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IGCSE

London Examinations IGCSE

Mathematics (4400)

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Specification

London Examinations IGCSE

Mathematics (4400)

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Changes from Issue 1 are indicated by marginal lines.

Acknowledgements

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Contents

Introduction

This specification is designed as a two-year course in Mathematics to meet the needs of students of all abilities.

Key features

- tiers of entry allow students to be entered at the appropriate level
- questions designed to be accessible to students of all abilities within that tier
- papers balanced for topics and difficulty
- standards equivalent to Edexcel's UK GCSE Mathematics
- a full range of teacher support
- provides a solid basis for Edexcel's AS and Advanced GCE, or equivalent qualifications.

Availability of examinations sessions

The specification will be examined twice a year, in May and November.

Summary of scheme of assessment

Paper/ component	Mode of assessment	Weighting	Length
1	Examination Paper 1F, targeted at Grades C – G (Foundation Tier)	50%	2 hours
2	Examination Paper 2F, targeted at Grades C – G (Foundation Tier)	50%	2 hours
3	Examination Paper 3H, targeted at grades A* – D (Higher Tier)	50%	2 hours
4	Examination Paper 4H, targeted at grades A* – D (Higher Tier)	50%	2 hours

Students will be required to take **two** papers.

Foundation Tier students will take papers 1F and 2F. The Foundation Tier papers are targeted at grades C to G.

Higher Tier students will take Papers 3H and 4H. The Higher Tier papers are targeted at grades A* to D.

Specification aims and assessment objectives

Aims

This specification details the requirements for

Number

- use numerical skills in a purely mathematical way and in real life situations

Algebra

- use letters as equivalent to numbers and as variables
- understand the distinction between expressions, equations and formulae
- use algebra to set up and solve problems
- demonstrate manipulative skills
- construct and use graphs

Geometry

- use properties of angles
- understand a range of transformations
- work within the metric system
- understand ideas of space and shape
- use ruler, compasses and protractor appropriately

Statistics

- understand basic ideas of statistical averages
- use a range of statistical techniques
- use basic ideas of probability.

Assessment objectives

The specification requires candidates to demonstrate their knowledge, understanding and skills in the following:

AO1 Number and algebra

- numbers and the numbering system
- calculations
- solving numerical problems
- equations, formulae and identities
- sequences, functions and graphs.

AO2 Shape, space and measures

- geometry
- vectors and transformation geometry.

AO3 Handling data

- statistics.

Scheme of assessment

Tiers of entry

Candidates are entered at **either** Foundation Tier **or** Higher Tier.

Questions in the Foundation Tier papers are targeted at grades C to G. The highest grade which will be awarded at Foundation Tier is grade C.

Questions in the Higher Tier papers are targeted at grades A* to D. There is a 'safety net' grade E for candidates who narrowly fail to achieve grade D.

Candidates who fail to achieve grade G on Foundation Tier or grade E on Higher Tier will be awarded 'Ungraded'.

Some examination questions will be common to both tiers.

Relationship of assessment objectives to external assessment

	Assessment objective	Weighting
AO1	Number and algebra	55%
AO2	Shape, space and measures	25%
AO3	Handling data	20%

The percentages above are not intended to provide a precise statement of the number of marks allocated to particular Assessment Objectives.

External assessment

- each paper will address all of the Assessment Objectives
- papers will have approximately equal marks available for each of the targeted grades to be awarded
- each examination paper will carry a total of 100 marks
- there will be two parallel examination papers for each tier. Each examination paper will assess the full range of targeted grades at each tier
- questions on the Higher Tier examination papers will assume knowledge from the Foundation Tier subject content
- diagrams will not necessarily be drawn to scale and measurements should not be taken from diagrams unless instructions to this effect are given

- each candidate may be required to use mathematical instruments e.g. pair of compasses, ruler, protractor
- tracing paper may be used
- formulae sheets will be provided for both tiers
- there will be some common questions targeted at grades C and D, across examination papers 1F and 3H and across 2F and 4H, to aid standardisation and comparability of award between tiers.

Calculators

Candidates will be expected to have access to a suitable electronic calculator for all examination papers.

- the electronic calculator to be used by candidates attempting Foundation Tier examination papers (1F and 2F) should have these functions as a minimum

  +, –, ×, ÷, x^2, $\sqrt{x}$, memory, brackets, x^y, $x^{\frac{1}{y}}$, sine, cosine, tangent and their inverses

- the electronic calculator to be used by candidates attempting Higher Tier examination papers (3H and 4H) should have these functions as a minimum

  +, –, ×, ÷, x^2, $\sqrt{x}$, memory, constant function, brackets, x^y, $x^{\frac{1}{y}}$, $\bar{x}$, Σx, Σfx, standard form, sine, cosine, tangent and their inverses

- calculators with any of the following facilities are prohibited in any examination

  databanks; retrieval of text or formulae; QWERTY keyboards; built-in symbolic algebra manipulations; symbolic differentiation or integration,

- calculators which are **not** permitted in any paper include Texas TI-89, TI-92, Casio *cfx*-9970G, Hewlett Packard HP 48G, Casio C-300 (NB: There are almost certainly others that are **not** permitted. Check with London Examinations if unsure)

Awarding and reporting

The grading, awarding and certification of this specification will comply with the requirements of the IGCSE for courses being first examined in 2004.

Assessment of this specification will be available in English only. All written work for the examination must be submitted in English.

Students with particular requirements

Regulations and guidance relating to students with special requirements are published annually by the Joint Council for General Qualifications and are circulated to examinations officers. Further copies of guidance documentation may be obtained from the International Customer Relations Unit (ICRU) at the address below, or by telephoning +44 (0) 190 884 7750.

London Examinations will assess whether or not special consideration or concessions can be made for students with particular requirements. Requests should be addressed to

International Customer Relations Unit (ICRU)
Edexcel International
190 High Holborn
London
WC1V 7BE
UK

Specification content

Foundation Tier

AO1 NUMBER and ALGEBRA		
1. Numbers and the number system		
	Candidates should be taught to	***Notes***
1.1 Integers	understand and use integers (positive, negative and zero) both as positions and translations on a number line	
	use directed numbers in practical situations	Such as temperature, sea-level
	order integers	
	use the four rules of addition, subtraction, multiplication and division	
	use brackets and the hierarchy of operations	
	use the terms odd, even and prime numbers, factors and multiples	
	identify prime factors, common factors and common multiples	
1.2 Fractions	understand and use equivalent fractions, simplifying a fraction by cancelling common factors	$\frac{8}{60} = \frac{2}{15}$ in its simplest form (lowest terms)
	understand and use mixed numbers and vulgar fractions	
	identify common denominators	
	applying common denominators to order fractions	
	calculate a given fraction of a given quantity, expressing the answer as a fraction	
	express a given number as a fraction of another number	
	use common denominators to add and subtract fractions	
	convert between fractions, decimals and percentages	$\frac{3}{5} = 0.6 = 60\%$ $\frac{4}{9} = 0.4444\ldots = 0.\dot{4}$
	understand and use unit fractions as multiplicative inverses	$3 \div 5 = 3 \times \frac{1}{5}$

	multiply and divide a given fraction by an integer, by a unit fraction and by a general fraction	
1.3 Decimals	use decimal notation order decimals recognise that a terminating decimal is a fraction	 $0.65 = \frac{65}{100} = \frac{13}{20}$
1.4 Powers and Roots	calculate squares, square roots, cubes and cube roots use index notation and index laws for multiplication and division of positive integer powers express integers as the product of powers of prime factors	 $720 = 2^4 \times 3^2 \times 5$
1.5 Set Language and Notation	understand the definition of a set of numbers use the set notation $\cup$, $\cap$ and $\in$ understand the concept of the Universal Set and the Null Set and the symbols for these sets	 $\mathscr{E}$ = Universal Set Ø or { } = Null Set
1.6 Percentages	understand that 'percentage' means 'number of parts per 100' express a given number as a percentage of another number express a percentage as a fraction and as a decimal convert simple fractions of a whole to percentages of the whole and vice versa understand the multiplicative nature of percentages as operators solve simple percentage problems, including percentage increase and percentage decrease	 15% of 120 = $\frac{15}{100} \times 120$ Find the interest earned after one year on \$3,000 invested at 5% per annum
1.7 Ratio and Proportion	use ratio notation including reduction to its simplest form and its various links to fraction notation divide a quantity in a given ratio use the process of proportionality to evaluate unknown quantities calculate an unknown quantity from quantities that vary in direct proportion solve word problems about ratio and proportion	Expressing in the form 1: *n* Share £416 in the ratio 5:3 *s* varies directly as *t*. Find the missing value in a table Including maps and scale diagrams

1.8 Degree of Accuracy	round integers to a given power of 10 round to a given number of significant figures or decimal places identify upper and lower bounds where values are given to a degree of accuracy use estimation to evaluate approximations to numerical calculations	By rounding each value to one significant figure, estimate the value of $\frac{4.9 \times 24.6}{46.3}$ to one significant figure
1.9 Standard Form	***Higher Tier only***	
1.10 Applying Number	use and apply number in everyday personal, domestic or community life carry out calculations using standard units of mass, length, area, volume and capacity understand and carry out calculations using time carry out calculations using money, including converting between currencies	metric units only
1.11 Electronic Calculators	use a scientific electronic calculator to determine numerical results	$3.3^2 + \sqrt{4.3}$ correct to 2 significant figures

2. Equations, Formulae and Identities

	Candidates should be taught to	*Notes*
2.1 Use of Symbols	understand that symbols may be used to represent numbers in equations or variables in expressions and formulae	
	understand that algebraic expressions follow the generalised rules of arithmetic	
	use index notation for positive integer powers	$a^3 = a \times a \times a$
	use index laws in simple cases	$x^3 \times x^2 = x^5$ $\frac{x^7}{x^3} = x^4$ $(x^2)^3 = x^6$ $\frac{x^2}{x^5} = \frac{1}{x^3}$
2.2 Algebraic Manipulation	evaluate expressions by substituting numerical values for letters	
	collect like terms	
	multiply a single term over a bracket	
	take out single common factors	Factorise $x^2 + 3x$
	expand the product of two simple linear expressions	$(x + 3)(x - 2)$ $= x^2 + 3x - 2x - 6$ $= x^2 + x - 6$
2.3 Expressions and Formulae	understand that a letter may represent an unknown number or a variable	
	use correct notational conventions for algebraic expressions and formulae	
	substitute positive and negative integers, decimals and fractions for words and letters in expressions and formulae	Evaluate $2x - 3y$ when $x = -2$ and $y = 4$
	use formulae from mathematics and other real life contexts expressed initially in words or diagrammatic form and converting to letters and symbols	

2.4 Linear Equations	solve linear equations with integer or fractional coefficients in one unknown in which the unknown appears on either side or both sides of the equation	$3x + 7 = 22$, $\frac{2}{3}x = 60$, $4x - 2 = 10 - x$, $5x + 17 = 3(x + 6)$, $\frac{15 - x}{4} = 2$, $\frac{1}{6}x + \frac{1}{3}x = 5$
	set up simple linear equations from data given	The three angles of a triangle are $a°$, $(a + 10)°$, $(a + 20)°$. Find the value of a
2.5 Proportion	***Higher Tier only***	
2.6 Simultaneous Linear Equations	calculate the exact solution of two simple simultaneous equations in two unknowns	$y = 2x$, $x + y = 12$ $x + y = 14$, $x - y = 2$
2.7 Quadratic Equations	***Higher Tier only***	
2.8 Inequalities	understand and use the symbols $>$, $<$, $\geq$ and $\leq$	
	understand and use the convention for open and closed intervals on a number line	
	solve simple linear inequalities in one variable and represent the solution set on a number line	$3x - 2 < 10$, so $x < 4$ $7 - x \leq 5$, so $2 \leq x$
	represent simple linear inequalities on rectangular cartesian graphs	
	identify regions on rectangular cartesian graphs defined by simple linear inequalities	Shade the region defined by the inequalities $x \geq 0$, $y > 1$, $x + y < 5$

3. Sequences, Functions and Graphs		
	Candidates should be taught to	***Notes***
3.1 Sequences	generate terms of a sequence using term-to-term and position-to-term definitions of the sequence find subsequent terms of an integer sequence	Including odd, even, squares, multiples and powers 1, 2, 4, 8, … 5, 9, 13, 17 …
3.2 Functional notation	***Higher Tier only***	
3.3 Graphs	interpret information presented in a range of linear and non-linear graphs understand and use conventions for rectangular cartesian coordinates plot points (x , y) in any of the four quadrants of a graph locate points with given coordinates determine the coordinates of points identified by geometrical information determine the coordinates of the midpoint of a line segment given the coordinates of the two end points draw and interpret straight line conversion graphs understand the concept of a gradient of a straight line recognise that equations of the form $y = mx + c$ are straight line graphs generate points and plot graphs of linear and quadratic functions	To include speed/time and distance/time graphs To include currency conversion graphs A ramp rises 15 m over a horizontal distance of 60 m, therefore the gradient of the ramp is 15/60 = 0.25 Including completion of values in tables and equations of the form $ax + by = c$
3.4 Calculus	***Higher Tier only***	

AO2 SHAPE, SPACE AND MEASURES		
4. Geometry		
	Candidates should be taught to	***Notes***
4.1 Angles and Triangles	distinguish between acute, obtuse, reflex and right angles estimate the size of angles in degrees use angle properties of intersecting lines, parallel lines and angles on a straight line understand the exterior angle of a triangle property and the angle sum of a triangle property understand the terms isosceles, equilateral and right-angled triangles and the angle properties of these triangles	 Angles at a point, vertically opposite angles, alternate angles, corresponding angles
4.2 Polygons	recognise and give the names of polygons understand and use the term quadrilateral and the angle sum property of quadrilaterals understand and use the properties of the parallelogram, rectangle, square, rhombus, trapezium and kite understand the term regular polygon and calculate interior and exterior angles of regular polygons understand and use the angle sum of polygons understand congruence as meaning the same shape and size understand that two or more polygons with the same shape and size are said to be congruent to each other	To include parallelogram, rectangle, square, rhombus, trapezium, kite, pentagon, hexagon and octagon The four angles of a quadrilateral are 90°, $(x + 15)°$, $(x + 25)°$ and $(x + 35)°$. Find the value of x For a polygon with n sides, the sum of the interior angles is $(2n – 4)$ right angles
4.3 Symmetry	recognise line and rotational symmetry identify any lines of symmetry and the order of rotational symmetry of a given two-dimensional figure	 Name a quadrilateral with no lines of symmetry and order of rotational symmetry of 2

4.4 Measures	interpret scales on a range of measuring instruments calculate time intervals in terms of the 24-hour and 12-hour clock make sensible estimates of a range of measures understand angle measure including three-figure bearings measure an angle to the nearest degree understand and use the relationship between average speed, distance and time	 Use a.m. , p.m.
4.5 Construction	measure and draw lines to the nearest millimetre construct triangles and other two-dimensional shapes using a combination of a ruler, protractor and compasses solve problems using scale drawings use straight edge and compasses to (i) construct the perpendicular bisector of a line segment (ii) construct the bisector of an angle	
4.6 Circle Properties	recognise the terms centre, radius, chord, diameter, circumference, tangent, arc, sector and segment of a circle understand chord and tangent properties of circles	 Two tangents from a point to a circle are equal in length Tangents are perpendicular to the radius at the point of contact The line from the centre of a circle which is perpendicular to a chord, bisects the chord (and the converse)
4.7 Geometrical Reasoning	Give informal reasons, where required, when arriving at numerical solutions to geometrical problems	Reasons will only be required for geometrical calculations based on lines, triangles or polygons
4.8 Trigonometry and Pythagoras' Theorem	understand and use Pythagoras' theorem in two dimensions understand and use sine, cosine and tangent of acute angles to determine lengths and angles of a right-angled triangle apply trigonometrical methods to solve problems in two dimensions	 To include bearings

4.9 Mensuration	convert measurements within the metric system to include linear, area and volume units find the perimeter of shapes made from triangles and rectangles find the area of simple shapes using the formulae for the areas of triangles and rectangles find the area of parallelograms and trapezia find circumferences and areas of circles using relevant formulae find the surface area of simple shapes using the area formulae for triangles and rectangles find the volume of right prisms, including cuboids and cylinders, using an appropriate formula understand the terms face, edge and vertex in the context of a three-dimensional solid	$cm^2 \rightarrow m^2$ and vice versa $cm^3 \rightarrow$ litres and vice versa
4.10 Similarity	understand and use the geometrical properties that similar figures have corresponding lengths in the same ratio but corresponding angles remain unchanged	

5. Vectors and Transformation Geometry		
	Candidates should be taught to	***Notes***
5.1 Vectors	***Higher Tier only***	
5.2 Transformation Geometry	understand that rotations are specified by a centre and an angle	
	rotate a shape about a point and measure the angle of a rotation	
	recognise that an anti-clockwise rotation is a *positive* angle of rotation and a clockwise rotation is a *negative* angle of rotation	
	understand that reflections are specified by a mirror line	Such as $x = 1$, $y = 2$, $y = x$, $y - x = 0$
	construct a mirror line given a reflected shape	
	construct a reflected shape given an object and a mirror line	Reflect a triangle in the line $y = x$
	understand that translations are specified by a distance and direction	
	construct a translated shape given the distance and direction of the translation	For example, 5 units in the x direction, and 3 units in the y direction (not angle and distance)
	understand that rotations, reflections and translations preserve length and angle so that a transformed shape under any of these transformations remains congruent to the original shape	
	understand that enlargements are specified by a centre and a scale factor	Positive scale factor only
	understand that enlargements preserve angles and not lengths	
	construct enlargements of objects and identify the scale factor of an enlargement	
	identify and give complete descriptions of transformations	
	use and interpret maps and scale drawings	

AO3 HANDLING DATA		
6. Statistics		
	Candidates should be taught to	***Notes***
6.1 Graphical Representation of Data	use different methods of presenting data	Pictograms, bar charts and pie charts only
	use appropriate methods of tabulation to enable the construction of statistical diagrams	
	interpret statistical diagrams	
6.2 Statistical Measures	understand the concept of average	Data could be in a list or tabulated form
	calculate the mean, median, mode and range for a discrete data set	Includes simple problems using these measures
	calculate an estimate for the mean for grouped data	
	identify the modal class for grouped data	
6.3 Probability	understand the language of probability	Outcomes, equal likelihood, events, random
	understand and use the probability scale	
	understand and use estimates or measures of probability from theoretical models	
	understand the concepts of a sample space and an event and how the probability of an event happening can be determined from the sample space	
	list all the outcomes for single events and for two successive events in a systematic way	For the tossing of two coins, the sample space can be listed as: Heads (H), Tails (T) (H, H), (H, T), (T, H), (H, T)
	estimate probabilities from previously collected data	
	calculate the probability of the complement of an event happening	Recognise that $\Sigma P_i = 1$. If $P(A) = p$, then $P(A') = 1 - p$ where A' is the complement of A

	use the addition rule of probability for mutually exclusive events	P(Either A or B occurring) = P(A) + P(B) when A and B are mutually exclusive
	understand and use the term *expected frequency*	Determine an estimate of the number of times an event with a probability of $\frac{2}{5}$ will happen over 300 tries

Higher Tier

KNOWLEDGE OF THE CONTENT FOR THE FOUNDATION TIER IS ASSUMED FOR CANDIDATES BEING PREPARED FOR THE HIGHER TIER.

AO1 NUMBER and ALGEBRA		
1. Numbers and the number system		
	Candidates should be taught to	***Notes***
1.1 Integers	***See Foundation Tier***	
1.2 Fractions	***See Foundation Tier***	
1.3 Decimals	convert recurring decimals into fractions	$0.\dot{3} = \frac{1}{3}$, $0.2333\ldots = \frac{21}{90}$
1.4 Powers and Roots	understand the meaning of surds manipulate surds, including rationalising the denominator where the denominator is a pure surd use index laws to simplify and evaluate numerical expressions involving integer, fractional and negative powers evaluate Highest Common Factors (HCF) and Lowest Common Multiples (LCM)	 Express in the form $a\sqrt{2}$: $\frac{2}{\sqrt{8}}$, $\sqrt{18} + 3\sqrt{2}$ Express in the form $a + b\sqrt{2}$: $(3 + 5\sqrt{2})^2$ Evaluate: $\sqrt[3]{8^2}$, $625^{-\frac{1}{2}}$, $\left(\frac{1}{25}\right)^{\frac{3}{2}}$
1.5 Set Language and Notation	understand sets defined in algebraic terms understand and use subsets understand and use the complement of a set use Venn diagrams to represent sets and the number of elements in sets use the notation n(A) for the number of elements in the set A use sets in practical situations	 If A is a subset of B, then $A \subset B$ Use the notation A'
1.6 Percentages	use reverse percentages	In a sale, prices were reduced by 30%. The sale price of an item was £17.50. Calculate the original price of the item

1.7 Ratio and Proportion	***See Foundation Tier***	
1.8 Degree of Accuracy	solve problems using upper and lower bounds where values are given to a degree of accuracy	The dimensions of a rectangle are 12 cm and 8 cm to the nearest cm. Calculate, to 3 significant figures, the smallest possible area as a percentage of the largest possible area.
1.9 Standard Form	express numbers in the form $a \times 10^n$ where n is an integer and $1 \leq a < 10$ solve problems involving standard form	$150\,000\,000 = 1.5 \times 10^8$
1.10 Applying Number	***See Foundation Tier***	
1.11 Electronic Calculators	***See Foundation Tier***	

2. Equations, Formulae and Identities

	Candidates should be taught to	***Notes***
2.1 Use of Symbols	use index notation involving fractional powers	Simplify: $\left(64t^3\right)^{\frac{2}{3}}$, $\frac{a^{\frac{1}{2}} \times a^{\frac{3}{4}}}{a^{\frac{1}{3}}}$
2.2 Algebraic Manipulation	expand the product of two linear expressions understand the concept of a quadratic expression and be able to factorise such expressions manipulate algebraic fractions where the numerator and/or the denominator can be numeric, linear or quadratic	$(2x + 3)(3x – 1)$, $(2x – y)(3x + y)$ Factorise: $x^2 + 12x – 45$, $6x^2 – 5x – 4$ Express as a single fraction: $\frac{x+1}{3}+\frac{x-3}{4}$, $\frac{3(4x-1)}{2}-\frac{2(5x+3)}{3}$, $\frac{3}{2x}-\frac{4}{3x}$, $\frac{3}{1-x}+\frac{2}{1+x}$, $\frac{x+1}{x+2}-\frac{x-2}{x-1}$ Factorise and simplify: $\frac{x^2-4x}{x^2-x-12}$
2.3 Expressions and Formulae	understand the process of manipulating formulae to change the subject where the subject may appear twice or a power of the subject occurs	$v^2 = u^2 + 2gs$; make s the subject $m = \frac{1+at}{1-at}$; make t the subject $V = \frac{4}{3}\pi r^3$; make r the subject $T = 2\pi\sqrt{\frac{l}{g}}$; make l the subject
2.4 Linear Equations	***See Foundation Tier***	$\frac{17-x}{4} = 2 – x$, $\frac{(2x-3)}{6}+\frac{(x+2)}{3}=\frac{5}{2}$

2.5 Proportion	set up problems involving direct or inverse proportion and relate algebraic solutions to graphical representation of the equations	To include only the following: $y \propto x$, $y \propto 1/x$, $y \propto x^2$, $y \propto 1/x^2$, $y \propto x^3$, $y \propto \sqrt{x}$
2.6 Simultaneous Linear Equations	calculate the exact solution of two simultaneous equations in two unknowns interpret the equations as lines and the common solution as the point of intersection	$3x - 4y = 7$, $2x - y = 8$ $2x + 3y = 17$, $3x - 5y = 35$
2.7 Quadratic Equations	solve quadratic equations by factorisation solve quadratic equations by using the quadratic formula form and solve quadratic equations from data given in a context solve simultaneous equations in two unknowns, one equation being linear and the other equation being quadratic	$2x^2 - 3x + 1 = 0$, $x(3x - 2) = 5$ $y = 2x - 11$ and $x^2 + y^2 = 25$ $y = 11x - 2$ and $y = 5x^2$
2.8 Inequalities	solve quadratic inequalities in one unknown and represent the solution set on a number line harder examples of regions defined by linear inequalities	$x^2 \leq 25$, $4x^2 > 25$, $(2x - 1)(x - 1) < 0$ Shade the region defined by the inequalities $x \leq 4$, $y < 2x + 1$, $5x + 2y < 20$

3. Sequences, Functions and Graphs

	Candidates should be taught to	*Notes*
3.1 Sequences	use linear expressions to describe the nth term of an arithmetic sequence	1, 3, 5, 7, 9, …. nth term = $2n - 1$
3.2 Function notation	understand the concept that a function is a mapping between elements of two sets	
	use function notations of the form f(x) = … and f : $x \mapsto$ …	
	understand the terms domain and range and which parts of a domain may need to be excluded	i.e. f(x) = $1/x$, $x \neq 0$
	understand and use the notations composite function fg and inverse function f^{-1}	'fg' will mean '*do* g *first, then* f'
3.3 Graphs	plot and draw graphs with equation: $y = Ax^3 + Bx^2 + Cx + D$ in which (i) the constants are integers and some could be zero (ii) the letters x and y can be replaced with any other two letters or: $y = Ax^3 + Bx^2 + Cx + D + E/x + F/x^2$ in which (i) the constants are numerical and at least three of them are zero (ii) the letters x and y can be replaced with any other two letters	$y = x^3$, $y = 3x^3 - 2x^2 + 5x - 4$, $y = 2x^3 - 6x + 2$, $V = 60w(60 - w)$ $y = \frac{1}{x}$, $x \neq 0$, $y = 2x^2 + 3x + 1/x$, $x \neq 0$, $y = \frac{1}{x}(3x^2 - 5)$, $x \neq 0$, $W = \frac{5}{d^2}$, $d \neq 0$
	find the gradients of non-linear graphs	By drawing a tangent
	find the intersection points of two graphs, one linear (y_1) and one non-linear (y_2), and recognise that the solutions correspond to the solutions of $y_2 - y_1 = 0$.	The x-values of the intersection of the two graphs $y = 2x + 1$, $y = x^2 + 3x - 2$ are the solutions of: $x^2 + x - 3 = 0$ Similarly, the x-values of the intersection of the two graphs $y = 5$, $y = x^3 - 3x^2 + 7$ are the solutions of: $x^3 - 3x^2 + 2 = 0$
	calculate a gradient of a straight line given two coordinates	
	recognise that equations of the form $y = mx+c$ are straight line graphs with gradient m and intercept on the y axis at the point (0, c)	
	find the equation of a straight line parallel to a given line	

3.4 Calculus	understand the concept of a variable rate of change	
	differentiate integer powers of x	
	determine gradients, rates of change, turning points (maxima and minima) by differentiation and relate these to graphs	$y = x + \frac{9}{x}$. Find the coordinates of the maximum and minimum points
	distinguish between maxima and minima by considering the general shape of the graph	
	apply calculus to linear kinematics and to other simple practical problems	The displacement, s metres, of a particle from a fixed point O after t seconds is given by $s = 24t^2 - t^3, \quad 0 \le t \le 20$. Find expressions for the velocity and the acceleration.

AO2 SHAPE, SPACE AND MEASURES		
4. Geometry		
	Candidates should be taught to	***Notes***
4.1 Lines and Triangles	***See Foundation Tier***	
4.2 Polygons	***See Foundation Tier***	
4.3 Symmetry	***See Foundation Tier***	
4.4 Measures	***See Foundation Tier***	
4.5 Construction	***See Foundation Tier***	
4.6 Circle Properties	understand and use the internal and external intersecting chord properties recognise the term *cyclic quadrilateral* understand and use angle properties of the circle including angle subtended by an arc at the centre of a circle is twice the angle subtended at any point on the remaining part of the circumference angle subtended at the circumference by a diameter is a right angle angles in the same segment are equal the sum of the opposite angles of a cyclic quadrilateral is 180° the alternate segment theorem	Formal proof of these theorems is not required
4.7 Geometrical Reasoning	provide reasons, using standard geometrical statements, to support numerical values for angles obtained in any geometrical context involving lines, polygons and circles	

4.8 Trigonometry	understand and use sine, cosine and tangent of obtuse angles understand and use angles of elevation and depression understand and use the sine and cosine rules for any triangle use Pythagoras' theorem in 3 dimensions understand and use the formula ½*bc* sin *A* for the area of a triangle apply trigonometrical methods to solve problems in 3 dimensions including finding the angle between a line and a plane	 The angle between two planes will not be required
4.9 Mensuration	find perimeters and areas of sectors of circles find the surface area and/or volume of a sphere and a right circular cone using relevant formulae convert between volume measures	Radian measure is excluded $m^3 \rightarrow cm^3$ and vice versa
4.10 Similarity	understand that areas of similar figures are in the ratio of the square of corresponding sides understand that volumes of similar figures are in the ratio of the cube of corresponding sides use areas and volumes of similar figures in solving problems	

5. Vectors and Transformation Geometry		
	Candidates should be taught to	***Notes***
5.1 Vectors	understand that a vector has both magnitude and direction	
	understand and use vector notation	The notations $\overrightarrow{OA}$ and **a** will be used
	multiply vectors by scalar quantities	
	add and subtract vectors	
	calculate the modulus (magnitude) of a vector	
	find the resultant of two or more vectors	$\overrightarrow{OA} = 3\mathbf{a}$, $\overrightarrow{AB} = 2\mathbf{b}$, $\overrightarrow{BC} = \mathbf{c}$ so: $\overrightarrow{OC} = 3\mathbf{a} + 2\mathbf{b} + \mathbf{c}$ $\overrightarrow{CA} = -\mathbf{c} - 2\mathbf{b}$
	apply vector methods for simple geometrical proofs	
5.2 Transformation Geometry	***See Foundation Tier***	Column vectors may be used to define translations

AO3 HANDLING DATA		
6. Statistics		
	Candidates should be taught to	***Notes***
6.1 Graphical Representation of Data	construct and interpret histograms construct cumulative frequency diagrams from tabulated data	For unequal class intervals
6.2 Statistical Measures	estimate the median from a cumulative frequency diagram understand the concept of a measure of spread estimate the interquartile range from given data or from a cumulative frequency diagram	 The terms upper quartile and lower quartile may be used
6.3 Probability	draw and use tree diagrams determine the probability that two or more independent events will both occur use simple conditional probability when combining events apply probability to simple problems	 Picking two balls out of a bag, one after the other, without replacement

Grade descriptions

The following grade descriptions indicate the level of attainment characteristic of the given grade at IGCSE. They give a general indication of the required learning outcomes at each specified grade. The descriptions should be interpreted in relation to the content outlined in the specification; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of the examination may be balanced by better performances in others.

Grade F

In order to carry through tasks and solve mathematical problems, candidates identify and obtain necessary information; they check their results, considering whether these are sensible. Candidates show understanding of situations by describing them mathematically, using symbols, words and diagrams. They draw simple conclusions of their own and give an explanation of their reasoning.

Candidates use their understanding of place value to multiply and divide whole numbers and decimals by 10, 100 and 1000. They order, add and subtract negative numbers in context. They use all four operations with decimals to two places. They reduce a fraction to its simplest form by cancelling common factors and solve simple problems involving ratio and direct proportion. They calculate fractional or percentage parts of quantities and measurements, using a calculator where necessary. In solving problems with or without a calculator, candidates check the reasonableness of their results by reference to their knowledge of the context or to the size of the numbers, by applying inverse operations or by estimating using approximations. Candidates explore and describe number patterns and relationships including multiple, factor and square. They construct, express in symbolic form, and use simple formulae involving one or two operations.

When constructing models and when drawing, or using shapes, candidates measure and draw angles as accurately as practicable, and use language associated with angle. They know the angle sum of a triangle and that of angles at a point. They identify all the symmetries of 2-D shapes. They convert from one metric unit to another. They make sensible estimates of a range of measures in relation to everyday situations. Candidates calculate areas of rectangles and right-angled triangles, and volumes of cuboids.

Candidates understand and use the mean of discrete data. They compare two simple distributions using the range and one of the mode, median or mean. They interpret graphs and diagrams, including pie charts, and draw conclusions. They understand and use the probability scale from 0 to 1. Candidates make and justify estimates of probability by selecting and using a method based on equally likely outcomes or on experimental evidence as appropriate. They understand that different outcomes may result from repeating an experiment.

Grade C

In making estimates candidates round to one significant figure and multiply and divide mentally. They solve numerical problems involving multiplication and division with numbers of any size using a calculator efficiently and appropriately. They understand and use the equivalences between fractions, decimals and percentages and calculate using ratios in appropriate situations. They understand and use proportional changes. Candidates find and describe in symbols the next term or the *n*th term of a sequence, where the rule is linear; they multiply two expressions of the form $(x + n)$; they simplify the corresponding quadratic expressions. They represent inequalities using a number line. They formulate and solve linear equations with whole number coefficients. They manipulate simple algebraic formulae, equations and expressions. Candidates use algebraic and graphical methods to solve simultaneous linear equations in two variables.

Candidates solve problems using angle and symmetry properties of polygons and properties of intersecting and parallel lines. They understand and apply Pythagoras' theorem when solving problems in two dimensions. Candidates find areas and circumferences of circles. They calculate lengths, areas and volumes in plane shapes and right prisms. Candidates enlarge shapes by positive whole number or fractional scale factor. They appreciate the imprecision of measurement and recognise that a measurement given to the nearest whole number may be inaccurate by up to one half in either direction. They understand and use compound measures such as speed.

Candidates construct and interpret frequency diagrams. They determine the modal class and estimate the mean, median and range of a set of grouped data, selecting the statistic most appropriate to a line of enquiry. They use measures of average and range with associated frequency polygons, as appropriate, to compare distributions and make inferences. Candidates understand relative frequency as an estimate of probability and use this to compare outcomes of experiments.

Grade A

Candidates understand and use direct and inverse proportion. They manipulate algebraic formulae, equations and expressions, finding common factors and multiplying two linear expressions. In simplifying algebraic expressions, they use rules of indices for negative and fractional values. In finding formulae that approximately connect data, candidates express general laws in symbolic form. They solve problems using intersections and gradients of graphs. Candidates use Pythagoras' theorem when solving problems in two and three dimensions. They calculate lengths of circular arcs and areas of sectors, and calculate the surface area of cylinders and volumes of cones and spheres.

Candidates interpret and construct histograms. They recognise when and how to work with probabilities associated with independent and mutually exclusive events.

Textbooks and other resources

Particularly recommended

- *Longman Mathematics for IGCSE, Book 1*, – I Potts, W Waite, V Hony and D Turner (Longman 2004) ISBN: 1405 80211 1

- *Longman Mathematics for IGCSE, Book 2* – I Potts, W Waite, V Hony and D Turner (Longman 2005) ISBN: 1405 80212 X

Also recommended

- *Edexcel GCSE Mathematics* – Keith Pledger et al. (Heinemann 2001) ISBN: 0435532715

- *Mathematics for IGCSE* – David Rayner (OUP 2000) ISBN: 0199147868

- *IGCSE Mathematics* – Ric Pimental, and Terry Wall (John Murray 1997) ISBN: 0719574587

Further teacher guidance material on set language and notation, function notation and calculus is available as an additional resource on the Edexcel International website: www.edexcel-international.org by following the links to IGCSE and then to Mathematics.

Support and training

Training

A programme of INSET courses covering various aspects of the specifications and assessment will be arranged by London Examinations on a regular basis. Full details may be obtained from

International Customer Relations Unit
Edexcel International
190 High Holborn
London
WC1V 7BE
UK

Tel: +44 (0) 190 884 7750
E-mail: international@edexcel.org.uk

Edexcel publications

Support materials and further copies of this specification can be obtained from

Edexcel Publications
Adamsway
Mansfield
Notts NG18 4LN
UK

Tel: +44 (0) 1623 450 781
Fax: +44 (0) 1623 450 481
E-mail: intpublications@linneydirect.com

The following support materials will be available from 2003 onwards

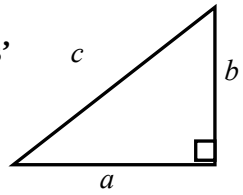
- Specimen papers and mark schemes (Publication code: UG013054)
- Teacher's Guide (Publication code: UG013033)

Appendices

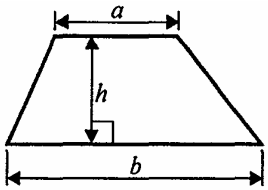
Appendix one – formulae sheet for Foundation Tier

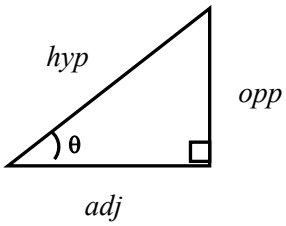
Pythagoras' theorem

$a^2+b^2=c^2$



Area of trapezium = $\frac{1}{2}(a+b)h$





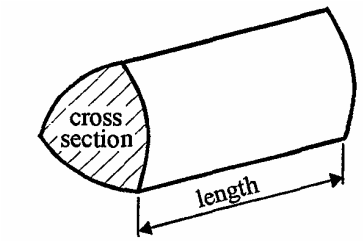
adj = hyp × cos θ
opp = hyp × sinθ
opp = adj × tan θ

or $\sin\theta = \frac{\text{opp}}{\text{hyp}}$

$\cos\theta = \frac{\text{adj}}{\text{hyp}}$

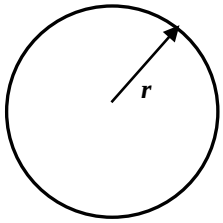
$\tan\theta = \frac{\text{opp}}{\text{adj}}$

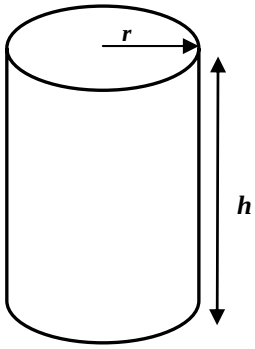
Volume of prism = area of cross section × length



Circumference of circle = $2\pi r$

Area of circle = πr^2



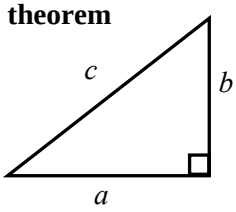


Volume of cylinder = $\pi r^2 h$

Curved surface area of cylinder = $2\pi rh$

Appendix two – formulae sheet for Higher Tier

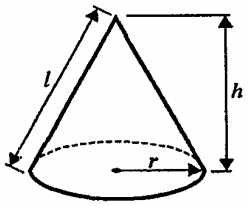
Pythagoras' theorem



$a^2+b^2=c^2$

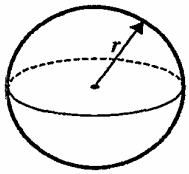
Volume of cone = $\frac{1}{3}\pi r^2 h$

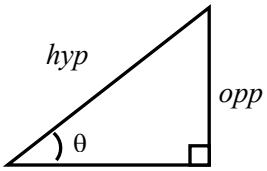
Curved surface area of cone = πrl



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

Surface area of sphere = $4\pi r^2$





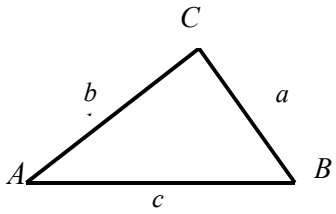
adj = hyp × cos θ
opp = hyp × sin θ
opp = adj × tan θ

or $\sin\theta = \frac{\text{opp}}{\text{hyp}}$

$\cos\theta = \frac{\text{adj}}{\text{hyp}}$

$\tan\theta = \frac{\text{opp}}{\text{adj}}$

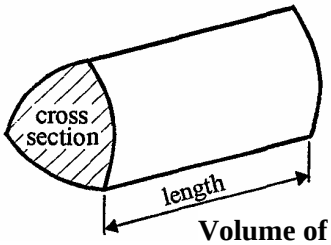
In any triangle ABC



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

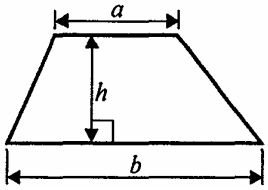
Cosine Rule $a^2 = b^2 + c^2 - 2bc\cos A$

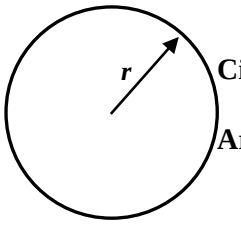
Area of triangle = $\frac{1}{2}ab\sin C$



Volume of prism = area of cross section × length

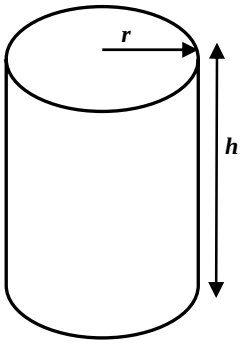
Area of trapezium = $\frac{1}{2}(a+b)h$





Circumference of circle = $2\pi r$

Area of circle = πr^2



Volume of cylinder = $\pi r^2 h$

Curved surface area of cylinder = $2\pi rh$

The quadratic equation

The solutions of $ax^2 + bx + c = 0$ where $a \neq 0$, are given by

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

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