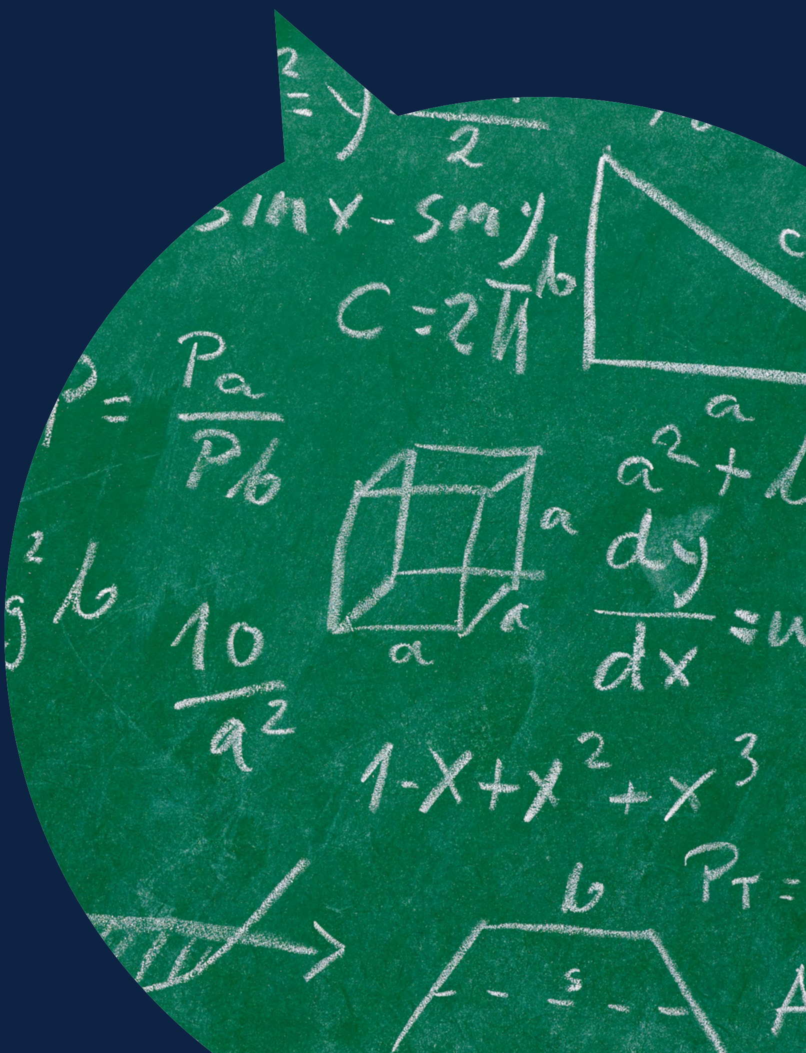
OXFORD AQA
INTERNATIONAL QUALIFICATIONS

International AS and A-level

Mathematics

(9660) Specification



For teaching from September 2017 onwards

For International AS exams
May/June 2018 onwards

For International A-level exams
May/June 2019 onwards

For teaching and examination outside the United Kingdom

Contents

Are you using the latest version of this specification?

- You will always find the most up-to-date version of this specification on our website at **oxfordaqa.com/9660**
- We will write to you if there are significant changes to the specification.

1 Introduction

1.1 Why choose OxfordAQA International AS and A-levels?

Our International qualifications enable schools that follow a British curriculum to benefit from the best education expertise in the United Kingdom (UK).

Our International AS and A-levels offer the same rigour and high quality as AS and A-levels in the UK and are relevant and appealing to students worldwide. They reflect a deep understanding of the needs of teachers and schools around the globe and are brought to you by Oxford University Press and AQA, the UK's leading awarding body.

Providing valid and reliable assessments, these qualifications are based on over 100 years of experience, academic research and international best practice. They have been independently validated as being to the same standard as the qualifications accredited by the UK examinations regulator, Ofqual. They reflect the latest changes to the British system, enabling students to progress to higher education with up-to-date qualifications.

You can find out about OxfordAQA at **oxfordaqa.com**

1.2 Why choose our International AS and A-level Mathematics?

We have worked closely with teachers to design our specification to inspire, challenge and motivate every student, no matter what their level of ability, while supporting you in developing creative and engaging lessons.

Maths is for everyone. It is diverse, engaging and essential in equipping students with the right skills to reach their future destination, whatever that may be. At OxfordAQA, we design qualifications and support to enable students to engage with, explore, enjoy and succeed in maths. By putting students at the heart of everything we do, our aim is to support teachers to shape what success in maths looks like for every student.

Our question papers are designed with students in mind. We're committed to ensuring that students are settled early in our exams and have the best possible opportunity to demonstrate their knowledge and understanding of maths, to ensure they achieve the results they deserve.

The specification takes an approach to the study of mathematics that is consistent across the topic areas. Our experienced team has produced question papers and mark schemes that allow you to get back to inspirational mathematics teaching and allow students of all abilities to achieve their best on every question.

You can find out about all our International AS and A-level Mathematics qualifications at **oxfordaqa.com/maths**

1.3 Recognition

OxfordAQA meet the needs of international students. Please refer to the published timetables on the exams administration page of our website **(oxfordaqa.com/exams-administration)** for up to date exam timetabling information. They are an international alternative and comparable in standard to the Ofqual regulated qualifications offered in the UK.

Our qualifications have been independently benchmarked by UK NARIC, the UK national agency for providing expert opinion on qualifications worldwide. They have confirmed they can be considered 'comparable to the overall GCE A-level and GCSE standard offered in the UK'. Read their report at **oxfordaqa.com/recognition**

To see the latest list of universities who have stated they accept these international qualifications, visit **oxfordaqa.com/recognition**

1.4 Support and resources to help you teach

We know that support and resources are vital for your teaching and that you have limited time to find or develop good quality materials. That's why we've worked with experienced teachers to provide you with resources that will help you confidently plan, teach and prepare for exams.

Teaching resources

You will have access to:

- sample schemes of work to help you plan your course with confidence
- teacher guidance notes to give you the essential information you need to deliver the specification
- training courses to help you deliver our qualifications
- student textbooks that have been checked and approved by us
- engaging worksheets and activities developed by teachers, for teachers.

Preparing for exams

You will have access to the support you need to prepare for our exams, including:

- specimen papers and mark schemes
- exemplar student answers with examiner commentaries
- a searchable bank of past AQA exam questions mapped to these new international qualifications.

Analyse your students' results with Enhanced Results Analysis (ERA)

After the first examination series, you can use this tool to see which questions were the most challenging, how the results compare to previous years and where your students need to improve. ERA, our free online results analysis tool, will help you see where to focus your teaching.

Information about results, including maintaining standards over time, grade boundaries and our post-results services, will be available on our website in preparation for the first examination series.

Help and support

Visit our website for information, guidance, support and resources at **oxfordaqa.com/9660**

You can contact the subject team directly at **maths@oxfordaqa.com** or call us on +44 (0)161 696 5995 (option 1 and then 1 again)

Please note: We aim to respond to all email enquiries within two working days.

Our UK office hours are Monday to Friday, 8am – 5pm.

2 Specification at a glance

The titles of the qualifications are:

- OxfordAQA International Advanced Subsidiary Mathematics
- OxfordAQA International Advanced Level Mathematics.

These qualifications are modular. The full International A-level is intended to be taken over two years. The specification content for the International AS is half that of an International A-level. The International AS can be taken as a stand-alone qualification or can be used to count towards the International A-level. Students can take the International AS in the first year and then take the International A2 in the second year to complete the International A-level or they can take all the units together in the same examination series at the end of the course.

The International AS content will be 50% of the International A-level content but International AS assessments will contribute 40% of the total marks for the full International A-level qualification with the remaining 60% coming from the International A2 assessments.

Candidates may re-sit a unit any number of times within the shelf-life of the specification. The best result for each unit will count towards the final qualification. Exams will be available in January and May/June.

The guided learning hours (GLH) for an OxfordAQA International Advanced Subsidiary is 180.

The guided learning hours (GLH) for an OxfordAQA International Advanced Level is 360.

These figures are for guidance only and may vary according to local practice and the learner's prior experience of the subject.

2.1 Subject content

- Pure maths
- Statistics
- Mechanics

Assessments

International AS	Unit P1 + Unit PSM1

International A-level	International AS Unit P1 + International AS Unit PSM1 + International A-level Unit P2 **and either** International A-level Unit S2 **or** International A-level Unit M2

2.2 International AS

Unit P1 calculator allowed

What's assessed

Pure maths from the P1 content area of the specification

How it's assessed

- Written exam: 1 hour 30 minutes
- 80 marks
- Calculator allowed
- 50% of the International AS assessment, 20% of the International A-level assessment

+

Unit PSM1 calculator allowed

What's assessed

Content from the PSM1 content area of the specification

How it's assessed

- Written exam: 1 hour 30 minutes
- 80 marks consisting of:
- 40 marks Pure maths
  20 marks Statistics
  20 marks Mechanics
- Calculator allowed
- 50% of the International AS assessment
  20% of the International A-level assessment

2.3 International A-level

International AS papers plus;

Unit P2 calculator allowed

What's assessed

Content from the P2 area of the specification

How it's assessed

- Written exam:
  2 hours 30 minutes
- 120 marks
- Calculator allowed
- 37.5% of the International A-level assessment

+

Unit S2 calculator allowed

What's assessed

Content from the S2 content area of the specification

How it's assessed

- Written exam:
  1 hour 30 minutes
- 80 marks
- Calculator allowed
- 22.5% of the International A-level assessment

or

Unit M2 calculator allowed

What's assessed

Content from the M2 content area of the specifications

How it's assessed

- Written exam:
  1 hour 30 minutes
- 80 marks
- Calculator allowed
- 22.5% of the International A-level assessment

3 Subject content

3.1 International AS Unit P1 (Pure Maths)

Students will be required to demonstrate:

1. construction and presentation of mathematical arguments through appropriate use of logical deduction and precise statements involving correct use of symbols and appropriate connecting language;
2. correct understanding and use of mathematical language and grammar in respect of terms such as 'equals', 'identically equals', 'therefore', 'because', 'implies', 'is implied by', 'necessary', 'sufficient' and notation such as $\therefore$, $\Rightarrow$, $\Leftarrow$ and $\Leftrightarrow$

Electronic calculators or graphical calculators may be used.

Students may use relevant formulae included in the formulae booklet without proof.

Students should learn the following formulae, which are **not** included in the formulae booklet, but which may be required to answer questions.

Quadratic equations	$ax^2 + bx + c = 0$ has roots $\dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$		
Differentiation	**function** ax^n $\mathrm{f}(x) + \mathrm{g}(x)$	**derivative** anx^{n-1} $\mathrm{f}'(x) + \mathrm{g}'(x)$	n is a rational number
Integration	**function** ax^n $\mathrm{f}'(x) + \mathrm{g}'(x)$	**integral** $\dfrac{a}{n+1}x^{n+1} + c$ $\mathrm{f}(x) + \mathrm{g}(x) + c$	n is a rational number, $n \neq -1$
Area	Area under a curve $= \int_a^b y\,\mathrm{d}x$, where $y \geqslant 0$		

P1.1: Algebra

Content	Additional information
Use and manipulation of surds.	To include simplification and rationalisation of the denominator of a fraction. eg $\sqrt{12}+2\sqrt{27}=8\sqrt{3}$; $\frac{1}{\sqrt{2}-1}=\sqrt{2}+1$; $\frac{2\sqrt{3}+\sqrt{2}}{3\sqrt{2}+\sqrt{3}}=\frac{\sqrt{6}}{3}$
Laws of indices for all rational exponents.	
Quadratic functions and their graphs.	To include reference to the vertex and line of symmetry of the graph.
The discriminant of a quadratic function.	To include the conditions for equal roots, for distinct real roots and for no real roots
Factorisation of quadratic polynomials.	eg factorisation of $2x^2+x-6$
Completing the square.	eg $x^2+6x-1=(x+3)^2-10$; $2x^2-6x+2=2(x-1.5)^2-2.5$
Solution of quadratic equations.	Use of factorisation, $\frac{-b\pm\sqrt{b^2-4ac}}{2a}$ or completing the square may be required.
Simultaneous equations, eg one linear and one quadratic, analytical solution by substitution.	
Solution of linear and quadratic inequalities.	eg $2x^2+x\geqslant 6$
Algebraic manipulation of polynomials, including expanding brackets and collecting like terms.	
Simple algebraic division.	Applied to a quadratic or a cubic polynomial divided by a linear term of the form $(x-a)$, where a is an integer. Any method will be accepted, eg by inspection, by equating coefficients or by formal division eg $\frac{x^3-x^2-5x+2}{x+2}$
Use of the Remainder Theorem and the Factor Theorem.	Knowledge that when a quadratic or cubic polynomial $\mathrm{f}(x)$ is divided by $(x-a)$ the remainder is $\mathrm{f}(a)$ and, that when $\mathrm{f}(a)=0$, then $(x-a)$ is a factor and vice versa.
Application of the Factor Theorem.	Greatest level of difficulty as indicated by x^3-5x^2+7x-3, ie a cubic, always with a factor $(x-a)$ where a is an integer, but including the cases of three distinct linear factors, repeated linear factors or a quadratic factor which cannot be factorised in the real numbers.
Graphs of functions; sketching curves defined by simple equations.	Linear, quadratic and cubic functions. The $\mathrm{f}(x)$ notation may be used but only a very general idea of the concept of a function is required. Domain and range are **not** included.

Content	Additional information
Geometrical interpretation of algebraic solution of equations and use of intersection points of graphs of functions to solve equations.	Interpreting the solutions of equations as the intersection points of graphs and vice versa.
Knowledge of the effect of simple transformations on the graph of $y = \mathrm{f}(x)$ as represented by $y = a\mathrm{f}(x)$, $y = \mathrm{f}(x) + a$, $y = \mathrm{f}(x + a)$, $y = \mathrm{f}(ax)$	Students are expected to use the terms reflection, translation and stretch in the x or y direction in their descriptions of these transformations. eg transformations such as $y=\sqrt{x}$ to $y=\sqrt{2x}$; $y=2^x$ to $y=2^{x+3}$; $y=3^{-x}$ to $y=3^x$; $y=(x-1)^2+3$ to $y=x^2$ Descriptions involving combinations of more than one type of transformation will not be tested; translations may involve vectors such as $\begin{bmatrix} 3 \\ -2 \end{bmatrix}$

P1.2: Coordinate geometry

Content	Additional information
Equation of a straight line, including the forms $y - y_1 = m(x - x_1)$ and $ax + by + c = 0$	To include problems using gradients, mid-points and the distance between two points. The form $y = mx + c$ is also included.
Conditions for two straight lines to be parallel or perpendicular to each other.	Knowledge that the product of the gradients of two perpendicular lines is -1
The intersection of a straight line and a curve.	Using algebraic methods. Students will be expected to interpret the geometrical implication of equal roots, distinct real roots or no real roots.

P1.3: Differentiation

Content	Additional information
The derivative of $\mathrm{f}(x)$ as the gradient of the tangent to the graph of $y = \mathrm{f}(x)$ at a point; the gradient of the tangent as a limit; interpretation as a rate of change.	The notations $\mathrm{f}'(x)$ or $\frac{\mathrm{d}y}{\mathrm{d}x}$ will be used. A general appreciation only of the derivative when interpreting it is required. Differentiation from first principles will **not** be tested.
Differentiation of polynomials.	
Differentiation of x^n, where n is a rational number, and related sums and differences.	eg expressions such as $2x^2 - 5x^3$, $x^{\frac{3}{2}} + \frac{3}{x^2}$, including terms which can be expressed as a single power such as $x\sqrt{x}$
Applications of differentiation to gradients, tangents and normals, maxima and minima and stationary points, increasing and decreasing functions.	Questions will not be set requiring the determination of or knowledge of points of inflection. Questions may be set in the form of a practical problem where a function of a single variable has to be optimised.
Second order derivatives.	Application to determining maxima and minima.

P1.4: Integration

Content	Additional information
Indefinite integration as the reverse of differentiation.	
Integration of polynomials.	
Integration of x^n, where n is a rational number not equal to -1, and related sums and differences.	eg expressions such as $2x^2 - 5x^3$, $x^{\frac{3}{2}} + 2x^{-\frac{1}{2}}$ or $\frac{x+2}{\sqrt{x}} = x^{\frac{1}{2}} + 2x^{-\frac{1}{2}}$
Evaluation of definite integrals. Interpretation of the definite integral as the area under a curve.	Integration to determine the area of a region between a curve and the x–axis. To include regions wholly below the x–axis, ie knowledge that the integral will give a negative value. Questions involving regions partially above and below the x–axis will not be set. Questions may involve finding the area of a region bounded by a straight line and a curve, or by two curves.
Approximation of the area under a curve using the trapezium rule.	The term 'ordinate' will be used. To include a graphical determination of whether the rule over- or under- estimates the area and improvement of an estimate by increasing the number of steps.

P1.5: Sequences and series

Content	Additional information
Sequences, including those given by a formula for the nth term.	
Sequences generated by a simple relation of the form $x_{n+1} = \mathrm{f}(x_n)$	To include their use in finding of a limit L as $n \to \infty$ by putting $L = \mathrm{f}(L)$
Arithmetic series, including the formula for the sum of the first n natural numbers.	To include $\sum$ notation for sums of series.
The sum of a finite geometric series.	
The sum to infinity of a convergent $(-1 < r < 1)$ geometric series.	Students should be familiar with the notation $\|r\| < 1$ in this context.
The binomial expansion of $(1+x)^n$ for positive integer n.	To include the notations $n!$ and $\binom{n}{r}$. Use of Pascal's triangle or formulae to expand $(a+b)^n$ will be accepted.

3.2 International AS Unit PSM1 (Pure Maths, Statistics and Mechanics)

Students will be expected to be familiar with the knowledge, skills and understanding implicit in the Pure Core International AS Unit P1.

Unit PSM1 is comprised of the Pure Maths PP1, Statistics S1 and Mechanics M1 content on the following pages.

Students will be required to demonstrate:

1. construction and presentation of mathematical arguments through appropriate use of logical deduction and precise statements involving correct use of symbols and appropriate connecting language;
2. correct understanding and use of mathematical language and grammar in respect of terms such as 'equals', 'identically equals', 'therefore', 'because', 'implies', 'is implied by', 'necessary', 'sufficient' and notation such as $\therefore$, $\Rightarrow$, $\Leftarrow$ and $\Leftrightarrow$

Electronic calculators or graphical calculators may be used.

Students may use relevant formulae included in the formulae booklet without proof.

Students should learn the following formulae, which are **not** included in the formulae booklet, but which may be required to answer questions.

Circles	A circle, centre (a,b) and radius r, has equation $(x-a)^2+(y-b)^2=r^2$
Trigonometry	In the triangle ABC $\frac{a}{\sin A}=\frac{b}{\sin B}=\frac{c}{\sin C}$ area $=\frac{1}{2}ab\sin C$ arc length of a circle, $l=r\theta$ area of a sector of a circle, $A=\frac{1}{2}r^2\theta$ $\tan\theta=\frac{\sin\theta}{\cos\theta}$ $\sin^2\theta+\cos^2\theta=1$
Laws of logarithms	$\log_a x+\log_a y=\log_a(xy)$ $\log_a x-\log_a y=\log_a\left(\frac{x}{y}\right)$ $k\log_a x=\log_a(x^k)$

3.2.1 PP1: Pure Maths

PP1.1: Circle

Content	Additional information
The equation of a circle in the form $(x-a)^2 + (y-b)^2 = r^2$	Students will be expected to complete the square to find the centre and radius of a circle where the equation of the circle is for example given as $x^2 + 4x + y^2 - 6y - 12 = 0$
Translation of circles.	Students will be expected to understand how the equation of a circle is transformed by a translation.
Coordinate geometry of the circle.	The use of the following circle properties is required: • the angle in a semicircle is a right angle • the perpendicular from the centre to a chord bisects the chord • the tangent to a circle is perpendicular to the radius at its point of contact.
The equation of the tangent and normal at a given point to a circle.	Implicit differentiation is **not** required. Students will be expected to use the coordinates of the centre and a point on the circle or of other appropriate points to find relevant gradients.

PP1.2: Trigonometry

Content	Additional information
The sine and cosine rules. The area of a triangle in the form $\frac{1}{2}ab\sin C$	
Degree and radian measure.	
Arc length, area of a sector of a circle.	Knowledge of the formulae $l = r\theta$, $A = \frac{1}{2}r^2\theta$
Sine, cosine and tangent functions. Their graphs, symmetries and periodicity.	The concepts of odd and even functions are not required.
Knowledge and use of $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$; and $\sin^2\theta + \cos^2\theta = 1$	
Solution of simple trigonometric equations in a given interval of degrees or radians.	Maximum level of difficulty as indicated by $\sin\theta = -0.4$, $\sin(\theta - 20°) = 0.2$, $2\sin\theta - \cos\theta = 0$ and $2\sin^2\theta + 5\cos\theta = 4$

PP1.3: Exponential and logarithms

Content	Additional information
$y = a^x$ and its graph.	Using the laws of indices where appropriate.
Logarithms and the laws of logarithms.	$\log_a x + \log_a y = \log_a(xy)$ $\log_a x - \log_a y = \log_a\left(\frac{x}{y}\right)$; $k\log_a x = \log_a(x^k)$ The equivalence of $y = a^x$ and $x = \log_a y$
The solution of equations of the form $a^x = b$	Including use of a calculator logarithm function to solve, for example, $3^{2x} = 2$

3.2.2 S1: Statistics

Students may use relevant formulae included in the formulae booklet without proof.

S1.1: Further probability

Content	Additional information
Elementary probability; the concept of a random event and its probability.	Assigning probabilities to events using relative frequencies or equally likely outcomes. Students will be expected to understand set notation but its use will not be essential.
Addition law of probability. Mutually exclusive events.	$P(A \cup B) = P(A) + P(B) - P(A \cap B)$; two events only. $P(A \cup B) = P(A) + P(B)$; two or more events. $P(A') = 1 - P(A)$
Multiplication law of probability and conditional probability. Independent events.	$P(A \cap B) = P(A) \times P(B \mid A) = P(B) \times P(A \mid B)$; two or more events. $P(A \cap B) = P(A) \times P(B)$; two or more events.
Application of probability laws.	Only simple problems will be set that can be solved by direct application of the probability laws, by counting equally likely outcomes and/or the construction and the use of frequency tables or relative frequency (probability) tables. Questions requiring the use of tree diagrams or Venn diagrams will not be set, but their use will be permitted.

S1.2: Discrete random variables

Content	Additional information
Discrete random variables and their associated probability distributions.	The number of possible outcomes will be finite. Distributions will be given or easily determined in the form of a table or simple function.
Measures of central tendency and spread.	Measures of central tendency. Measures of spread; in particular, variance and standard deviation.
Mean, variance and standard deviation for discrete random variables.	Knowledge of the formulae $\mathrm{E}(X) = \mu = \sum X_i p_i$ $\mathrm{E}(\mathrm{g}(X)) = \sum \mathrm{g}(X_i) p_i$ $\mathrm{Var}(X) = \sigma^2 = \mathrm{E}\left((X-\mu)^2\right) = \mathrm{E}(X^2) - \mu^2$ $\mathrm{E}(aX+b) = a\,\mathrm{E}(X)+b$ and $\mathrm{Var}(aX+b) = a^2\mathrm{Var}(X)$ will be expected.
Mean, variance and standard deviation of a simple function of a discrete random variable.	eg $\mathrm{E}(2X+3)$, $\mathrm{E}(5X^2)$, $\mathrm{E}(10X^{-1})$, $\mathrm{E}(100X^{-2})$. eg $\mathrm{Var}(3X)$, $\mathrm{Var}(4X-5)$, $\mathrm{Var}(6X^{-1})$
Mean and variance of the sum or difference of two independent discrete random variables.	Knowledge of the formulae $\mathrm{E}(aX \pm bY) = a\mathrm{E}(X) \pm b\mathrm{E}(Y)$ and $\mathrm{Var}(aX \pm bY) = a^2\mathrm{Var}(X) + b^2\mathrm{Var}(Y)$ will be expected.
Mean and variance of a sum of independent discrete random variables.	Knowledge of the formulae $\mathrm{E}\left(\sum X_i\right) = \sum \mathrm{E}(X_i)$ and $\mathrm{Var}\left(\sum X_i\right) = \sum \mathrm{Var}(X_i)$ will be expected.

S1.3: Bernoulli and binomial distributions

Content	Additional information
Conditions for application of a Bernoulli distribution.	
Mean and variance of a Bernoulli.	Derivations of $\mathrm{E}(X) = p$ and $\mathrm{Var}(X) = p(1-p)$
Binomial distribution.	Introduced as the sum of independent Bernoulli trials.
Calculation of probabilities using formula and tables.	Use of $\binom{n}{x}$ notation.
Mean, variance and standard deviation of a binomial distribution.	Deductions of np and $np(1-p)$ from corresponding values for a Bernoulli distribution.

3.2.3 M1: Mechanics

Students should learn the following formulae, which are not included in the formulae booklet.

Weight	$W = mg$
Momentum	Momentum = mv
Newton's Second Law	$F = ma$ or Force = rate of change of momentum
Friction, dynamic	$F = \mu R$

M1.1: Motion in a straight line with constant acceleration

Content	Additional information
Displacement, speed, velocity, acceleration.	Understanding the difference between displacement and distance and the difference between velocity and speed.
Sketching and interpreting kinematics graphs.	Use of gradients and area under graphs to solve problems.
Knowledge and use of constant acceleration equations.	$s = ut + \frac{1}{2}at^2 \quad s = vt - \frac{1}{2}at^2 \quad v = u + at$ $s = \frac{1}{2}(u+v)t \quad v^2 = u^2 + 2as$
Vertical motion under gravity.	
Average speed.	

M1.2: Motion in a straight line with variable acceleration

Content	Additional information
Relationship between displacement, velocity and acceleration.	Application of calculus techniques will be required to solve problems. $v = \frac{\mathrm{d}s}{\mathrm{d}t}$; $a = \frac{\mathrm{d}v}{\mathrm{d}t} = \frac{\mathrm{d}^2 s}{\mathrm{d}t^2}$ $s = \int v\,\mathrm{d}t$; $v = \int a\,\mathrm{d}t$ Problems will be restricted to the calculus in the AS unit P1.

M1.3: Forces and Newton's Laws

Content	Additional information
Force of gravity.	$W = mg$ The acceleration due to gravity, g, will be taken as 9.8 ms^{-2}
Tensions in strings and rods, thrusts in rods. Normal Reactions. Resistive forces.	Including dynamic friction, $F = \mu R$
Newton's three laws of motion.	Restricted to dynamics in a straight line on the horizontal or motion vertically including resistive forces.
Connected particle problems.	To include the motion of two particles connected by a light inextensible string passing over a smooth fixed peg or a smooth light pulley, when the forces on each particle are constant. Also includes other connected particle problems, such as a car and trailer. Resolution of forces will not be required.

M1.4: Momentum and impulse (Restricted to motion in a straight line)

Content	Additional information
Concept of momentum.	Momentum $= mv$
The principle of conservation of momentum applied to two particles.	Knowledge of Newton's law of restitution is not required
Impulse.	Impulse = change in momentum
Direct impact with a fixed surface.	Restricted to particles which are moving perpendicular to a fixed smooth surface.

3.3 International A-level Unit P2 (Pure Maths)

Students will be expected to be familiar with the knowledge, skills and understanding implicit in the Pure Core International AS Unit P1 and the Pure content of PSM1.

Students will be required to demonstrate:

1. construction and presentation of mathematical arguments through appropriate use of logical deduction and precise statements involving correct use of symbols and appropriate connecting language
2. correct understanding and use of mathematical language and grammar in respect of terms such as 'equals', 'identically equals', 'therefore', 'because', 'implies', 'is implied by', 'necessary', 'sufficient' and notation such as $\therefore$, $\Rightarrow$, $\Leftarrow$ and $\Leftrightarrow$
3. methods of proof, including proof by contradiction and disproof by counter-example
4. an ability to solve problems presented in unstructured form.

Electronic calculators or graphical calculators may be used.

Students may use relevant formulae included in the formulae booklet without proof.

Students should learn the following formulae, which are **not** included in the formulae booklet, but which may be required to answer questions.

Trigonometry	$\sec^2 A = 1 + \tan^2 A$	
	$\operatorname{cosec}^2 A = 1 + \cot^2 A$	
	$\sin 2A = 2\sin A\cos A$	
	$\cos 2A = \begin{cases} \cos^2 A - \sin^2 A \\ 2\cos^2 A - 1 \\ 1 - 2\sin^2 A \end{cases}$	
	$\tan 2A = \dfrac{2\tan A}{1 - \tan^2 A}$	
	$a\cos\theta + b\sin\theta = R\sin(\theta + \alpha)$, where $R = \sqrt{a^2 + b^2}$ and $\tan\alpha = \dfrac{a}{b}$	
	$a\cos\theta - b\sin\theta = R\cos(\theta + \alpha)$, where $R = \sqrt{a^2 + b^2}$ and $\tan\alpha = \dfrac{b}{a}$	
Differentiation	**function**	**derivative**
	e^{kx}	ke^{kx}
	$\ln x$	$\dfrac{1}{x}$
	$\sin kx$	$k\cos kx$
	$\cos kx$	$-k\sin kx$
	$f(x)g(x)$	$f'(x)g(x) + f(x)g'(x)$
	$f(g(x))$	$f'(g(x))g'(x)$
Volumes	Volume of solid of revolution:	
	about the x-axis: $V = \int_a^b \pi y^2 \, dx$	
	about the y-axis: $V = \int_c^d \pi x^2 \, dy$	
Integration	**function**	**integral**
	$\cos kx$	$\dfrac{1}{k}\sin kx + c$
	$\sin kx$	$-\dfrac{1}{k}\cos kx + c$
	e^{kx}	$\dfrac{1}{k}e^{kx} + c$
	$\dfrac{1}{x}$	$\ln \lvert x \rvert + c \quad (x \neq 0)$
	$f'(g(x))g'(x)$	$f(g(x)) + c$
Vector	$\begin{bmatrix} x \\ y \\ z \end{bmatrix} \bullet \begin{bmatrix} a \\ b \\ c \end{bmatrix} = xa + yb + zc = \left(\sqrt{x^2 + y^2 + z^2}\right)\left(\sqrt{a^2 + b^2 + c^2}\right)\cos\theta$	

P2.1: Algebra and functions

Content	Additional information
Definition of a function. Domain and range of a function.	Notation such as $f(x) = x^2 - 4$ may be used. Domain may be expressed as $x > 1$ for example and range may be expressed as $f(x) > -3$ for example.
Composition of functions.	$fg(x) = f(g(x))$
Inverse functions and their graphs.	The notation f^{-1} will be used for the inverse of f To include reflection in $y = x$
The modulus function.	To include related graphs and the solution from them of inequalities such as $\|x+2\| < 3\|x\|$ using solutions of $\|x+2\| = 3\|x\|$
Combinations of the transformations on the graph of $y = f(x)$ as represented by $y = af(x)$, $y = f(x) + a$, $y = f(x+a)$, $y = f(ax)$	For example the transformations of: $y = e^x$ leading to $y = e^{2x} - 1$; $y = \ln x$ leading to $y = 2\ln(x-1)$; $y = \sec x$ leading to $y = 3\sec 2x$ Transformations on the graphs of functions included in the International AS Pure modules P1 and Pure elements of PSM1.
Rational functions. Simplification of rational expressions including factorising and cancelling.	Including use of the Factor Theorem and Remainder Theorem for divisors of the form $(ax+b)$. Expressions of the type $\frac{x^2-4x}{x^2-5x+4} = \frac{x(x-4)}{(x-4)(x-1)} = \frac{x}{x-1}$
Algebraic division.	Any method will be accepted, eg by inspection, by equating coefficients or by formal division. $\frac{3x+4}{x-1} = 3 + \frac{7}{x-1}$; $\frac{2x^3-3x^2-2x+2}{x-2} = 2x^2 + x + \frac{2}{x-2}$; $\frac{2x^2}{(x+5)(x-3)} = 2 - \frac{4x-30}{(x+5)(x-3)}$ by using the given identity $\frac{2x^2}{(x+5)(x-3)} = A + \frac{Bx+C}{(x+5)(x-3)}$
Partial fractions (denominators not more complicated than repeated linear terms).	Greatest level of difficulty $\frac{3+2x^2}{(2x+1)(x-3)^2}$ Irreducible quadratic factors will not be tested.

P2.2: Sequences and series

Content	Additional information
Binomial series for any rational n	Expansion of $(1+x)^n$, $\|x\| < 1$ Greatest level of difficulty $(2+3x)^{-2} = \frac{1}{4}\left(1+\frac{3x}{2}\right)^{-2}$, expansion valid for $\|x\| < \frac{2}{3}$
Series expansion of rational functions including the use of partial fractions.	Greatest level of difficulty $\frac{3+2x^2}{(2x+1)(x-3)^2}$

P2.3: Coordinate geometry in the *(x, y)* plane

Content	Additional information
Cartesian and parametric equations of curves and conversion between the two forms.	eg $x = t^2,\ y = 2t;\ x = a\cos\theta,\ y = b\sin\theta;$ $x = \frac{1}{t}, y = 3t; x = t + \frac{1}{t}, y = t - \frac{1}{t} \Rightarrow (x+y)(x-y) = 4$

P2.4: Trigonometry

Content	Additional information
Knowledge of $\sin^{-1}$, $\cos^{-1}$ and $\tan^{-1}$ functions. Understanding of their domains and graphs.	Knowledge that $-\frac{\pi}{2} \leqslant \sin^{-1}x \leqslant \frac{\pi}{2}$; $0 \leqslant \cos^{-1}x \leqslant \pi$; $-\frac{\pi}{2} < \tan^{-1}x < \frac{\pi}{2}$ The graphs of these functions as reflections of the relevant parts of trigonometric graphs in $y = x$ are included. The addition formulae for inverse functions are not required.
Knowledge of secant, cosecant and cotangent. Their relationships to cosine, sine and tangent functions. Understanding of their domains and graphs.	
Knowledge and use of $1 + \tan^2 x = \sec^2 x$ $1 + \cot^2 x = \text{cosec}^2 x$	
Use of formulae for $\sin(A \pm B)$, $\cos(A \pm B)$ and $\tan(A \pm B)$ and of expressions for $a\cos\theta + b\sin\theta$ in the equivalent forms of $r\cos(\theta \pm \alpha)$ or $r\sin(\theta \pm \alpha)$	
Knowledge and use of double angle formulae.	Knowledge that $\sin 2x = 2\sin x \cos x$ $\cos 2x = \cos^2 x - \sin^2 x$ $= 2\cos^2 x - 1$ $= 1 - 2\sin^2 x$ $\tan 2x = \frac{2\tan x}{1 - \tan^2 x}$ is expected.
Trigonometric identities.	eg $\sin 3x = \sin(2x + x) = \sin x(3 - 4\sin^2 x)$ prove that $\frac{\text{cosec}\theta}{\text{cosec}\theta - \sin\theta} = \sec^2\theta$ Use in integration. For example $\int \cos^2 x \, dx$
Solution of trigonometric equations in a given interval.	eg solve $3\sin 2x = \cos x,\ 0 \leqslant x \leqslant 4\pi;$ solve , $2\sin x + 3\cos x = 1.5,\ -180° < x \leqslant 180°$

P2.5: Exponentials and logarithms

Content	Additional information
The function e^x and its graph.	
The function $\ln x$ and its graph; $\ln x$ as the inverse function of e^x	
Exponential growth and decay.	The use of exponential functions as models.

P2.6: Differentiation

Content	Additional information
Differentiation of e^x, $\ln x$, $\sin x$, $\cos x$, $\tan x$ and linear combinations of these functions.	
Differentiation using the product rule, the quotient rule, the chain rule and by the use of $\frac{dy}{dx} = \frac{1}{\frac{dx}{dy}}$	eg $x^2 \ln x$; $e^{3x} \sin x$; $\frac{e^{2x}-1}{e^{2x}+1}$; $\frac{2x+1}{3x-2}$ eg A curve has equation $x = y^2 - 4y + 1$ Find $\frac{dy}{dx}$ when $y = 1$
Differentiation of simple functions defined implicitly or parametrically.	The second derivative of curves defined implicitly or parametrically is not required.
Equations of tangents and normals for curves specified implicitly.	
Equations of tangents and normals for curves specified in parametric form.	Including equations of tangents and normals at a general point.

P2.7: Integration

Content	Additional information
Integration of e^x, $\frac{1}{x}$, $\sin x$, $\cos x$	
Simple cases of integration: by inspection or substitution;	eg $\int e^{-3x} dx$, $\int \sin 4x dx$, $\int x\sqrt{1+x^2} dx$
by substitution;	eg $\int x(2+x)^6 dx$, $\int x\sqrt{2x-3} dx$
and integration by parts.	eg $\int xe^{2x} dx$, $\int x \sin 3x dx$, $\int x \ln x dx$
These methods as the reverse processes of the chain and product rules respectively.	Including the use of $\int \frac{f'(x)}{f(x)} dx = \ln\lvert f(x) \rvert + c$ by inspection or substitution.
Evaluation of a volume of revolution.	The axes of revolution will be restricted to the $x-$ and $y-$axis.
Simple cases of integration using partial fractions.	eg $\int \frac{(1-4x)}{(3x-4)(x+3)^2} dx$, $\int \frac{x^2}{(x+5)(x-3)} dx$.

P2.8: Differential equations

Content	Additional information
Formation of simple differential equations.	To include the context of growth and decay.
Analytical solution of simple first order differential equations with separable variables.	To include applications to practical problems.

P2.9: Numerical methods

Content	Additional information
Location of roots of $\mathrm{f}(x) = 0$ by considering changes of sign of $\mathrm{f}(x)$ in an interval of x in which $\mathrm{f}(x)$ is continuous.	
Approximate solutions of equations using simple iterative methods, including recurrence relations of the form $x_{n+1} = \mathrm{f}(x_n)$	Rearrangement of equations to the form $x = \mathrm{g}(x)$ Staircase and cobweb diagrams to illustrate the iteration and their use in considerations of convergence.
Numerical integration of functions using the mid-ordinate rule and Simpson's Rule.	To include improvement of an estimate by increasing the number of steps. To include geometrical interpretation of the mid-ordinate rule.

P2.10: Vectors

Content	Additional information
Vectors in two and three dimensions.	Column vectors will be used in questions but students may use **i, j, k** notation if they wish.
Magnitude of a vector.	
Algebraic operations of vector addition and multiplication by scalars, and their geometrical interpretations.	The result $\overrightarrow{AB} = \overrightarrow{OB} - \overrightarrow{OA}$ Parallel vectors.
Position vectors.	
The distance between two points.	
Vector equations of lines.	Equations of lines in the form $\mathbf{r} = \mathbf{a} + t\mathbf{b}$ eg $\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 2 \end{bmatrix} + t\begin{bmatrix} -1 \\ 2 \\ 3 \end{bmatrix}$ To include the intersection of two straight lines in two and three dimensions. Parallel lines. Skew lines in three dimensions.
The scalar product. Its use for calculating the angle between two lines.	To include finding the coordinates of the foot of the perpendicular from a point to a line and hence the perpendicular distance from a point to a line.

3.4 International A-level Unit S2 (Statistics)

Students will be expected to be familiar with the knowledge, skills and understanding implicit in the International AS units and Unit P2.

Students may use relevant formulae included in the formulae booklet without proof.

Electronic calculators or graphical calculators may be used.

S2.1: Poisson distribution

Content	Additional information
Conditions for application of a Poisson distribution.	
Poisson distribution as a limiting form of binomial distribution.	Conditions of n large and p small with $np = \lambda$
Calculation of probabilities using formula and tables.	To include calculation of values of $e^{-\lambda}$ from a calculator.
Mean, variance and standard deviation of a Poisson distribution.	Deduction from mean and variance of binomial distribution (mean $= np = \lambda$ and variance $= np(1-\mathrm{p}) \rightarrow np = \lambda$ as $p \rightarrow 0$) Formal derivations will not be required.
Distribution of sum of independent Poisson random variables.	Result, not proof.

S2.2: Continuous random variables

Content	Additional information
Differences from discrete random variables.	
Probability density functions, cumulative distribution functions and their relationship.	$\mathrm{F}(x) = \int_{-\infty}^{x} \mathrm{f}(t)\mathrm{d}t$ and $\mathrm{f}(x) = \frac{\mathrm{d}}{\mathrm{d}x}\mathrm{F}(x)$
Probability of an observation lying in a specified interval.	$\mathrm{P}(a < X < b) = \int_{a}^{b} \mathrm{f}(x)\mathrm{d}x$ and $\mathrm{P}(X = a) = 0$ To include finding a value corresponding to a specified probability.
Mean, variance and standard deviation for continuous random variables.	Knowledge of the formulae $\mathrm{E}(X) = \mu = \int x\mathrm{f}(x)\mathrm{d}x$, $\mathrm{E}\left(\mathrm{g}(X)\right) = \int \mathrm{g}(x)\mathrm{f}(x)\mathrm{d}x$ $\mathrm{Var}(X) = \sigma^2 = \mathrm{E}\left((X-\mu)^2\right) = \mathrm{E}(X^2) - \mu^2$ $\mathrm{E}(aX+b) = a\mathrm{E}(X) + b$ and $\mathrm{Var}(aX+b) = \mathrm{a}^2\mathrm{Var}(X)$ will be expected.
Mean, variance and standard deviation of a simple function of a continuous random variable.	eg $\mathrm{E}(2X+3)$, $\mathrm{E}(5X^2)$, $\mathrm{E}(10X^{-1})$, $\mathrm{E}(100X^{-2})$ eg $\mathrm{Var}(3X)$, $\mathrm{Var}(4X-5)$, $\mathrm{Var}(6X^{-1})$
Mean and variance of the sum or difference of two independent continuous random variables.	Knowledge of the formulae $\mathrm{E}(aX \pm bY) = a\mathrm{E}(X) \pm b\mathrm{E}(Y)$ $\mathrm{Var}(aX \pm bY) = a^2\mathrm{Var}(X) + b^2\mathrm{Var}(Y)$ will be expected.

Content	Additional information
Mean and variance of a sum of independent continuous random variables.	Knowledge of the formulae $\mathrm{E}(\sum X_i) = \sum \mathrm{E}(X_i)$ and $\mathrm{Var}(\sum X_i) = \sum \mathrm{Var}(X_i)$ will be expected.

S2.3: Exponential distribution

Content	Additional information
Conditions for application of an exponential distribution.	Knowledge that lengths of intervals between Poisson events have an exponential distribution.
Calculation of probabilities for an exponential distribution.	Using cumulative distribution function or by integration of probability density function.
Mean, variance and standard deviation of an exponential distribution.	Proofs will not be expected.

S2.4: Normal distribution

Content	Additional information
Properties of normal distributions.	Shape, symmetry and area properties. Knowledge that approximately $\frac{2}{3}$ of observations lie within $\mu \pm \sigma$, and equivalent results.
Calculation of probabilities.	Transformation to the standardised normal distribution and use of tables. Interpolation will not be essential; rounding z-values to two decimal places will be accepted.
Mean, variance and standard deviation of a normal distribution.	To include finding unknown mean and/or standard deviation by making use of a table of percentage points.
Distribution of sum of independent normal random variables.	Result, not proof.

S2.5: Estimation

Content	Additional information
Population and sample.	To include the terms ‘parameter’ and ‘statistic’. Students will be expected to understand the concept of a simple random sample. Methods for obtaining simple random samples will not be tested directly in the examination.
Unbiased estimators of a population mean and variance.	$\bar{X}$ and S^2 respectively.
Sampling distribution of the mean of a random sample from a normal distribution.	To include the standard error of the sample mean, $\frac{\sigma}{\sqrt{n}}$, and its estimator, $\frac{S}{\sqrt{n}}$
Normal distribution as an approximation to the sampling distribution of the mean of a large sample from any distribution.	Knowledge and application of the Central Limit Theorem.

S2.6: Hypothesis testing

Content	Additional information
Null and alternative hypotheses.	The null hypothesis to be of the form that a parameter takes a specified value.
One-tailed and two-tailed tests, significance level, critical value, critical region, acceptance region, test statistic, p-value, Type I and Type II errors.	The concepts of Type I errors (reject $\mathrm{H_0} \mid \mathrm{H_0}$ true) and Type II errors (accept $\mathrm{H_0} \mid \mathrm{H_0}$ false) should be understood but questions which require the calculation of the risk of a Type II error will not be set. The significance level to be used in a hypothesis test will be given.
Tests for a population proportion.	Using exact binomial probabilities.
Tests for the mean of a Poisson distribution.	Using exact Poisson probabilities.
Tests for the mean of a normal distribution with known variance.	Using a z-statistic.
Tests for the mean of a distribution using a normal approximation.	Large samples only. Known and unknown variance. Using a z-statistic.
Tests for the mean of a normal distribution with unknown variance.	Using a t-statistic.

3.5 International A-level Unit M2 (Mechanics)

Students will be expected to be familiar with the knowledge, skills and understanding implicit in the International AS units and Unit P2.

Students may use relevant formulae included in the formulae booklet without proof.

Electronic calculators or graphical calculators may be used.

Students should learn the following formulae, which are not included in the formulae booklet, but which may be required to answer questions.

Centres of mass	$\bar{X}\sum m_i = \sum m_i x_i$ and $\bar{Y}\sum m_i = \sum m_i y_i$	
Circular motion	$v = r\omega,\ a = r\omega^2$ and $a = \frac{v^2}{r}$	
Work and energy	Work done, constant force:	Work = $Fd\cos\theta$ Gravitational Potential Energy = mgh Kinetic Energy = $\frac{1}{2}mv^2$

M2.1: Mathematical modelling

Content	Additional information
Use of assumptions in simplifying reality.	Students are expected to use mathematical models to solve problems.
Mathematical analysis of models.	Modelling will include the appreciation that: it is appropriate at times to treat relatively large moving bodies as point masses.
Interpretation and validity of models.	Students should be able to comment on the modelling assumptions made when using terms such as particle, light, inextensible string, smooth surface and motion under gravity.

M2.2: Kinematics

Content	Additional information
Relationship between position, velocity and acceleration in one, two or three dimensions, involving variable acceleration.	Application of calculus techniques will be required to solve problems.
Finding position, velocity and acceleration vectors, by the differentiation or integration of $\mathrm{f}(t)\mathbf{i} + \mathrm{g}(t)\mathbf{j} + \mathrm{h}(t)\mathbf{k}$, with respect to t.	If $\mathbf{r} = \mathrm{f}(t)\mathbf{i} + \mathrm{g}(t)\mathbf{j} + \mathrm{h}(t)\mathbf{k}$ then $\mathbf{v} = \mathrm{f}'(t)\mathbf{i} + \mathrm{g}'(t)\mathbf{j} + \mathrm{h}'(t)\mathbf{k}$ and $\mathbf{a} = \mathrm{f}''(t)\mathbf{i} + \mathrm{g}''(t)\mathbf{j} + \mathrm{h}''(t)\mathbf{k}$ Vectors may be expressed in the form $a\mathbf{i} + b\mathbf{j} + c\mathbf{k}$ or as column vectors. Students may use either notation.

M2.3: Statics and forces

Content	Additional information
Drawing force diagrams, identifying forces present and clearly labelling diagrams.	
Friction, limiting friction, and the relationship $F \leqslant \mu R$	Students should be able to derive and work with inequalities from the relationship $F \leqslant \mu R$
Modelling forces as vectors, finding the resultant of a number of forces acting at a point.	Students will be required to resolve forces.
Knowledge that the resultant force is zero if a body is in equilibrium.	Find unknown forces on bodies that are at rest.
Finding the moment of a force about a given point.	
Determining the forces acting on a rigid body when in equilibrium.	Knowledge that when a rigid body is in equilibrium, the resultant force and the resultant moment are both zero. This will include situations where all the forces are parallel, as on a horizontal beam or where the forces act in two dimensions, as on a ladder leaning against a wall.
Centres of Mass	
Finding centres of mass by symmetry (eg for circle, rectangle).	Integration methods are not required.

Content	Additional information
Finding the centre of mass of a system of particles.	Centre of mass of a system of particles is given by $(\bar{X}, \bar{Y})$ where $\bar{X}\sum m_i = \sum m_i x_i$ and $\bar{Y}\sum m_i = \sum m_i y_i$
Finding the centre of mass of a composite body.	
Finding the position of a body when suspended from a given point and in equilibrium.	

M2.4: Newton's Law of Motion

Content	Additional information
Applications of Newton's laws to linear motion with constant acceleration.	Including motion up or down an inclined plane.
Application to situations, with variable acceleration.	Problems will be posed in one, two or three dimensions and may require the use of integration or differentiation.

M2.5: Projectiles

Content	Additional information
Motion of a particle under gravity in two dimensions.	Students will be expected to state and use equations of the form $x = (V\cos\alpha)t$ and $y = (V\sin\alpha)t - \frac{1}{2}gt^2$ Students should be aware of any assumptions they are making.
Calculate range, time of flight and maximum height.	Formulae for the range, time of flight and maximum height should not be quoted in exams. Inclined plane and problems involving resistance will not be set.
Elimination of time from equations to derive the equation of the trajectory of a projectile.	Students will **not** be required to know the formula $y = x\tan\alpha - \frac{gx^2}{2v^2}\sec^2\alpha$ but should be able to derive it when needed.

M2.6: Work and energy

Content	Additional information
Work done by a constant force.	Forces may or may not act in the direction of motion. Work done = $Fd\cos\theta$
Gravitational potential energy.	Gravitational Potential Energy = mgh
Kinetic energy.	Kinetic Energy = $\frac{1}{2}mv^2$
The work-energy principle.	Use of Work Done = Change in Kinetic Energy.
Conservation of mechanical energy.	Solution of problems using conservation of energy.
Power, as the rate at which a force does work, and the relationship $P = Fv$	

M2.7: Uniform circular motion

Content	Additional information
Motion of a particle in a circle with constant speed.	Problems will involve either horizontal circles or situations, such as a satellite describing a circular orbit, where the gravitational force is towards the centre of the circle.
Knowledge and use of the relationships $v = r\omega,\ a = r\omega^2$ and $a = \frac{v^2}{r}$	
Angular speed in radians s^{-1} converted from other units such as revolutions per minute or time for one revolution.	Use of the term angular speed.
Position, velocity and acceleration vectors in relation to circular motion in terms of **i** and **j**	Students may be required to show that motion is circular by showing that the body is at a constant distance from a given point.
Conical pendulum.	

4 Scheme of assessment

Find mark schemes, and specimen papers for new courses, on our website at **oxfordaqa.com/9660**

These qualifications are modular. The full International A-level is intended to be taken over two years. The specification content for the International AS is half that of an International A-level.

The International AS can be taken as a stand-alone qualification or it can count towards the International A-level. To complete the International A-level, students can take the International AS in their first year and the International A2 in their second year or they can take all the units together in the same examination series at the end of the two year course.

The International AS content will be 50% of the International A-level content. International AS assessments contribute 40% of the total marks for the full International A-level qualification. The remaining 60% comes from the International A2 assessments.

The specification provides an opportunity for students to produce extended responses either in words or using open-ended calculations.

The specification content will be split across units and will include some synoptic assessment. This allows students to draw together different areas of knowledge from across the full course of study.

All materials are available in English only.

4.1 Availability of assessment units and certification

Exams and certification for this specification are available as follows:

	Availability of units		Availability of certification	
	P1 and PSM1	P2, S2, M2	International AS	International A-level
June 2018	✓		✓	
January 2019	✓		✓	
June 2019	✓	✓	✓	✓
January 2020	✓	✓	✓	✓
June 2020	✓	✓	✓	✓

4.2 Aims

Courses based on this specification should encourage students to:

- develop their understanding of mathematics and mathematical processes in a way that promotes confidence and fosters enjoyment
- develop abilities to reason logically and to recognise incorrect reasoning, to generalize and to construct mathematical proofs
- extend their range of mathematical skills and techniques and use them in more difficult unstructured problems
- develop an understanding of coherence and progression in mathematics and how different areas of mathematics can be connected
- recognize how a situation may be represented mathematically and understand the relationship between 'real world' problems and standard and other mathematical models and how these can be refined and improved
- use mathematics as an effective means of communication
- read and comprehend mathematical arguments and articles concerning applications of mathematics
- acquire the skills needed to use technology such as calculators and computers effectively yet be aware of any limitations of using these
- develop an awareness of the relevance of mathematics to other fields of study, to the world of work and to society in general.

4.3 Assessment Objectives

The exams will measure how students have achieved the following assessment objectives:

- AO1: Recall and select knowledge of mathematical facts, concepts, models and techniques required to solve problems in a variety of contexts.
- AO2: Construct rigorous mathematical arguments and proofs through use of precise statements, mathematical manipulation, logical deduction, modelling assumptions and justifications to solve structured and unstructured problems, and to deduce, interpret and communicate results.

Quality of Written Communication (QWC)

Students must:

- ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Questions in the papers for this specification do not include specific marks for QWC. However, poor written communication may lead to lower marks due to lack of clarity in answers.

4.3.1 Assessment Objective weightings for International AS Mathematics

Assessment Objectives (AOs)	Unit weightings (approx %)		Overall weighting of AOs (approx %)
	Unit P1	Unit PSM1	
AO1	20 – 25	20 – 25	40 – 50
AO2	25 – 30	25 – 30	50 – 60
Overall weighting of units (%)	50	50	100

4.3.2 Assessment Objective weightings for International A-level Mathematics

Assessment Objectives (AOs)	Unit weightings (approx %)				Overall weighting of AOs (approx %)
	Unit P1	Unit PSM1	Unit P2	Unit S2 or M2	
AO1	8 – 10	8 – 10	15 – 18.75	9 – 11.25	40 – 50
AO2	10 – 12	10 – 12	18.75 – 22.5	11.25 – 13.5	50 – 60
Overall weighting of units (%)	20	20	37.5	22.5	100

4.4 Assessment weightings

The raw marks awarded on each unit will be transferred to a uniform mark scale (UMS) to meet the weighting of the units and to ensure comparability between units sat in different exam series. Students' final grades will be calculated by adding together the uniform marks for all units. The maximum raw and uniform marks are shown in the table below.

Unit	Maximum raw mark	Percentage weighting A-level (AS)	Maximum uniform mark
1	80	20 (50)	80
2	80	20 (50)	80
3	120	37.5	150
4	80	22.5	90
5	80	22.5	90
Qualification			
International AS (P1 + PSM1)	–	40 (100)	160
International A-level (P1 + PSM1 + P2 + S2 or M2)	–	100	400

For more detail on UMS, see Section 5.3.

5 General administration

We are committed to delivering assessments of the highest quality and have developed practices and procedures to support this aim. To ensure all students have a fair experience, we have worked with other awarding bodies in England to develop best practice for maintaining the integrity of exams. This is published through the Joint Council for Qualifications (JCQ). We will maintain the same high standard through their use for OxfordAQA Exams.

More information on all aspects of administration is available at **oxfordaqa.com/exams-administration**

For any immediate enquiries please contact **info@oxfordaqa.com**

Please note: We aim to respond to all email enquiries within two working days.

Our UK office hours are Monday to Friday, 8am – 5pm local time.

5.1 Entries and codes

You should use the following subject award entry codes:

Qualification title	OxfordAQA Exams entry code
OxfordAQA International Advanced Subsidiary Mathematics	9661
OxfordAQA International Advanced Level Mathematics	9662

Please check the current version of the Entry Codes book and the latest information about making entries on **oxfordaqa.com/exams-administration**

You should use the following unit entry codes:

Unit P1	MA01
Unit PSM1	MA02
Unit P2	MA03
Unit S2	MA04
Unit M2	MA05

A unit entry will not trigger certification. You will also need to make an entry for the overall subject award in the series that certification is required.

Exams will be available May/June and in January.

5.2 Overlaps with other qualifications

There is overlapping content in the International AS and A-level specifications. This helps you teach the International AS and A-level together.

5.3 Awarding grades and reporting results

The International AS qualification will be graded on a five-point scale: A, B, C, D and E.

The International A-level qualification will be graded on a six-point scale: A*, A, B, C, D and E.

Students who fail to reach the minimum standard for grade E will be recorded as U (unclassified) and will not receive a qualification certificate.

We will publish the minimum raw mark needed for each grade in each unit when we issue students' results. We will report a student's unit results to schools in terms of uniform marks and unit grades and we will report qualification results in terms of uniform marks and grades.

The relationship between uniform marks and grades is shown in the table below.

	Uniform mark range per unit and per qualification						
Grade	P1	PSM1	International AS Mathematics	P2	Option M2	Option S2	International A-level Mathematics
Maximum uniform mark	80	80	160	150	90	90	400
A*				135–150	81–90	81–90	*See note below
A	64–80	64–80	128–160	120–134	72–80	72–80	320
B	56–63	56–63	112–127	105–119	63–71	63–71	280–319
C	48–55	48–55	96–111	90–104	54–62	54–62	240–279
D	40–47	40–47	80–95	75–89	45–53	45–53	200–239
E	32–39	32–39	64–79	60–74	36–44	36–44	160–199

* For the award of grade A*, a student must achieve grade A in the full International A-level qualification and a minimum of 216 uniform marks in the aggregate of units P2 with M2 or S2.

5.4 Re-sits

Unit results remain available to count towards certification, whether or not they have already been used, provided the specification remains valid. Students can re-sit units as many times as they like, as long as they're within the shelf-life of the specification. The best result from each unit will count towards the final qualification grade. Students who wish to repeat a qualification may do so by re-sitting one or more units.

To be awarded a new subject grade, the appropriate subject award entry, as well as the unit entry/entries, must be submitted.

5.5 Previous learning and prerequisites

There are no previous learning requirements. Any requirements for entry to a course based on this specification are at the discretion of schools.

5.6 Access to assessment: equality and inclusion

Our general qualifications are designed to prepare students for a wide range of occupations and further study whilst assessing a wide range of competences.

The subject criteria have been assessed to ensure they test specific competences. The skills or knowledge required do not disadvantage particular groups of students.

Exam access arrangements are available for students with disabilities and special educational needs.

We comply with the *UK Equality Act 2010* to make reasonable adjustments to remove or lessen any disadvantage that affects a disabled student. Information about access arrangements is issued to schools when they become OxfordAQA centres.

5.7 Working with OxfordAQA for the first time

You will need to apply to become an OxfordAQA centre to offer our specifications to your students. Find out how at **oxfordaqa.com/centreapprovals**

5.8 Private candidates

Centres may accept private candidates for examined units/components only with the prior agreement of OxfordAQA. If you are an approved OxfordAQA centre and wish to accept private candidates, please contact OxfordAQA at: **info@oxfordaqa.com**

Private candidates may also enter for examined only units/components via the British Council; please contact your local British Council office for details.

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