Unit P1: Pure Mathematics 1

Compulsory unit for IAS Mathematics and Pure Mathematics
Compulsory unit for IAL Mathematics and Pure Mathematics

Externally assessed

P1.1 Unit description

Algebra and functions; coordinate geometry in the (x,y); trigonometry; differentiation; integration.

P1.2 Assessment information

1. Examination

- First assessment: January 2019.
- The assessment is 1 hour and 30 minutes.
- The assessment is out of 75 marks.
- Students must answer all questions.
- Calculators may be used in the examination. Please see *Appendix 6: Use of calculators*.
- The booklet *Mathematical Formulae and Statistical Tables* will be provided for use in the assessments.

2. Notation and formulae

Students will be expected to understand the symbols outlined in *Appendix 7: Notation*.

Formulae that students are expected to know are given below and will **not** appear in the booklet; *Mathematical Formulae and Statistical Tables*. This booklet will be provided for use with the paper. Questions will be set in SI units and other units in common usage.

Quadratic equations

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

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 $= r\theta$

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

2. Notation and formulae *continued*

Differentiation

$\mathbf{f}(x)$	$\mathbf{f}'(x)$
x^n	nx^{n-1}

Integration

$\mathbf{f}(x)$	$\int \mathbf{f}(x)\,\mathrm{d}x$
x^n	$\frac{1}{n+1}x^{n+1} + c,\ n \neq -1$

P1.3 Unit content

What students need to learn:		Guidance
1. Algebra and functions		
1.1	Laws of indices for all rational exponents.	$a^m \times a^n = a^{m+n}$, $a^m \div a^n = a^{m-n}$, $(a^m)^n = a^{mn}$ The equivalence of $a^{\frac{m}{n}}$ and $\sqrt[n]{a^m}$ should be known.
1.2	Use and manipulation of surds.	Students should be able to rationalise denominators.
1.3	Quadratic functions and their graphs.	
1.4	The discriminant of a quadratic function.	Need to know and to use $b^2 - 4ac > 0$, $b^2 - 4ac = 0$ and $b^2 - 4ac < 0$
1.5	Completing the square. Solution of quadratic equations.	Solution of quadratic equations by factorisation, use of the formula, use of a calculator and completing the square. $ax^2 + bx + c = a\left(x + \frac{b}{2a}\right)^2 + \left(c - \frac{b^2}{4a}\right)$
1.6	Solve simultaneous equations; analytical solution by substitution.	
1.7	Interpret linear and quadratic inequalities graphically.	For example, $ax + b > cx + d$, $px^2 + qx + r \geqslant 0$, $px^2 + qx + r < ax + b$. Interpreting the third inequality as the range of x for which the curve $y = px^2 + qx + r$ is below the line with equation $y = ax + b$. Including inequalities with brackets and fractions. These would be reducible to linear or quadratic inequalities, e.g. $\frac{a}{x} < b$ becomes $ax < bx^2$, $x \neq 0$.
1.8	Represent linear and quadratic inequalities graphically.	Represent linear and quadratic inequalities such as $y > x + r$ and $y > ax^2 + bx + c$ graphically. Shading and use of dotted and solid line convention is required.
1.9	Solutions of linear and quadratic inequalities.	For example, solving $ax + b > cx + d$, $px^2 + qx + r \geqslant 0$, $px^2 + qx + r < ax + b$.
1.10	Algebraic manipulation of polynomials, including expanding brackets and collecting like terms, factorisation.	Students should be able to use brackets. Factorisation of polynomials of degree n, $n \leqslant 3$, e.g. $x^3 + 4x^2 + 3x$. The notation f(x) may be used.

What students need to learn:		Guidance
1. Algebra and functions *continued*		
1.11	Graphs of functions; sketching curves defined by simple equations. Geometrical interpretation of algebraic solution of equations. Use of intersection points of graphs of functions to solve equations.	Functions to include simple cubic functions and the reciprocal functions $y = \frac{k}{x}$ and $y = \frac{k}{x^2}$ with $x \neq 0$. Knowledge of the term asymptote is expected. Also, trigonometric graphs.
1.12	Knowledge of the effect of simple transformations on the graph of $y = f(x)$ as represented by $y = af(x)$, $y = f(x) + a$, $y = f(x + a)$, $y = f(ax)$.	Students should be able to apply one of these transformations to any of the above functions (quadratics, cubics, reciprocals, sine, cosine, and tangent) and sketch the resulting graphs. Given the graph of any function $y = f(x)$, students should be able to sketch the graph resulting from one of these transformations.
2. Coordinate geometry in the (x, y) plane		
2.1	Equation of a straight line, including the forms $y - y_1 = m(x - x_1)$ and $ax + by + c = 0$.	To include: (i) the equation of a line through two given points (ii) the equation of a line parallel (or perpendicular) to a given line through a given point. For example, the line perpendicular to the line $3x + 4y = 18$ through the point (2, 3) has equation $y - 3 = \frac{4}{3}(x - 2)$.
2.2	Conditions for two straight lines to be parallel or perpendicular to each other.	
3. Trigonometry		
3.1	The sine and cosine rules, and the area of a triangle in the form $\frac{1}{2}ab\sin C$.	Including the ambiguous case of the sine rule.
3.2	Radian measure, including use for arc length and area of sector.	Use of the formulae $s = r\theta$ and $A = \frac{1}{2}r^2\theta$.
3.3	Sine, cosine and tangent functions. Their graphs, symmetries and periodicity.	Knowledge of graphs of curves with equations such as $y = 3\sin x$, $y = \sin\left(x + \frac{\pi}{6}\right)$, $y = \sin 2x$ is expected.

What students need to learn:		Guidance
4. Differentiation		
4.1	The derivative of f(x) as the gradient of the tangent to the graph of y = f(x) at a point; the gradient of the tangent as a limit; interpretation as a rate of change; second order derivatives.	For example, knowledge that $\frac{\mathrm{d}y}{\mathrm{d}x}$ is the rate of change of y with respect to x. Knowledge of the chain rule is not required. The notation f′(x) and f″(x) may be used.
4.2	Differentiation of x^n, and related sums, differences and constant multiples.	The ability to differentiate expressions such as $(2x + 5)(x - 1)$ and $\frac{x^2 + 5x - 3}{3\sqrt{x}}$ is expected.
4.3	Applications of differentiation to gradients, tangents and normals.	Use of differentiation to find equations of tangents and normals at specific points on a curve.
5. Integration		
5.1	Indefinite integration as the reverse of differentiation.	Students should know that a constant of integration is required.
5.2	Integration of x^n and related sums, differences and constant multiples.	(Excluding $n = -1$ and related sums, differences and multiples). For example, the ability to integrate expressions such as $\frac{1}{2}x^2 - 3x^{-\frac{1}{2}}$ and $\frac{(x+2)^2}{\sqrt{x}}$ is expected. Given f′(x) and a point on the curve, students should be able to find an equation of the curve in the form y = f(x).

Unit P2: Pure Mathematics 2

Compulsory unit for IAS Mathematics and Pure Mathematics
Compulsory unit for IAL Mathematics and Pure Mathematics

Externally assessed

P2.1 Unit description

Proof; algebra and functions; coordinate geometry in the (x, y) plane; sequences and series; exponentials and logarithms; trigonometry; differentiation; integration.

P2.2 Assessment information

1. Prerequisites

A knowledge of the specification for P1 and its associated formulae is assumed and may be tested.

2. Examination

- First assessment: June 2019.
- The assessment is 1 hour and 30 minutes.
- The assessment is out of 75 marks.
- Students must answer all questions.
- Calculators may be used in the examination. Please see *Appendix 6: Use of calculators*.
- The booklet *Mathematical Formulae and Statistical Tables* will be provided for use in the assessments.

2. Notation and formulae

Students will be expected to understand the symbols outlined in *Appendix 7: Notation*.

Formulae that students are expected to know are given below and will **not** appear in the booklet; *Mathematical Formulae and Statistical Tables*, which will be provided for use with the paper. Questions will be set in SI units and other units in common usage.

Laws of logarithms

$\log_a x + \log_a y \equiv \log_a (xy)$

$\log_a x - \log_a y \equiv \log_a \left(\frac{x}{y}\right)$

$k \log_a x \equiv \log_a (x^k)$

Trigonometry

$\sin^2 A + \cos^2 A \equiv 1$

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

Area

area under a curve $= \int_a^b y \, \mathrm{d}x \quad (y \geqslant 0)$

P2.3 Unit content

What students need to learn:		Guidance
1. Proof		
1.1	Understand and use the structure of mathematical proof, proceeding from given assumptions through a series of logical steps to a conclusion; use methods of proof stated below:	
1.2	Proof by exhaustion	Proof by exhaustion. This involves trying all the options. Suppose x and y are odd integers less than 7. Prove that their sum is divisible by 2.
1.3	Disproof by counter example.	Disproof by counter example – show that the statement "$n^2 - n + 1$ is a prime number for all values of n" is untrue.
2. Algebra and functions		
2.1	Simple algebraic division; use of the Factor Theorem and the Remainder Theorem.	Only division by $(ax + b)$ or $(ax - b)$ will be required, e.g. students should know that if $f(x) = 0$ when $x = \frac{b}{a}$, then $(ax - b)$ is a factor of $f(x)$. Students may be required to factorise cubic expressions such as $x^3 + 3x^2 - 4$ and $6x^3 + 11x^2 - x - 6$. 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 $(ax + b)$.
3. Coordinate geometry in the (x, y) plane		
3.1	Coordinate geometry of the circle using the equation of a circle in the form $(x - a)^2 + (y - b)^2 = r^2$ and including use of the following circle properties: (i) the angle in a semicircle is a right angle; (ii) the perpendicular from the centre to a chord bisects the chord; (iii) the perpendicularity of radius and tangent.	Students should be able to find the radius and the coordinates of the centre of the circle, given the equation of the circle and vice versa.

What students need to learn:		Guidance
4. Sequences and series		
4.1	Sequences, including those given by a formula for the nth term and those generated by a simple relation of the form $x_{n+1} = f(x_n)$.	
4.2	Understand and work with arithmetic sequences and series, including the formula for the nth term and the sum of a finite arithmetic series; the sum of the first n natural numbers.	The proof of the sum formula should be known. Understanding of $\sum$ notation will expected.
4.3	Increasing sequences, decreasing sequences and periodic sequences.	
4.4	Understand and work with geometric sequences and series, including the formulae for the nth term and the sum of a finite geometric series; the sum to infinity of a convergent geometric series, including the use of $\|r\| < 1$.	For example, given the sum of a series students should be able to use logs to find the value of n. The proof of the sum formula for a finite series should be known. The sum to infinity may be expressed as S_∞.
4.5	Binomial expansion of $(a + bx)^n$ for positive integer n.	The notations $n!$, $\binom{n}{r}$ and ${}^nC_r$ may be used.
5. Exponentials and logarithms		
5.1	$y = a^x$ and its graph.	$a > 0$, $a \neq 1$
5.2	Laws of logarithms.	To include $\log_a (xy) \equiv \log_a x + \log_a y$, $\log_a \left(\frac{x}{y}\right) \equiv \log_a x - \log_a y$, $\log_a (x^k) \equiv k \log_a x$, $\log_a \left(\frac{1}{x}\right) \equiv -\log_a x$, $\log_a a = 1$ where $a, x, y > 0$, $a \neq 1$.
5.3	The solution of equations of the form $a^x = b$.	Students may use the change of base formula.

What students need to learn:		Guidance
6. Trigonometry		
6.1	Knowledge and use of $\tan\theta = \frac{\sin\theta}{\cos\theta}$, and $\sin^2\theta + \cos^2\theta = 1$.	
6.2	Solution of simple trigonometric equations in a given interval.	Students should be able to solve equations such as $\sin\left(x + \frac{\pi}{2}\right) = \frac{3}{4}$ for $0 < x < 2\pi$, $\cos(x + 30°) = \frac{1}{2}$ for $-180° < x < 180°$, $\tan 2x = 1$ for $90° < x < 270°$, $6\cos^2 x + \sin x - 5 = 0$ for $0 \leqslant x < 360°$, $\sin^2\left(x + \frac{\pi}{6}\right) = \frac{1}{2}$ for $-\pi \leqslant x < \pi$.
7. Differentiation		
7.1	Applications of differentiation to maxima and minima and stationary points, increasing and decreasing functions.	To include applications to curve sketching. Maxima and minima problems may be set in the context of a practical problem.
8. Integration		
8.1	Evaluation of definite integrals.	
8.2	Interpretation of the definite integral as the area under a curve.	Students will be expected to be able to evaluate the area of a region bounded by a curve and given straight lines. For example, find the finite area bounded by the curve $y = 6x - x^2$ and the line $y = 2x$. $\int x\,\mathrm{d}y$ will not be required. Students will be expected to be able to evaluate the area of a region bounded by two curves.
8.3	Approximation of area under a curve using the trapezium rule.	For example, use the trapezium rule to approximate $\int_0^1 \sqrt{(2x+1)}\,\mathrm{d}x$ using four strips. Use of increasing number of trapezia to improve accuracy and an estimate of the error may be required.

Unit M1: Mechanics 1

Optional unit for IAS Mathematics and Further Mathematics
Optional unit for IAL Mathematics and Further Mathematics

Externally assessed

M1.1 Unit description

Mathematical models in mechanics; vectors in mechanics; kinematics of a particle moving in a straight line; dynamics of a particle moving in a straight line or plane; statics of a particle; moments.

M1.2 Assessment information

1. Prerequisites

A knowledge of P1 and P2 and associated formulae and of vectors in two dimensions.

2. Examination

- First assessment: June 2019.
- The assessment is 1 hour and 30 minutes.
- The assessment is out of 75 marks.
- Students must answer all questions.
- Calculators may be used in the examination. Please see *Appendix 6: Use of calculators*.
- The booklet *Mathematical Formulae and Statistical Tables* will be provided for use in the assessments.

3. Notation and formulae

Students will be expected to understand the symbols outlined in *Appendix 7: Notation*.

Formulae that students are expected to know are given below and will **not** appear in the booklet *Mathematical Formulae and Statistical Tables*, which will be provided for use with the paper. Questions will be set in SI units and other units in common usage.

Momentum = mv

Impulse = $mv - mu$

For constant acceleration:

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$s = vt - \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

$s = \frac{1}{2}(u + v)t$

M1.3 Unit content

What students need to learn:		Guidance
1. Mathematical models in mechanics		
1.1	The basic ideas of mathematical modelling as applied in Mechanics.	Students should be familiar with the terms: particle, lamina, rigid body, rod (light, uniform, non-uniform), inextensible string, smooth and rough surface, light smooth pulley, bead, wire, peg. Students should be familiar with the assumptions made in using these models.
2. Vectors in mechanics		
2.1	Magnitude and direction of a vector. Resultant of vectors may also be required.	Students may be required to resolve a vector into two components or use a vector diagram. Questions may be set involving the unit vectors **i** and **j**.
2.2	Application of vectors to displacements, velocities, accelerations and forces in a plane.	Use of velocity = $\frac{\text{change of displacement}}{\text{time}}$ in the case of constant velocity, and of acceleration = $\frac{\text{change of velocity}}{\text{time}}$ in the case of constant acceleration, will be required.
3. Kinematics of a particle moving in a straight line		
3.1	Motion in a straight line with constant acceleration.	Graphical solutions may be required, including displacement-time, velocity-time, speed-time and acceleration-time graphs. Knowledge and use of formulae for constant acceleration will be required.
4. Dynamics of a particle moving in a straight line or plane		
4.1	The concept of a force. Newton's laws of motion.	Simple problems involving constant acceleration in scalar form or as a vector of the form $a\mathbf{i} + b\mathbf{j}$.
4.2	Simple applications including the motion of two connected particles.	Problems may include (i) the motion of two connected particles moving in a straight line or under gravity when the forces on each particle are constant; problems involving smooth fixed pulleys and/or pegs may be set (ii) motion under a force which changes from one fixed value to another, e.g. a particle hitting the ground (iii) motion directly up or down a smooth or rough inclined plane.
4.3	Momentum and impulse. The impulse-momentum principle. The principle of conservation of momentum applied to two particles colliding directly.	Knowledge of Newton's law of restitution is not required. Problems will be confined to those of a one-dimensional nature.
4.4	Coefficient of friction.	An understanding of $F = \mu R$ when a particle is moving.

What students need to learn:		Guidance
5. Statics of a particle		
5.1	Forces treated as vectors. Resolution of forces.	
5.2	Equilibrium of a particle under coplanar forces. Weight, normal reaction, tension and thrust, friction.	Only simple cases of the application of the conditions for equilibrium to uncomplicated systems will be required.
5.3	Coefficient of friction.	An understanding of $F \leqslant \mu R$ in a situation of equilibrium.
6. Moments		
6.1	Moment of a force.	Simple problems involving coplanar parallel forces acting on a body and conditions for equilibrium in such situations.

Appendix 1: Codes

Type of code	Use of code	Code
Unit codes	Each unit is assigned a unit code. This unit code is used as an entry code to indicate that a student wishes to take the assessment for that unit. Centres will need to use the entry codes only when entering students for their examination.	Unit P1: WMA11/01 Unit P2: WMA12/01 Unit P3: WMA13/01 Unit P4: WMA14/01 Unit FP1: WFM01/01 Unit FP2: WFM02/01 Unit FP3: WFM03/01 Unit M1: WME01/01 Unit M2: WME02/01 Unit M3: WME03/01 Unit S1: WST01/01 Unit S2: WST02/01 Unit S3: WST03/01 Unit D1: WDM11/01
Cash in codes	The cash-in code is used as an entry code to aggregate the student's unit scores to obtain the overall grade for the qualification. Centres will need to use the entry codes only when entering students for their qualification.	**International Advanced Subsidiary:** Mathematics – XMA01 Further Mathematics – XFM01 Pure Mathematics – XPM01 **International Advanced Level:** Mathematics – YMA01 Further Mathematics – YFM01 Pure Mathematics – YPM01
Entry codes	The entry codes are used to: • enter a student for the assessment of a unit • aggregate the student's unit scores to obtain the overall grade for the qualification.	Please refer to the *Pearson Information Manual*, available on our website.