MATHEMATICS SYLLABUS T

GCE NORMAL (TECHNICAL) LEVEL (2017)

(Syllabus 4046)

CONTENTS

Singapore Examinations and Assessment Board

CAMBRIDGE International Examinations

INTRODUCTION

The syllabus is intended to provide students with the fundamental mathematical knowledge and skills to prepare them for technical- or service-oriented education. The syllabus consists of three content strands, namely, *Number and Algebra*, *Geometry and Measurement*, and *Statistics and Probability*, and a context strand called *Real-World Contexts*. Application of mathematics is an important emphasis of the content strands. The approach to teaching should involve meaningful contexts so that students can see and appreciate the relevance and application of mathematics in their daily life and the world around them. Real-world contexts are realistic contexts that naturally have practical applications of mathematics, and the mathematics can come from any part of the 'Content'.

AIMS

The N(T) Level Mathematics Syllabus aims to enable all students who are bound for post-secondary vocational education to:

- acquire mathematical concepts and skills for real life, to support learning in other subjects and to prepare for vocational education
- develop thinking, reasoning, communication, application and metacognitive skills through a mathematical approach to problem-solving
- build confidence in using mathematics and appreciate its value in making informed decisions in real life.

ASSESSMENT OBJECTIVES

The assessment will test candidates' abilities to:

AO1 understand and apply mathematical concepts and skills in a variety of contexts

AO2 organise and analyse data and information; formulate problems into mathematical terms and select and apply appropriate techniques of solution

AO3 apply mathematics in real-world contexts; interpret mathematical results and make inferences.

SCHEME OF ASSESSMENT

Paper	Duration	Description	Marks	Weighting
Paper 1	1 hour 30 minutes	There will be 11–13 short questions carrying 2–4 marks, largely free from context, testing more on fundamental concepts and skills, followed by 2 longer questions carrying 6–8 marks, developed around a context. Candidates are required to answer all questions which will cover topics from the following strands • Number and Algebra • Geometry and Measurement • Real-World Contexts related to Number and Algebra and Geometry and Measurement	50	50%
Paper 2	1 hour 30 minutes	There will be 11–13 short questions carrying 2–4 marks, largely free from context, testing more on fundamental concepts and skills, followed by 2 longer questions carrying 6–8 marks, developed around a context. Candidates are required to answer all questions which will cover topics from the following strands • Number and Algebra • Statistics and Probability • Real-World Contexts related to Number and Algebra and Statistics and Probability	50	50%

NOTES

1. Omission of essential working will result in loss of marks.

2. Relevant mathematical formulae will be provided for candidates.

3. Candidates should also have geometrical instruments with them for Paper 1.

4. Unless stated otherwise within a question, three-figure accuracy will be required for answers. This means that four-figure accuracy should be shown throughout the working, including cases where answers are used in subsequent parts of the question. Premature approximation will be penalised, where appropriate. Angles in degrees should be given to one decimal place.

5. SI units will be used in questions involving mass and measures.

   Both the 12-hour and 24-hour clock may be used for quoting times of the day. In the 24-hour clock, for example, 3.15 a.m. will be denoted by 03 15; 3.15 p.m. by 15 15.

6. Candidates are expected to be familiar with the solidus notation for the expression of compound units, e.g. 5 cm/s for 5 centimetres per second, 13.6 g/cm^3 for 13.6 grams per cubic centimetre.

7. Unless the question requires the answer in terms of π, the calculator value for π or $\pi = 3.142$ should be used.

8. Spaces will be provided in each question paper for working and answers.

USE OF CALCULATORS

An approved calculator may be used in **both** Paper 1 and Paper 2.

SUBJECT CONTENT

Topic/Sub-topics		Content
NUMBER AND ALGEBRA		
N1	**Numbers and their operations**	• negative numbers and primes (exclude prime factorisation) • integers and their four operations • four operations on fractions and decimals (including negative fractions and decimals) • calculations with calculator, including squares, cubes, square roots and cube roots • representation and ordering of numbers on the number line • use of $<$, $>$, $\leqslant$, $\geqslant$ • rounding off numbers to a required number of decimal places or significant figures • estimating the results of computation • use of index notation for integer powers • use of standard form $A \times 10^n$, where n is an integer, and $1 \leqslant A < 10$
N2	**Ratio and proportion**	• comparison between two or more quantities by ratio • dividing a quantity in a given ratio • ratios involving fractions and decimals • equivalent ratios • writing a ratio in its simplest form • map scales (distance and area) • direct and inverse proportion
N3	**Percentage**	• expressing percentage as a fraction or decimal • finding the whole given a percentage part • expressing one quantity as a percentage of another • comparing two quantities by percentage • percentages greater than 100% • finding one quantity given the percentage and the other quantity • increasing/decreasing a quantity by a given percentage • finding percentage increase/decrease
N4	**Rate and speed**	• rates and average rates (including the concepts of speed 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 $a \times b$ ∗ $\frac{a}{b}$ as $a \div b$ or a $\times$ $\frac{1}{b}$ ∗ 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 $3 \times (x + y)$ ∗ $\frac{3+y}{5}$ as $(3 + y) \div 5$ or $\frac{1}{5}\times(3+y)$ • evaluation of algebraic expressions and formulae • translation of simple real-world situations into algebraic expressions • recognising and representing number patterns (including finding an algebraic expression for the nth term for simple cases such as $n + 3$, $2n + 1$) • addition and subtraction of linear expressions • simplification of linear expressions, such as: $-2(3x - 5) + 4x$ $\frac{2x}{3}-\frac{3(x-5)}{2}$ • expansion of the product of two linear expressions • multiplication and division of simple algebraic fractions, such as: $\left(\frac{3a}{4b^2}\right)\left(\frac{5ab}{3}\right)$ $\frac{3a}{4}\div\frac{9a^2}{10}$ • changing the subject of a simple formula • finding the value of an unknown quantity in a given formula • factorisation of linear expressions of the form $ax + kay$ • factorisation of quadratic expressions of the form $x^2 + px + q$ Exclude: • use of ∗ $(a \pm b)^2 = a^2 \pm 2ab + b^2$ ∗ $a^2 - b^2 = (a + b)(a - b)$ • addition and subtraction of algebraic fractions such as $\frac{1}{x}+\frac{1}{x-1}$
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

Topic/Sub-topics		Content
N7	**Solutions of equations**	• solving linear equations in one variable • solving simple fractional equations that can be reduced to linear equations, such as: ∗ $\frac{x}{3}+\frac{x-2}{4}=3$ ∗ $\frac{3}{x-2}=6$ • graphs of linear equations in two variables ($ax + by = c$) • solving simultaneous linear equations in two variables by ∗ substitution and elimination methods ∗ graphical method • solving quadratic equations in one variable by use of formula • formulating a linear equation in one variable, a quadratic equation in one variable, or a pair of linear equations in two variables to solve problems
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 and special quadrilaterals • 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 protractor where appropriate
G2	**Symmetry, congruence and similarity**	• line and rotational symmetry of plane figures • lines of symmetry • order of rotational symmetry • congruent and similar figures • properties of similar triangles and quadrilaterals: ∗ corresponding angles are equal ∗ corresponding sides are proportional
G3	**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 (including problems involving angles of elevation and depression)
G4	**Mensuration**	• area of triangle as $\frac{1}{2}$ × base × height • area and circumference of circle • area of parallelogram and trapezium • problems involving perimeter and area of composite plane figures • visualising and sketching cube, cuboid, prism, cylinder, pyramid, cone and sphere (including use of nets to visualise the surface area of these solids, where applicable) • 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 as fraction of the circumference and sector area as fraction of the area of a circle

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 • purposes and use, advantages and disadvantages of the different forms of statistical representations • purposes and use of mean, mode and median • calculation of the mean, mode and median for a set of ungrouped data • percentiles, quartiles, range and interquartile range • analysis and interpretation of cumulative frequency diagrams
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)
REAL-WORLD CONTEXTS		
R1	**Problems derived from real-world contexts**	• real-world contexts such as: ∗ profit and loss (exclude use of the terms ‘percentage profit’ and ‘percentage loss’) ∗ simple interest and compound interest ∗ household finance (earnings, expenditures, budgeting, etc.) ∗ payment/subscription rates (hire-purchase, utilities bills, etc.) ∗ money exchange ∗ time schedules (including 24-hour clock) and time zone variation ∗ designs (models/structures, maps and plans, packaging, etc.) ∗ everyday statistics (sport/game statistics, household and market surveys, etc.) • tasks involving: ∗ use of data from tables and charts ∗ interpretation and use of graphs in practical situations ∗ drawing graphs from given data ∗ creating geometrical patterns and designs ∗ interpretation and use of quantitative information

MATHEMATICAL FORMULAE

Note:
Below is the list of formulae for Paper 1. For Paper 2, only the section on *Number and Algebra* will be given.

Number and Algebra

Compound interest

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

Quadratic equation $ax^2 + bx + c = 0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Geometry and Measurement

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

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

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

$$\text{Volume of a pyramid} = \frac{1}{3} \times \text{base area} \times \text{height}$$

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

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
$\mathrm{n}(A)$	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, $\{0, \pm1, \pm2, \pm3, \ldots\}$
$\mathbb{Z}^+$	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
$a \div b$, $\frac{a}{b}$, a/b	a divided by b
$a : b$	the ratio of a to b
$\sum_{i=1}^{n} a_i$	$a_1 + a_2 + ... + a_n$
$\sqrt{a}$	the positive square root of the real number a
$\lvert a \rvert$	the modulus of the real number a
$n!$	n factorial for $n \in \mathbb{Z}^+ \cup \{0\}$, $(0! = 1)$
$\binom{n}{r}$	the binomial coefficient $\frac{n!}{r!(n-r)!}$, for $n, r \in \mathbb{Z}^+ \cup \{0\}$, $0 \leqslant r \leqslant n$ $\frac{n(n-1)...(n-r+1)}{r!}$, for $n \in \mathbb{Q}$, $r \in \mathbb{Z}^+ \cup \{0\}$

4. *Functions*

f	the function f
$\mathrm{f}(x)$	the value of the function f at x
$\mathrm{f}: A \to B$	f is a function under which each element of set A has an image in set B
$\mathrm{f}: x \mapsto y$	the function f maps the element x to the element y
f^{-1}	the inverse of the function f
$\mathrm{g} \circ \mathrm{f}$, gf	the composite function of f and g which is defined by $(\mathrm{g} \circ \mathrm{f})(x)$ or $\mathrm{gf}(x) = \mathrm{g}(\mathrm{f}(x))$
$\lim\limits_{x \to a} \mathrm{f}(x)$	the limit of $\mathrm{f}(x)$ as x tends to a
Δx ; δx	an increment of x
$\dfrac{\mathrm{d}y}{\mathrm{d}x}$	the derivative of y with respect to x
$\dfrac{\mathrm{d}^n y}{\mathrm{d}x^n}$	the nth derivative of y with respect to x
$\mathrm{f}'(x), \mathrm{f}''(x), \ldots, \mathrm{f}^{(n)}(x)$	the first, second, … nth derivatives of $\mathrm{f}(x)$ with respect to x
$\int y \, \mathrm{d}x$	indefinite integral of y with respect to x
$\int_a^b y \, \mathrm{d}x$	the definite integral of y with respect to x for values of x between a and b
$\dot{x}, \ddot{x}, \ldots$	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
$\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$ 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
$\hat{\mathbf{a}}$	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
$\lvert \mathbf{a} \rvert$	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
$\mathrm{P}(A)$	probability of the event A
A'	complement of the event A, the event 'not A'
$\mathrm{P}(A \mid B)$	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
$\mathrm{p}(x)$	the value of the probability function $\mathrm{P}(X = x)$ 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
$\mathrm{f}(x)$, $\mathrm{g}(x) \ldots$	the value of the probability density function of the continuous random variable X
$\mathrm{F}(x)$, $\mathrm{G}(x) \ldots$	the value of the (cumulative) distribution function $\mathrm{P}(X \leqslant x)$ of the random variable X
$\mathrm{E}(X)$	expectation of the random variable X
$\mathrm{E}[\mathrm{g}(X)]$	expectation of $\mathrm{g}(X)$
$\mathrm{Var}(X)$	variance of the random variable X
$\mathrm{B}(n, p)$	binomial distribution, parameters n and p
$\mathrm{Po}(\mu)$	Poisson distribution, mean μ
$\mathrm{N}(\mu, \sigma^2)$	normal distribution, mean μ and variance σ^2
μ	population mean
σ^2	population variance
σ	population standard deviation
$\bar{x}$	sample mean
s^2	unbiased estimate of population variance from a sample, $s^2 = \frac{1}{n-1}\sum(x - \bar{x})^2$
φ	probability density function of the standardised normal variable with distribution $\mathrm{N}(0, 1)$
Φ	corresponding cumulative distribution function
ρ	linear product-moment correlation coefficient for a population
r	linear product-moment correlation coefficient for a sample