
φ	probability density function of the standardised normal variable with distribution $N(0, 1)$
Φ	corresponding cumulative distribution function
ρ	linear product-moment correlation coefficient for a population
r	linear product-moment correlation coefficient for a sample