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INTERNATIONAL A LEVEL MATHEMATICS • PURE 2

Pure Mathematics 2

Exam Questions by Topic: Mark Scheme

Pearson Edexcel International Advanced Level (WMA12/01) • Calculator allowed

Every question in the booklet, marked line by line the way an examiner marks it

Chapters (tap a chapter to jump to it)	Qs	Marks	Page	My score
1 Algebraic Methods Algebraic fractions, the factor and remainder theorems, proof	10	66	own PDF	
2 Coordinate Geometry in the (x, y) Plane Equations of circles, tangents, chords and intersections	10	68	own PDF	
3 Exponentials and Logarithms Laws of logarithms, exponential equations, modelling	10	68	3	
4 The Binomial Expansion Expanding $(a + bx)^n$, coefficients and approximations	10	65	own PDF	
5 Sequences and Series Arithmetic and geometric series, sigma notation, recurrence	10	69	own PDF	
6 Trigonometric Identities and Equations $\tan \theta = \frac{\sin \theta}{\cos \theta}$, $\sin^2 \theta + \cos^2 \theta = 1$, solving equations	10	66	own PDF	
7 Differentiation Increasing and decreasing functions, stationary points, optimisation	10	67	own PDF	
8 Integration Definite integrals, areas under curves, the trapezium rule	10	67	own PDF	

Question booklet

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How to use this mark scheme

The same marking rules Pearson examiners use for WMA12.

Mark every line, not just the answer. Method marks are given for a correct method even when the final answer is wrong. If you lost marks, find the *first* line where your working differs from the scheme. That is the thing to fix.

Code	Meaning
M1	Method mark: for knowing a correct method and attempting to apply it. Small slips in the working do not lose this mark.
dM1	Dependent method mark: can only be given if the method mark before it has been given.
A1	Accuracy mark: for a correct answer or line of working. It can only be given if the method mark it depends on has been given.
B1	Independent mark: for a correct result or statement, whatever method was used.
*	The answer is given in the question. Every step must be shown, and the answer must follow from correct working (cso).
cao	Correct answer only.
cso	Correct solution only: no errors anywhere in the working.
ft	Follow through: the mark can be given for correct work using your own earlier (wrong) answer.
oe	Or equivalent: any correct equivalent form is accepted.

“Solutions relying on calculator technology are not acceptable.” When a question says this, a correct final answer with no algebraic working scores **no marks**. The notes under each scheme line say when this applies.



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Chapter 3: Exponentials and Logarithms

Mark scheme. Marks are shown on the right of each line.

Question 1

4 marks

Part	Scheme	Marks
(a)	4	B1 (1)
(b)	Power law: $2\log_a 5 = \log_a 25$ Combines: $\log_a \left(\frac{25 \times 4}{10} \right)$ $\log_a 10$	M1 M1 A1 (3)
Total for Question 1: 4 marks		

Question 2

5 marks

Part	Scheme	Marks
(a)	$x = \frac{\log 12}{\log 5}$ (or $\log_5 12$) 1.54	M1 A1 (2)
(b)	$(2x - 1)\log 3 = x\log 7$ $x(2\log 3 - \log 7) = \log 3$, so $x = \frac{\log 3}{\log 9 - \log 7}$ 4.37	M1 M1 A1 (3)
Total for Question 2: 5 marks		



Question 3

6 marks

Part	Scheme	Marks
	Uses the addition law: $\log_3((2x+3)(x-1))$	M1
	Writes 2 as $\log_3 9$ and combines: $(2x+3)(x-1) = 9(x+1)$	M1
	$2x^2 - 8x - 12 = 0 \Rightarrow x^2 - 4x - 6 = 0$	A1
	$x = \frac{4 \pm \sqrt{16+24}}{2} = 2 \pm \sqrt{10}$	M1
	$x = 2 + \sqrt{10}$	A1
	$2 - \sqrt{10} < 0$, so $\log_3(x-1)$ would not be defined: it is rejected	B1
	<i>Removing the logs term by term, e.g. $(2x+3) + (x-1) = \dots$, scores M0 M0.</i>	
		(6)
Total for Question 3: 6 marks		

Question 4

5 marks

Part	Scheme	Marks
(a)	Decreasing curve, approaching $y = 4$ as $x \rightarrow -\infty$	B1
	$(0, 3)$ and $(2, 0)$	B1
	Asymptote $y = 4$	B1
	<i>The y intercept is at $y = 3$, not at the height of the asymptote.</i>	
		(3)
(b)	$4 - 2^x = 1 \Rightarrow 2^x = 3$	M1
	$x = \log_2 3$ (or $\frac{\log 3}{\log 2}$)	A1
		(2)
Total for Question 4: 5 marks		



Question 5

5 marks

Part	Scheme	Marks
(a)	Change of base: $\log_4 x = \frac{\log_2 x}{\log_2 4}$ $\log_2 4 = 2$, so $\log_4 x = \frac{1}{2} \log_2 x$ *	M1 A1* (2)
(b)	$\log_2 x + \frac{1}{2} \log_2 x = 6$ $\log_2 x = 4$ $x = 16$	M1 A1 A1 (3)
Total for Question 5: 5 marks		

Question 6

8 marks

Part	Scheme	Marks
(a)	$2^{2x+1} = 2 \times (2^x)^2 = 2y^2$ $2y^2 - 11y + 12 = 0$ *	M1 A1* (2)
(b)	$(2y - 3)(y - 4) = 0$ $y = \frac{3}{2}$ or $y = 4$ $2^x = 4 \Rightarrow x = 2$ and $2^x = \frac{3}{2} \Rightarrow x = \frac{\log 1.5}{\log 2}$ $x = 2, x = 0.585$	M1 A1 M1 A1 (4)
(c)	$\frac{3}{2} < 2^x < 4$ (the quadratic is negative between its roots) $0.585 < x < 2$ <i>2^x is increasing, so the inequality in y gives the same order of x values.</i>	M1 A1 (2)
Total for Question 6: 8 marks		



Question 7

8 marks

Part	Scheme	Marks
(a)	Two increasing exponential curves, above the x -axis and asymptotic to it for $x < 0$ C_1 through $(0, 1)$ and C_2 through $(0, 2)$ C_1 crosses C_2 for $x > 0$ and is steeper to the right of P	B1 B1 B1 (3)
(b)	$5^x = 2 \times 2^x$ $\left(\frac{5}{2}\right)^x = 2$ (or $x \log 5 = (x+1) \log 2$) $x = \frac{\log 2}{\log 2.5}^*$	M1 M1 A1* (3)
(c)	$x = 0.756 \dots$ and uses the sketch: C_1 is above C_2 to the right of P $x > 0.756$	M1 A1 (2)
Total for Question 7: 8 marks		

Question 8

8 marks

Part	Scheme	Marks
(a)	$\log_a x^2 + \log_a \sqrt{y} - \log_a a$ Uses the power law on both terms and $\log_a a = 1$ $2p + \frac{1}{2}q - 1$	M1 M1 A1 (3)
(b)	$x + y = 2^3 = 8$ $\log_2(xy) = \log_2 15$, so $xy = 15$ Substitutes: $x(8 - x) = 15 \Rightarrow x^2 - 8x + 15 = 0$ $(x - 3)(x - 5) = 0$ $x = 3, y = 5$ and $x = 5, y = 3$ <i>Both pairs are valid because x and y are positive in each.</i>	B1 B1 M1 A1 A1 (5)
Total for Question 8: 8 marks		



Question 9

9 marks

Part	Scheme	Marks
(a)	Change of base: $\log_y a = \frac{1}{\log_a y}$	M1
	Let $u = \log_a y$: $u + 2 = \frac{3}{u}$	M1
	Multiplies by u ($u \neq 0$ as $y \neq 1$): $(\log_a y)^2 + 2\log_a y - 3 = 0$ *	A1*
		(3)
(b)	$(u + 3)(u - 1) = 0$, so $\log_a y = 1$ or $\log_a y = -3$	M1
	Converts from log form	M1
	$y = a$ or $y = a^{-3}$	A1
		(3)
(c)	$a \times a^{-3} = \frac{1}{16}$	M1
	$a^{-2} = \frac{1}{16}$, so $a^2 = 16$	M1
	$a = 4$ (as $a > 1$)	A1
		(3)
Total for Question 9: 9 marks		



Question 10

10 marks

Part	Scheme	Marks
(a)	Uses a subtraction law: $\log_2 \left(\frac{x^2}{x-1} \right) = 3$ Removes the logs: $\frac{x^2}{x-1} = 2^3 = 8$ $x^2 = 8x - 8 \Rightarrow x^2 - 8x + 8 = 0$ *	M1 M1 A1* (3)
(b)	$x = \frac{8 \pm \sqrt{64 - 32}}{2}$ $= \frac{8 \pm 4\sqrt{2}}{2}$ $x = 4 \pm 2\sqrt{2}$ Both valid: $4 - 2\sqrt{2} \approx 1.17 > 1$, so $x - 1 > 0$ and $x^2 > 0$ for both values	M1 A1 A1 B1 (4)
(c)	Recognises $x = 2y$: $\log_2 ((2y)^2) - \log_2 (2y - 1) = 3$ is the same equation $2y = 4 \pm 2\sqrt{2}$ $y = 2 \pm \sqrt{2}$ Both satisfy $y > \frac{1}{2}$ since $2 - \sqrt{2} \approx 0.59$. Solving from scratch ($4y^2 = 8(2y - 1)$) is equally valid.	M1 M1 A1 (3)
Total for Question 10: 10 marks		

