Contents

1 About this specification

The Pearson Edexcel International GCSE in **Further Pure Mathematics** is part of a suite of International GCSE qualifications offered by Pearson.

This qualification is not accredited or regulated by any UK regulatory body.

This specification includes the following key features.

Structure: the Pearson Edexcel International GCSE in Further Pure Mathematics is a linear qualification. It consists of two examinations available at Higher Tier only (targeted at grades 9–4, with 3 allowed). Both examinations must be taken in the same series at the end of the course of study.

Content: relevant, engaging, emphasising the importance of further pure mathematics at International GCSE Level. Constructed to extend knowledge of the further pure mathematics topics in the specifications for the Pearson Edexcel International GCSE in Mathematics (Specification A) (Higher Tier) and the Pearson Edexcel International GCSE in Mathematics (Specification B).

Assessment: designed to be accessible to students from grades 9–4 using varying question-style approaches and the introduction of a formulae sheet in the written examinations.

Approach: a solid basis for students wishing to progress to Edexcel AS and Advanced GCE Level, or equivalent qualifications.

Specification updates

This specification is Issue 1 and is valid for the Pearson Edexcel International GCSE in Further Pure Mathematics examination from 2019. If there are any significant changes to the specification Pearson will inform centres to let them know. Changes will also be posted on our website.

For more information please visit qualifications.pearson.com

Using this specification

This specification has been designed to give guidance to teachers and encourage effective delivery of the qualification. The following information will help you get the most out of the content and guidance.

Compulsory content: arranged according to topic headings, as summarised in *Section 2: Further Mathematics content*.

Examples: we have included examples to exemplify content statements to support teaching and learning. It is important to note that these examples are for illustrative purposes only and centres can use other examples. We have included examples that are easily understood and recognised by international centres.

Qualification aims and objectives

The Pearson Edexcel International GCSE in Further Pure Mathematics qualification enables students to:

- study knowledge of mathematical techniques beyond International GCSE Mathematics content

- provide a course of study for those whose mathematical competence may have developed early
- develop an understanding of mathematical reasoning and processes, and the ability to relate different areas of mathematics
- enable students to acquire knowledge and skills with confidence, satisfaction and enjoyment
- develop mathematical skills for further study in the subject or related areas.

Why choose Edexcel qualifications?

Pearson – the world's largest education company

Edexcel academic qualifications are from Pearson, the UK's largest awarding organisation. With over 3.4 million students studying our academic and vocational qualifications worldwide, we offer internationally recognised qualifications to schools, colleges and employers globally.

Pearson is recognised as the world's largest education company, allowing us to drive innovation and provide comprehensive support for Edexcel students to acquire the knowledge and skills they need for progression in study, work and life.

A heritage you can trust

The background to Pearson becoming the UK's largest awarding organisation began in 1836, when a royal charter gave the University of London its first powers to conduct exams and confer degrees on its students. With over 150 years of international education experience, Edexcel qualifications have firm academic foundations, built on the traditions and rigour associated with Britain's educational system.

Results you can trust

Pearson's leading online marking technology has been shown to produce exceptionally reliable results, demonstrating that at every stage, Edexcel qualifications maintain the highest standards.

Developed to Pearson's world-class qualifications standards

Pearson's world-class standards mean that all Edexcel qualifications are developed to be rigorous, demanding, inclusive and empowering. We work collaboratively with a panel of educational thought-leaders and assessment experts, to ensure that Edexcel qualifications are globally relevant, represent world-class best practice and maintain a consistent standard.

For more information on the World Class Qualification process and principles please go to *Appendix 2* or visit our website: uk.pearson.com/world-class-qualifications

Why choose Pearson Edexcel International GCSE in Further Pure Mathematics?

We've listened to feedback from all parts of the International school and UK Independent school subject community, including a large number of teachers. We've made changes that will engage students and develop their skills to progress to further study of Mathematics and a wide range of other subjects. Our content and assessment approach has been designed to meet students' needs and sits within our wider subject offer for Mathematics, providing the next step on from both our International GCSE qualifications in Mathematics (Specification A and B).

Extended Mathematics course of study – We have designed this qualification to enhance the learning for students whose mathematical competence may have developed early, or who wish to pursue their interest in the subject. It provides an additional Level 2 International GCSE qualification, which extends mathematical techniques beyond those covered in International GCSE/GCSE in Mathematics.

Clear and straightforward question papers – Our question papers are clear and designed specifically to target the Higher Tier (grades 9–4 with grade 3 allowed) making them accessible for students in this ability range. Our mark schemes are straightforward, so that the assessment requirements are clear.

Broaden and deepen students' skills – We have designed the International GCSE to extend students' knowledge by broadening and deepening skills, for example:

- Students use numerical skills in both a purely mathematical way and in real-life situations
- Students use algebra and calculus to set up and solve problems
- Students develop competence and confidence when manipulating mathematical expressions
- Students use vectors and rates of change to model situations.

Supports progression to A Level – Our qualifications enable successful progression onto A Level and beyond. Through our world-class qualification development process we have consulted with International A Level and GCE A Level teachers, as well as university professors to validate the appropriacy of this qualification including the content, skills and assessment structure. More information about all of our Mathematics qualifications can be found on our Edexcel International GCSE pages at: qualifications.pearson.com

Supporting you in planning and implementing this qualification

Planning

- Our *Getting Started Guide* gives you an overview of the Pearson Edexcel International GCSE in Further Pure Mathematics to help you understand the changes to content and assessment, and to help you understand what these changes mean for you and your students.
- We will provide you with a course planner and editable schemes of work.
- Our mapping documents highlight key differences between the new and 2009 legacy qualification.

Teaching and learning

- Our skills maps will highlight skills areas that are naturally developed through the study of mathematics, showing connections between areas and opportunities for further development.
- Print and digital learning and teaching resources – promotes any time, any place learning to improve student motivation and encourage new ways of working.

Preparing for exams

We will also provide a range of resources to help you prepare your students for the assessments, including:

- specimen papers to support formative assessments and mock exams
- examiner commentaries following each examination series.

ResultsPlus

ResultsPlus provides the most detailed analysis available of your students' exam performance. It can help you identify the topics and skills where further learning would benefit your students.

examWizard

A free online resource designed to support students and teachers with exam preparation and assessment.

Training events

In addition to online training, we host a series of training events each year for teachers to deepen their understanding of our qualifications.

Get help and support

Our subject advisor service will ensure you receive help and guidance from us. You can sign up to receive the Edexcel newsletter to keep up to date with qualification updates and product and service news.

Qualification at a glance

The Pearson Edexcel International GCSE in Further Pure Mathematics comprises of two externally assessed papers.

This specification is offered through a single tier.

Questions are targeted at grades in the range 9–4, with 3 allowed.

Students whose level of achievement is below the minimum judged by Pearson to be of sufficient standard will receive an unclassified U result.

Paper overview

Paper 1	*Component/paper code 4PM1/01
Paper 2	*Component/paper code 4PM1/02
• Externally assessed • Availability: January and June • First assessment: June 2019	Each paper is 50% of the total International GCSE
Content summary • Number • Algebra and calculus • Geometry and trigonometry	
Assessment • Each paper is assessed through a 2-hour examination set and marked by Pearson. • The total number of marks for each paper is 100. • Each paper will consist of around 11 questions with varying mark allocations per question, which will be stated on the paper. • Each paper will contain questions from any part of the specification content, and the solution of any questions may require knowledge of more than one section of the specification content. • The paper will have approximately 40% of the marks distributed evenly over grades 4 and 5 and approximately 60% of the marks distributed evenly over grades 6, 7, 8 and 9. • A formulae sheet (*Appendix 4*) will be included in the written examinations. • A calculator may be used in the examinations (see *page 22* for more information).	

* See *Appendix 1* for a description of this code and all the other codes relevant to this qualification.

2 Further Pure Mathematics content

Content

Externally assessed

Description

The Pearson Edexcel International GCSE in Further Pure Mathematics requires students to demonstrate application and understanding of the following:

Number

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

Algebra and calculus

- Use algebra and calculus to set up and solve problems.
- Develop competence and confidence when manipulating mathematical expressions.
- Construct and use graphs in a range of situations.

Geometry and trigonometry

- Understand the properties of shapes, angles and transformations.
- Use vectors and rates of change to model situations.
- Use coordinate geometry.
- Use trigonometry.

Students will be expected to have a thorough knowledge of the content common to the Pearson Edexcel International GCSE in Mathematics (Specification A) (Higher Tier) or Pearson Edexcel International GCSE in Mathematics (Specification B).

Questions may be set which assumes knowledge of some topics covered in these specifications, however knowledge of statistics and matrices will not be required.

Students will be expected to carry out arithmetic and algebraic manipulation, such as being able to change the subject of a formula and evaluate numerically the value of any variable in a formula, given the values of the other variables.

The use and notation of set theory will be adopted where appropriate.

Assessment information

Each paper is assessed through a 2-hour examination set and marked by Pearson.

The total number of marks for each paper is 100.

Each paper will consist of around 11 questions with varying mark allocations per question, which will be stated on the paper.

Each paper will contain questions from any part of the specification content, and the solution of any questions may require knowledge of more than one section of the specification content.

Each paper will have approximately 40% of the marks distributed evenly over grades 4 and 5 and approximately 60% of the marks distributed evenly over grades 6, 7, 8 and 9.

Diagrams will not necessarily be drawn to scale and measurements should not be taken from diagrams unless instructions to this effect are given.

A formulae sheet (*Appendix 4*) will be included in the written examinations.

A calculator may be used in the examinations (please see *page 22* for further information).

Questions will be set in SI units (international system of units).

1 Logarithmic functions and indices

What students need to learn	Notes
A The functions a^x and $\log_b x$ (where b is a natural number greater than one)	A knowledge of the shape of the graphs of a^x and $\log_b x$ is expected, but not a formal expression for the gradient.
B Use and properties of indices and logarithms, including change of base	To include: $\log_a xy = \log_a x + \log_a y,$ $\log_a \frac{x}{y} = \log_a x - \log_a y,$ $\log_a x^k = k \log_a x,$ $\log_a a = 1$ $\log_a 1 = 0$ The solution of equations of the form $a^x = b.$ Students may use the change of base formulae: $\log_a x = \frac{\log_b x}{\log_b a}$ $\log_a b = \frac{1}{\log_b a}$
C Simple manipulation of surds	Students should understand what surds represent and their use for exact answers. Manipulation will be very simple. For example: $5\sqrt{3} + 2\sqrt{3} = 7\sqrt{3}$ $\sqrt{48} = 4\sqrt{3}$
D Rationalising the denominator	$10 \times \frac{1}{\sqrt{5}} = 2\sqrt{5}$ or $\frac{1}{2-\sqrt{3}}$

2 The quadratic function

What students need to learn	Notes
A The manipulation of quadratic expressions	Students should be able to factorise quadratic expressions and complete the square.
B The roots of a quadratic equation	Students should be able to use the discriminant to identify whether the roots are equal real, unequal real or not real.
C Simple examples involving functions of the roots of a quadratic equation	Students are expected to understand and use: $ax^2 + bx + c = 0$ has roots $\alpha, \beta = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ and forming an equation with given roots, which are expressed in terms of α and β : $\alpha + \beta = \frac{-b}{a}$ and $\alpha\beta = \frac{c}{a}$

3 Identities and inequalities

What students need to learn	Notes
A Simple algebraic division	Division by $(x + a)$, $(x - a)$, $(ax + b)$ or $(ax - b)$ will be required.
B The factor and remainder theorems	Students should know that if $f(x) = 0$ when $x = a$, then $(x - a)$ is a factor of $f(x)$. Students may be required to factorise cubic expressions such as: $x^3 + 3x^2 - 4$ and $6x^3 + 11x^2 - x - 6$, when a factor has been provided. Students should be familiar with the terms 'quotient' and 'remainder' and be able to determine the remainder when the polynomial $f(x)$ is divided by $(ax + b)$ or $(ax - b)$.
C Solutions of equations, extended to include the simultaneous solution of one linear and one quadratic equation in two variables	The solution of a cubic equation containing at least one rational root may be set.
D Simple inequalities, linear and quadratic	For example $ax + b > cx + d$, $px^2 + qx + r < sx^2 + tx + u$
E The graphical representation of linear inequalities in two variables	The emphasis will be on simple questions designed to test fundamental principles. Simple problems on linear programming may be set.

4 Graphs

What students need to learn	Notes
A Graphs of polynomials and rational functions with linear denominators	The concept of asymptotes parallel to the coordinate axes is expected.
B The solution of equations and transcendental functions by graphical methods	Non-graphical iterative methods are not required.

5 Series

What students need to learn	Notes
A Use of the $\sum$ notation	The $\sum$ notation may be employed wherever its use seems desirable.
B Arithmetic and geometric series	Knowledge of the general term of an arithmetic series is required. Use of the sum to n terms of an arithmetic series is required. Knowledge of the general term of a geometric series is required. Use of the sum to n terms of a finite geometric series is required. Use of the sum to infinity of a convergent geometric series, including the use of $\|r\| < 1$ is required. Proofs of the above are not required.

6 The binomial series

What students need to learn	Notes
A Use of the binomial series $(1 + x)^n$	Use of the series when: (i) n is a positive integer (ii) n is rational and $\|x\| < 1$ The validity condition for (ii) is expected.

7 Scalar and vector quantities

What students need to learn	Notes
A The addition and subtraction of coplanar vectors and the multiplication of a vector by a scalar	Knowledge of the fact that if $\alpha_1\mathbf{a} + \beta_1\mathbf{b} = \alpha_2\mathbf{a} + \beta_2\mathbf{b}$, where $\mathbf{a}$ and $\mathbf{b}$ are non-parallel vectors, then $\alpha_1 = \alpha_2$ and $\beta_1 = \beta_2$, is expected.
B Components and resolved parts of a vector	Use of the vectors $\mathbf{i}$ and $\mathbf{j}$ will be expected.
C Magnitude of a vector	
D Position vector	$\overrightarrow{AB} = \overrightarrow{OB} - \overrightarrow{OA} = \mathbf{b} - \mathbf{a}$
E Unit vector	
F Use of vectors to establish simple properties of geometrical figures	The 'simple properties' will, in general, involve collinearity, parallel lines and concurrency. Position vector of a point dividing the line AB in the ratio $m : n$ is expected.

8 Rectangular Cartesian coordinates

What students need to learn	Notes
A The distance between two points	The distance d between two points (x_1, y_1) and (x_2, y_2) is given by $d^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2$
B The point dividing a line in a given ratio	The coordinates of the point dividing the line joining (x_1, y_1) and (x_2, y_2) in the ratio $m : n$ are given by $\left(\frac{nx_1 + mx_2}{m+n}, \frac{ny_1 + my_2}{m+n}\right)$
C Gradient of a straight line joining two points	
D The straight line and its equation	The $y = mx + c$ and $y - y_1 = m(x - x_1)$ forms of the equation of a straight line are expected to be known. The interpretation of $ax + by = c$ as a straight line is expected to be known.
E The condition for two lines to be parallel or to be perpendicular	

9 Calculus

What students need to learn	Notes
A Differentiation and integration of sums of multiples of powers of x (excluding integration of $\frac{1}{x}$), $\sin ax, \cos ax, e^{ax}$	No formal proofs of the results for ax^n, $\sin ax$, $\cos ax$ and e^{ax} will be required.
B Differentiation of a product, quotient and simple cases of a function of a function	
C Applications to simple linear kinematics and to determination of areas and volumes	Understanding how displacement, velocity and acceleration are related using calculus. The volumes will be obtained only by revolution about the coordinate axes.
D Stationary points and turning points	
E Maxima and minima	Maxima and minima problems may be set in the context of a practical problem. Justification of maxima and minima will be expected.
F The equations of tangents and normals to the curve $y = f(x)$	$f(x)$ may be any function which the students are expected to be able to differentiate.
G Application of calculus to rates of change and connected rates of change	The emphasis will be on simple examples to test principles. A knowledge of $dy \approx \frac{dy}{dx} dx$ for small dx is expected.

10 Trigonometry

What students need to learn	Notes
A Radian measure, including use for arc length and area of sector	The formulae: $s = r\theta$ and $A = \frac{1}{2}r^2\theta$ for a circle are expected to be known.
B The three basic trigonometric ratios of angles of any magnitude (in degrees or radians) and their graphs	To include the exact values for sine, cosine and tangent of $30°$, $45°$, $60°$ (and the radian equivalents), and the use of these to find the trigonometric ratios of related values such as $120°$, $300°$
C Applications to simple problems in two or three dimensions (including angles between a line and a plane and between two planes)	
D Use of the sine and cosine formulae	General proofs of the sine and cosine formulae will not be required. The cosine formula will be given but other formulae are expected to be known. The area of a triangle in the form: $\frac{1}{2}ab\sin C$ is expected to be known.
E The identity $\cos^2\theta + \sin^2\theta = 1$	$\cos^2\theta + \sin^2\theta = 1$ is expected to be known.
F Use of the identity $\tan\theta = \frac{\sin\theta}{\cos\theta}$	This will be provided on the formula sheet.
G The use of the basic addition formulae of trigonometry	Formal proofs of $\sin(A \pm B)$, $\cos(A \pm B)$ formulae will not be required. Questions using the formulae for $\sin(A \pm B)$, $\cos(A \pm B)$, $\tan(A \pm B)$ may be set; the formulae will be on the formula sheet, for example: $\sin(A + B) = \sin A\cos B + \cos A\sin B$ Long questions, explicitly involving excessive manipulation, will not be set.

What students need to learn	Notes
H Solution of simple trigonometric equations for a given interval	Students should be able to solve equations such as: $\sin(x-\frac{\pi}{2})=\frac{3}{4}$ for $0 < x < 2\pi$, $\cos(3x+30°)=\frac{1}{2}$ for $-90° < x < 90°$, $\tan 2x = 1$ for $90° < x < 270°$, $6\cos^2 x° + \sin x° - 5 = 0$ for $0 \square x < 360$, $\sin^2\left(x+\frac{\pi}{6}\right)=\frac{1}{2}$ for $-\pi \square x < \pi$

3 Assessment information

Assessment requirements

Paper number	Level	Assessment information	Number of marks allocated in the paper
Paper 1	Higher	Assessed through a 2-hour examination set and marked by Pearson. The paper is weighted at 50% of the qualification, targeted at grades 9–4 with 3 allowed.	100
Paper 2	Higher	Assessed through a 2-hour examination set and marked by Pearson. The paper is weighted at 50% of the qualification, targeted at grades 9–4 with 3 allowed.	100

Calculators

Students will be expected to have access to a suitable electronic calculator for all examination papers. The electronic calculator should have these functions as a minimum:

- $+, -, \times, \div, \pi$ x^2, $\sqrt{x}$, $\frac{1}{x}$, x^y ln x, e^x, standard form, sine, cosine, tangent and their inverses in degrees and decimals of a degree or radians.

Prohibitions

Calculators with any of the following facilities are prohibited in all examinations:

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

Assessment objectives and weightings

		% in International GCSE
AO1	Demonstrate a confident knowledge of the techniques of pure mathematics required in the specification	30–40%
AO2	Apply a knowledge of mathematics to the solutions of problems for which an immediate method of solution is not available and which may involve knowledge of more than one topic in the specification	20–30%
AO3	Write clear and accurate mathematical solutions	35–50%
	TOTAL	**100%**

Relationship of assessment objectives to units

Unit number	Assessment objective		
	AO1	**AO2**	**AO3**
Papers 1	15–20%	10–15%	17.5–25%
Papers 2	15–20%	10–15%	17.5–25%
Total for International GCSE	30–40%	20–30%	35–50%

All components will be available for assessment from June 2019.

4 Administration and general information

Entries

Details of how to enter students for the examinations for this qualification can be found in our *International Information Manual*. A copy is made available to all examinations officers and is available on our website.

Students should be advised that, if they take two qualifications in the same subject, colleges, universities and employers are very likely to take the view that they have achieved only one of the two GCSEs/International GCSEs. Students or their advisers who have any doubts about subject combinations should check with the institution to which they wish to progress before embarking on their programmes.

Access arrangements, reasonable adjustments, special consideration and malpractice

Equality and fairness are central to our work. Our equality policy requires all students to have equal opportunity to access our qualifications and assessments, and our qualifications to be awarded in a way that is fair to every student.

We are committed to making sure that:

- students with a protected characteristic (as defined by the UK Equality Act 2010) are not, when they are undertaking one of our qualifications, disadvantaged in comparison to students who do not share that characteristic
- all students achieve the recognition they deserve for undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

Language of assessment

Assessment of this qualification will only be available in English. All student work must be in English.

We recommend that students are able to read and write in English at Level B2 of the Common European Framework of Reference for Languages.

Access arrangements

Access arrangements are agreed before an assessment. They allow students with special educational needs, disabilities or temporary injuries to:

- access the assessment
- show what they know and can do without changing the demands of the assessment.

The intention behind an access arrangement is to meet the particular needs of an individual student with a disability without affecting the integrity of the assessment. Access arrangements are the principal way in which awarding bodies comply with the duty under the Equality Act 2010 to make 'reasonable adjustments'.

Access arrangements should always be processed at the start of the course. Students will then know what is available and have the access arrangement(s) in place for assessment.

Reasonable adjustments

The UK Equality Act 2010 requires an awarding organisation to make reasonable adjustments where a student with a disability would be at a substantial disadvantage in undertaking an assessment. The awarding organisation is required to take reasonable steps to overcome that disadvantage.

A reasonable adjustment for a particular student may be unique to that individual and therefore might not be in the list of available access arrangements.

Whether an adjustment will be considered reasonable will depend on a number of factors, including:

- the needs of the student with the disability
- the effectiveness of the adjustment
- the cost of the adjustment; and
- the likely impact of the adjustment on the student with the disability and other students.

An adjustment will not be approved if it involves unreasonable costs to the awarding organisation, timeframes or affects the security or integrity of the assessment. This is because the adjustment is not 'reasonable'.

Special consideration

Special consideration is a post-examination adjustment to a student's mark or grade to reflect temporary injury, illness or other indisposition at the time of the examination/ assessment, which has had, or is reasonably likely to have had, a material effect on a candidate's ability to take an assessment or demonstrate their level of attainment in an assessment.

Further information

Please see our website for further information about how to apply for access arrangements and special consideration.

For further information about access arrangements, reasonable adjustments and special consideration please refer to the JCQ website: www.jcq.org.uk

Malpractice

Candidate malpractice

Candidate malpractice refers to any act by a candidate that compromises or seeks to compromise the process of assessment or that undermines the integrity of the qualifications or the validity of results/certificates.

Candidate malpractice in examinations **must** be reported to Pearson using a *JCQ Form M1* (available at www.jcq.org.uk/exams-office/malpractice). The form can be emailed to pqsmalpractice@pearson.com or posted to: Investigations Team, Pearson, 190 High Holborn, London, WC1V 7BH. Please provide as much information and supporting documentation as possible. Note that the final decision regarding appropriate sanctions lies with Pearson.

Failure to report malpractice constitutes staff or centre malpractice.

Staff/centre malpractice

Staff and centre malpractice includes both deliberate malpractice and maladministration of our qualifications. As with candidate malpractice, staff and centre malpractice is any act that compromises or seeks to compromise the process of assessment or that undermines the integrity of the qualifications or the validity of results/certificates.

All cases of suspected staff malpractice and maladministration **must** be reported immediately, before any investigation is undertaken by the centre, to Pearson on a *JCQ Form M2(a)* (available at www.jcq.org.uk/exams-office/malpractice).

The form, supporting documentation and as much information as possible can be emailed to pqsmalpractice@pearson.com or posted to: Investigations Team, Pearson, 190 High Holborn, London, WC1V 7BH. Note that the final decision regarding appropriate sanctions lies with Pearson.

Failure to report malpractice itself constitutes malpractice.

More-detailed guidance on malpractice can be found in the latest version of the document *JCQ General and vocational qualifications Suspected Malpractice in Examinations and Assessments,* available at www.jcq.org.uk/exams-office/malpractice

Awarding and reporting

The International GCSE qualification will be graded and certificated on a six-grade scale from 9 to 4, with 3 allowed using the total subject mark where 9 is the highest grade. Individual components are not graded. The first certification opportunity for the Pearson Edexcel International GCSE in Further Pure Mathematics will be in June 2019. Students whose level of achievement is below the minimum judged by Pearson to be of sufficient standard to be recorded on a certificate will receive an unclassified U result.

Student recruitment and progression

Pearson's policy concerning recruitment to our qualifications is that:

- they must be available to anyone who is capable of reaching the required standard
- they must be free from barriers that restrict access and progression
- equal opportunities exist for all students.

Prior learning and other requirements

Students will be expected to have a thorough knowledge of the content common to the Pearson Edexcel International GCSE in Mathematics (Specification A) (Higher Tier) or Pearson Edexcel International GCSE in Mathematics (Specification B).

Progression

Students can progress from this qualification to:

- the GCE Advanced Subsidiary (AS) and Advanced Level in Mathematics, Further Mathematics and Pure Mathematics
- the International Advanced Subsidiary (AS) and Advanced Level in Mathematics, Further Mathematics and Pure Mathematics
- other equivalent, Level 3 Mathematics qualifications
- further study in other areas where mathematics is required
- other further training or employment where numerate skills and knowledge are required.

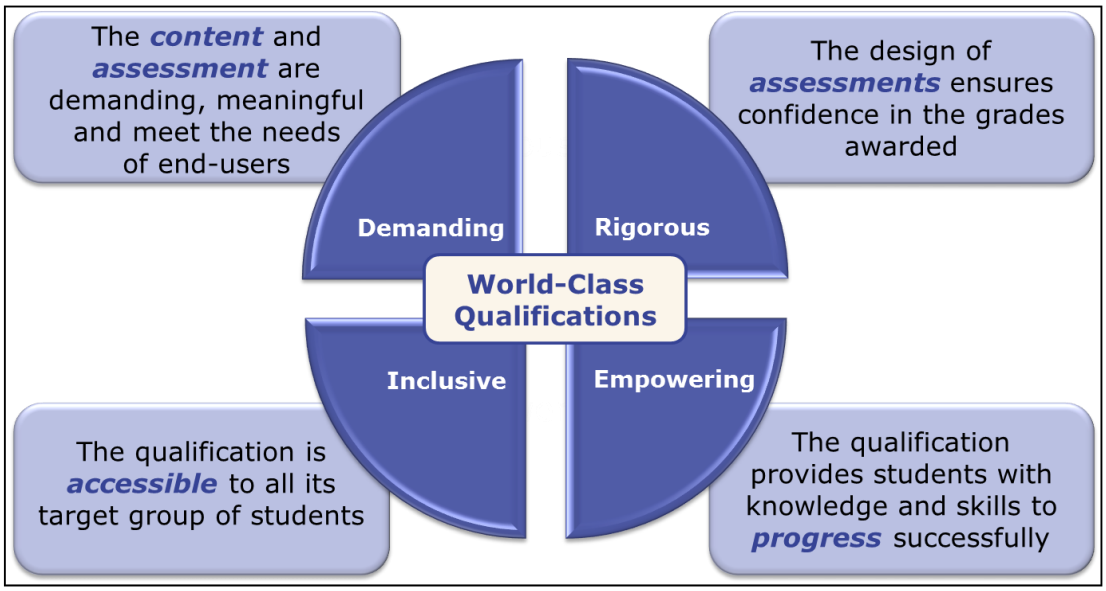
Appendices

Appendix 1: Codes

Type of code	Use of code	Code
Subject codes	The subject code is used by centres to enter students for a qualification.	Pearson Edexcel International GCSE Further Pure Mathematics: 4PM1
Paper codes	These codes are provided for information. Students need to be entered for individual papers.	Paper 1: 4PM1/01 Paper 2: 4PM1/02

Appendix 2: Pearson World Class Qualification Design Principles

Pearson's world-class qualification design principles mean that all Edexcel qualifications are developed to be **rigorous, demanding, inclusive and empowering**.



We work collaboratively to gain approval from an external panel of educational thought-leaders and assessment experts from across the globe. This is to ensure that Edexcel qualifications are globally relevant, represent world-class best practice in qualification and assessment design, maintain a consistent standard and support learner progression in today's fast changing world.

Pearson's Expert Panel for World-class Qualifications is chaired by Sir Michael Barber, a leading authority on education systems and reform. He is joined by a wide range of key influencers with expertise in education and employability.

"I'm excited to be in a position to work with the global leaders in curriculum and assessment to take a fresh look at what young people need to know and be able to do in the 21st century, and to consider how we can give them the opportunity to access that sort of education." Sir Michael Barber.

Endorsement from Pearson's Expert Panel for World-class Qualifications for International GCSE development processes

"We were chosen, either because of our expertise in the UK education system, or because of our experience in reforming qualifications in other systems around the world as diverse as Singapore, Hong Kong, Australia and a number of countries across Europe.

We have guided Pearson through what we judge to be a rigorous world-class qualification development process that has included:

- Extensive international comparability of subject content against the highest-performing jurisdictions in the world
- Benchmarking assessments against UK and overseas providers to ensure that they are at the right level of demand
- Establishing External Subject Advisory Groups, drawing on independent subject-specific expertise to challenge and validate our qualifications

Importantly, we have worked to ensure that the content and learning is future oriented, and that the design has been guided by Pearson's Efficacy Framework. This is a structured, evidence-based process which means that learner outcomes have been at the heart of this development throughout.

We understand that ultimately it is excellent teaching that is the key factor to a learner's success in education but as a result of our work as a panel we are confident that we have supported the development of Edexcel International GCSE qualifications that are outstanding for their coherence, thoroughness and attention to detail and can be regarded as representing world-class best practice."

Sir Michael Barber (Chair) Chief Education Advisor, Pearson plc	**Professor Sing Kong Lee** Professor, National Institute of Education in Singapore
Dr Peter Hill Former Chief Executive ACARA	**Bahram Bekhradnia** President, Higher Education Policy Institute
Professor Jonathan Osborne Stanford University	**Dame Sally Coates** Director of Academies (South), United Learning Trust
Professor Dr Ursula Renold Federal Institute of Technology, Switzerland	**Professor Bob Schwartz** Harvard Graduate School of Education
Professor Janice Kay Provost, University of Exeter	**Jane Beine** Head of Partner Development, John Lewis Partnership
Jason Holt CEO, Holts Group	

Appendix 3: Transferable skills

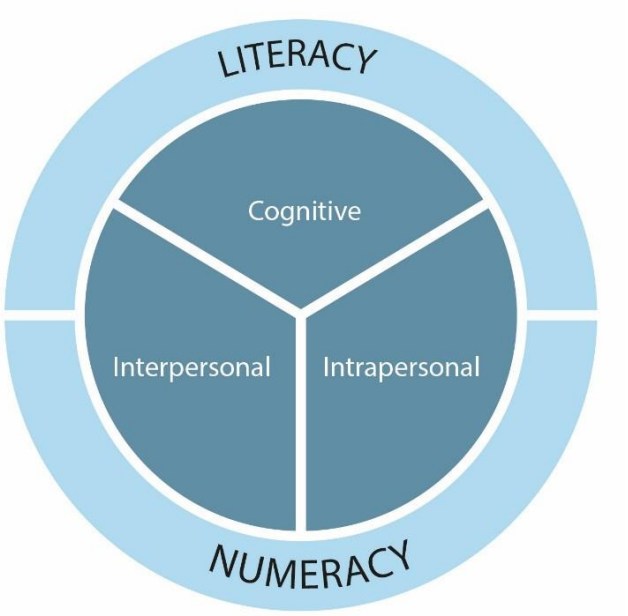
The need for transferable skills

In recent years, higher education institutions and employers have consistently flagged the need for students to develop a range of transferable skills to enable them to respond with confidence to the demands of undergraduate study and the world of work.

The Organisation for Economic Co-operation and Development (OECD) defines skills, or competencies, as 'the bundle of knowledge, attributes and capacities that can be learned and that enable individuals to successfully and consistently perform an activity or task and can be built upon and extended through learning.'[1]

To support the design of our qualifications, the Pearson Research Team selected and evaluated seven global 21st-century skills frameworks. Following on from this process, we identified the National Research Council's (NRC) framework [2] as the most evidence-based and robust skills framework, and have used this as a basis for our adapted skills framework.

The framework includes cognitive, intrapersonal skills and interpersonal skills.



The skills have been interpreted for this specification to ensure they are appropriate for the subject. All of the skills listed are evident or accessible in the teaching, learning and/or assessment of the qualification. Some skills are directly assessed. Pearson materials will support you in identifying these skills and developing these skills in students.

The table overleaf sets out the framework and gives an indication of the skills that can be found in the Pearson Edexcel International GCSE in Further Pure Mathematics and indicates the interpretation of the skill in this area. A full subject interpretation of each skill, with mapping to show opportunities for students' development is provided on the subject pages of our website: qualifications.pearson.com

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1 OECD (2012), Better Skills, Better Jobs, Better Lives (2012): http://skills.oecd.org/documents/OECDSkillsStrategyFINALENG.pdf

2 Koenig, J. A. (2011) Assessing 21st Century Skills: Summary of a Workshop, National Research Council

Cognitive skills	Cognitive processes and strategies:	• Critical thinking • Problem solving • Analysis • Reasoning • Interpretation • Decision making • Adaptive learning • Executive function
	Creativity:	• Creativity • Innovation
Intrapersonal skills	Intellectual openness:	• Adaptability • Personal and social responsibility • Continuous learning • Intellectual interest and curiosity
	Work ethic/ conscientiousness:	• Initiative • Self-direction • Responsibility • Perseverance • Productivity • Self-regulation (metacognition, forethought, reflection) • Ethics • Integrity
	Positive core self evaluation:	• Self-monitoring/self-evaluation/self-reinforcement
Interpersonal skills	Teamwork and collaboration:	• Communication • Collaboration • Teamwork • Co-operation • Interpersonal skills
	Leadership:	• Leadership • Responsibility • Assertive communication • Self-presentation

Problem solving for translating problems in mathematical or non-mathematical contexts into a process or a series of mathematical processes and solving them.

Initiative for using mathematical knowledge, independently (without guided learning), to further own understanding.

Communication to communicate a mathematical process or technique (verbally or written) to peers and teachers and answer questions from others.

Appendix 4: Formulae sheet for examinations

Mensuration

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

Curved surface area of cone = $\pi r \times$ slant height

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

Series

Arithmetic series

Sum to n terms, $S_n = \frac{n}{2}\left[2a + (n-1)d\right]$

Geometric series

Sum to n terms, $S_n = \frac{a\left(1-r^n\right)}{\left(1-r\right)}$

Sum to infinity, $S_\infty = \frac{a}{1-r} \quad |r| < 1$

Binomial series

$$\left(1+x\right)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \ldots + \frac{n(n-1)\ldots(n-r+1)}{r!}x^r + \ldots \quad \text{for } |x| < 1, n \in \mathbb{Q}$$

Calculus

Quotient rule (differentiation)

$$\frac{\mathrm{d}}{\mathrm{d}x}\left(\frac{\mathrm{f}(x)}{\mathrm{g}(x)}\right) = \frac{\mathrm{f}'(x)\mathrm{g}(x) - \mathrm{f}(x)\mathrm{g}'(x)}{\left[\mathrm{g}(x)\right]^2}$$

Trigonometry

Cosine rule

In triangle ABC: $a^2 = b^2 + c^2 - 2bc\cos A$

$$\tan\theta = \frac{\sin\theta}{\cos\theta}$$

$$\sin(A+B) = \sin A\cos B + \cos A\sin B \qquad \sin\left(A-B\right) = \sin A\cos B - \cos A\sin B$$

$$\cos\left(A+B\right) = \cos A\cos B - \sin A\sin B \qquad \cos\left(A-B\right) = \cos A\cos B + \sin A\sin B$$

$$\tan\left(A+B\right) = \frac{\tan A + \tan B}{1 - \tan A\tan B} \qquad \tan\left(A-B\right) = \frac{\tan A - \tan B}{1 + \tan A\tan B}$$

Logarithms

$$\log_a x = \frac{\log_b x}{\log_b a}$$

Appendix 5: Formulae to learn

This appendix gives formulae that students are expected to remember and will **not** be included on the formula sheet provided in the examination papers.

Logarithmic functions and indices

$\log_a xy = \log_a x + \log_a y$

$\log_a \frac{x}{y} = \log_a x - \log_a y$

$\log_a x^k = k \log_a x$

$\log_a \frac{1}{x} = -\log_a x$

$\log_a a = 1$

$\log_a 1 = 0$

$\log_a b = \frac{1}{\log_b a}$

Quadratic equations

$ax^2 + bx + c = 0$ has roots $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

when the roots of $ax^2 + bx + c = 0$ are α and β then $\alpha + \beta = -\frac{b}{a}$ and $\alpha\beta = \frac{c}{a}$

and the equation can be written $x^2 - (\alpha + \beta)x + \alpha\beta = 0$

Series

Arithmetic series

nth term $= l = a + (n-1)d$

Geometric series

nth term $= ar^{n-1}$

Coordinate geometry

The gradient of the line joining two points (x_1, y_1) and (x_2, y_2) is given by $\frac{y_2 - y_1}{x_2 - x_1}$

The distance d between two points (x_1, y_1) and (x_2, y_2) is given by $d^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2$

The coordinates of the point dividing the line joining (x_1, y_1) and (x_2, y_2) in the ratio $m : n$ are $\left(\frac{nx_1 + mx_2}{m+n}, \frac{ny_1 + my_2}{m+n}\right)$

Calculus

Differentiation:

Function	Derivative
x^n	nx^{n-1}
$\sin ax$	$a\cos ax$
$\cos ax$	$-a\sin ax$
e^{ax}	$a\mathrm{e}^{ax}$
$\mathrm{f}(x)\mathrm{g}(x)$	$\mathrm{f}'(x)\mathrm{g}(x) + \mathrm{f}(x)\mathrm{g}'(x)$
$\mathrm{f}(\mathrm{g}(x))$	$\mathrm{f}'(\mathrm{g}(x))\mathrm{g}'(x)$

Integration:

Function	Integral
x^n	$\frac{1}{n+1}x^{n+1} + c \quad n \neq -1$
$\sin ax$	$-\frac{1}{a}\cos ax + c$
$\cos ax$	$\frac{1}{a}\sin ax + c$
e^{ax}	$\frac{1}{a}\mathrm{e}^{ax} + c$

Area and volume:

Area between a curve and the x-axis = $\int_a^b y\,\mathrm{d}x, y \geq 0$

$\left|\int_a^b y\,\mathrm{d}x\right|, y < 0$

Area between a curve and the y-axis = $\int_c^d x\,\mathrm{d}y, x \geq 0$

$\left|\int_c^d x\,\mathrm{d}y\right|, x < 0$

Area between $\mathrm{g}(x)$ and $\mathrm{f}(x)$ = $\int_a^b |\mathrm{g}(x) - \mathrm{f}(x)|\,\mathrm{d}x$

Volume of revolution = $\int_a^b \pi y^2\,\mathrm{d}x$ or $\int_c^d \pi x^2\mathrm{d}y$

Trigonometry

Radian measure: length of arc = $r\theta$

area of sector $= \frac{1}{2}r^2\theta$

In triangle ABC: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

$\cos^2\theta + \sin^2\theta = 1$

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

Appendix 6: Notation

Notation used in the examination include the following:

$\{\quad\}$	the set of
$\mathrm{n}(A)$	the number of elements in the set A
$\{x:\ \}$	the set of all x such that
$\in$	is an element of
$\notin$	is not an element of
$\varnothing$	the empty (null) set
$\mathbf{E}$	the universal set
$\cup$	union
$\cap$	intersection
$\subset$	is a subset of
A'	the complement of the set A
$\mathbb{N}$	the set of natural numbers, $\{1, 2, 3, \ldots\}$
Z	the set of integers numbers, $\{0, \pm1, \pm2, \pm3\ldots\}$
$\mathbb{Q}$	the set of rational numbers, $\left\{\frac{p}{q} : p \in \mathrm{Z}, q \in \mathrm{Z}^+\right\}$
R	the set of real numbers
$\lvert x\rvert$	the modulus of x
$\approx$	is approximately equal to
$\sum_{i=1}^{n} a_i$	$a_1 + a_2 + \ldots + a_n$
$\binom{n}{r}$	$\frac{n(n-1)\ldots(n-r+1)}{r!}$ for $n \in \mathbb{N}$
$\ln x$	the natural logarithm of x
$\lg x$	logarithm of x to base 10
$\mathrm{f}'(x)$	the first derivative of $\mathrm{f}(x)$ with respect to x
$\mathrm{f}: A \to B$	is a function under which each element of set A has an image in set B
$\mathrm{f}: x \mapsto y$	f is a function under which x is mapped to y
$\mathrm{f}(x)$	the image of x under the function f
f^{-1}	the inverse relation of the function f
fg	the function g followed by function f, i.e. $\mathrm{f}(\mathrm{g}(x))$
—○—○—	open interval on the number line

	closed interval on the number line
$\mathbf{a}$	the vector $\mathbf{a}$
$\overrightarrow{AB}$	the vector represented in magnitude and direction by $\overrightarrow{AB}$ the vector from point A to point B
$\lvert\mathbf{a}\rvert$	the magnitude of vector $\mathbf{a}$

Appendix 7: Glossary

Term	Definition
Assessment objectives	The requirements that students need to meet to succeed in the qualification. Each assessment objective has a unique focus which is then targeted in examinations or coursework. Assessment objectives may be assessed individually or in combination.
External assessment	An examination that is held at the same time and place in a global region.
JCQ	Joint Council for Qualifications. This is a group of UK exam boards that develop policy related to the administration of examinations.
Linear	Qualifications that are linear have all assessments at the end of a course of study. It is not possible to take one assessment earlier in the course of study.
Unit	A modular qualification will be divided into a number of units. Each unit will have its own assessment.

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