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INTERNATIONAL A LEVEL MATHEMATICS • PURE 3

Pure Mathematics 3

Exam Questions by Topic: Mark Scheme

Pearson Edexcel International Advanced Level (WMA13/01) • 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, improper fractions and algebraic division	10	69	own PDF	
2 Functions and Graphs Modulus, composite and inverse functions, transformations	10	76	3	
3 Trigonometric Functions sec, cosec, cot, identities, inverse trigonometric functions	10	72	own PDF	
4 Trigonometric Addition Formulae Addition and double-angle formulae, $R\cos(\theta \pm \alpha)$	10	75	own PDF	
5 Exponentials and Logarithms e^x , $\ln x$, modelling, logarithmic graphs	10	78	own PDF	
6 Differentiation Chain, product and quotient rules, trigonometric and exponential functions	10	76	own PDF	
7 Integration Standard integrals, $f(ax+b)$, trigonometric identities, reverse chain rule	10	77	own PDF	
8 Numerical Methods Locating roots, iteration	10	77	own PDF	

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How to use this mark scheme

The same marking rules Pearson examiners use for WMA13.

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 2: Functions and Graphs

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

Question 1

6 marks

Part	Scheme	Marks
(a)	Shape: the part below the x -axis (for $x < -4$ and $1 < x < 5$) reflected above it; cusps at $x = -4, 1$ and 5	B1
	Maximum points $(-2, 6)$ and $(3, 4)$	B1
	Meets the axes at $(-4, 0)$, $(1, 0)$, $(5, 0)$ and $(0, 3)$	B1
		(3)
(b)	Shape: the part for $x \geq 0$ and its reflection in the y -axis (symmetrical W shape with a sharp point at $(0, 3)$)	B1
	Minimum points $(3, -4)$ and $(-3, -4)$	B1
	Crosses the x -axis at $(\pm 1, 0)$ and $(\pm 5, 0)$, and meets the y -axis at $(0, 3)$	B1
	<i>The maximum at $(-2, 6)$ is not on $y = f(x)$: only the curve for $x \geq 0$ is used.</i>	
		(3)
Total for Question 1: 6 marks		

Question 2

5 marks

Part	Scheme	Marks
(a)	$3x - 5 = x + 7 \Rightarrow x = 6$	B1
	$-(3x - 5) = x + 7$	M1
	$x = 6$ and $x = -\frac{1}{2}$	A1
		(3)
(b)	Chooses the region between the solutions (the line is above the V)	M1
	$-\frac{1}{2} < x < 6$	A1
		(2)
Total for Question 2: 5 marks		



Question 3

5 marks

Part	Scheme	Marks
(a)	V shape with vertex $\left(-\frac{a}{3}, a\right)$ (above the x -axis)	B1
	Meets the y -axis at $(0, 2a)$	B1
		(2)
(b)	$ 3x + a = 4a$	M1
	$3x + a = 4a$ or $3x + a = -4a$	M1
	$x = a, x = -\frac{5a}{3}$	A1
		(3)
Total for Question 3: 5 marks		

Question 4

5 marks

Part	Scheme	Marks
(a)	$(3, 2)$	B1
		(1)
(b)	$(3, -3)$	B1
	and its reflection $(-3, -3)$	B1
		(2)
(c)	$(2, -8)$	B1
		(1)
(d)	$\left(\frac{3}{2}, 4\right)$	B1
		(1)
Total for Question 4: 5 marks		



Question 5

5 marks

Part	Scheme	Marks
(a)	$(2x+1)^2 - 4(2x+1)$	M1
	$4x^2 - 4x - 3$	A1
		(2)
(b)	gf(x) = $2x^2 - 8x + 1$ and sets equal: $4x^2 - 4x - 3 = 2x^2 - 8x + 1$	M1
	$x^2 + 2x - 2 = 0$	A1
	$x = -1 \pm \sqrt{3}$	A1
		(3)
Total for Question 5: 5 marks		

Question 6

10 marks

Part	Scheme	Marks
(a)	$f(x) = 2 + \frac{1}{x+1}$: decreasing, $f(0) = 3$, and $f(x) \rightarrow 2$	M1
	$2 < f(x) \leq 3$	A1
	Both ends with the correct inequality signs are needed for the A mark.	(2)
(b)	$y(x+1) = 2x+3 \Rightarrow x(y-2) = 3-y$	M1
	Correct rearrangement	A1
	$f^{-1}(x) = \frac{3-x}{x-2}$	A1
	Domain $2 < x \leq 3$	B1ft
		(4)
(c)	$g(-2) = 3$, so $fg(-2) = f(3) = \frac{9}{4}$	B1
		(1)
(d)	$gf(x) = 3 \Rightarrow (f(x))^2 - 1 = 3$	M1
	$f(x) = \pm 2$	A1
	Neither value lies in the range $2 < f(x) \leq 3$, so there are no solutions *	A1*
		(3)
Total for Question 6: 10 marks		



Question 7

10 marks

Part	Scheme	Marks
(a)	(i) $P\left(\frac{b}{2}, a\right)$ (ii) $Q(0, a - b)$ (iii) $a - 2x - b = 0: 2x - b = \pm a$ $\left(\frac{b-a}{2}, 0\right)$ and $\left(\frac{a+b}{2}, 0\right)$	B1 B1 M1 A1 (4)
(b)	At $x = -2$: $y = -2 - 1 = 1$, and $2x - b < 0$, so $1 = a + (-4 - b)$ $a - b = 5$ At $x = 4$: $y = 3$, and $2x - b > 0$ (as $b < 8$), so $3 = a - (8 - b)$ $a + b = 11$ $a = 8, b = 3$ <i>Using the wrong branch of the modulus at either point is the common error: the sign of $2x - b$ must be decided.</i>	M1 A1 M1 A1 A1 (5)
(c)	$k < 8$	B1ft (1)
Total for Question 7: 10 marks		



Question 8

10 marks

Part	Scheme	Marks
(a)	W shape symmetrical in the y -axis Crosses the x -axis at $(\pm 1, 0)$ and $(\pm 5, 0)$ and the y -axis at $(0, 5)$ Minimum points $(\pm 3, -4)$	B1 B1 B1 (3)
(b)	Uses the minimum value -4 and the y intercept 5 $-4 < k < 5$	M1 A1 (2)
(c)	$k = 5$	B1 (1)
(d)	The part between $x = 1$ and $x = 5$ reflected above the x -axis Cusps at $(1, 0)$ and $(5, 0)$, maximum $(3, 4)$ and y intercept $(0, 5)$	B1 B1 (2)
(e)	$x^2 - 6x + 5 = \pm 3$ $x = 3 \pm \sqrt{7}, x = 2, x = 4$	M1 A1 (2)
Total for Question 8: 10 marks		



Question 9

10 marks

Part	Scheme	Marks
(a)	V shape with vertex $(-\frac{3}{2}, 0)$ and y intercept $(0, 3)$ Parabola $y = x^2$ through the origin Two points of intersection, both for $x > -\frac{3}{2}$	B1 B1 B1 (3)
(b)	$x^2 = 2x + 3 \Rightarrow (x - 3)(x + 1) = 0$ $x^2 = -(2x + 3)$ has no real roots (discriminant $4 - 12 < 0$) $(-1, 1)$ and $(3, 9)$	M1 M1 A1 (3)
(c)	Parabola below the V between the intersections $-1 < x < 3$	M1 A1 (2)
(d)	$2x + 3 = 3x - 1 \Rightarrow x = 4$; and $-(2x + 3) = 3x - 1 \Rightarrow x = -\frac{2}{5}$ $x = -\frac{2}{5}$ gives $3x - 1 < 0$, which cannot equal a modulus, so $x = 4$ only	M1 A1 (2)
Total for Question 9: 10 marks		



Question 10

10 marks

Part	Scheme	Marks
(a)	$f(0) = 2$ and $f(x) \rightarrow 0$ as $x \rightarrow \infty$ (f decreasing) $0 < f(x) \leq 2$	M1 A1 (2)
(b)	$gf(x) = \left(\frac{4}{x+2}\right)^2 - 2\left(\frac{4}{x+2}\right) = \frac{16 - 8(x+2)}{(x+2)^2}$ $= \frac{-8x}{(x+2)^2}$ *	M1 A1* (2)
(c)	$gf(x) = g(t)$ with $t = f(x)$ and $0 < t \leq 2$ $g(t) = (t - 1)^2 - 1$: minimum -1 at $t = 1$; $g(2) = 0$ $-1 \leq gf(x) \leq 0$ <i>Using the range of g over all of $\mathbb{R}$ ($g \geq -1$ only) scores M0: the inputs to g are restricted to $0 < t \leq 2$.</i>	M1 M1 A1 (3)
(d)	$t^2 - 2t + \frac{3}{4} = 0 \Rightarrow t = \frac{1}{2}$ or $t = \frac{3}{2}$ $\frac{4}{x+2} = \frac{1}{2}$ or $\frac{3}{2}$ $x = 6, x = \frac{2}{3}$	M1 M1 A1 (3)
Total for Question 10: 10 marks		

