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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	own PDF	
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	3	
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 6: Differentiation

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

Question 1

5 marks

Part	Scheme	Marks
(a)	Product rule: $3e^{3x} \ln(2x) + e^{3x} \times \frac{1}{x}$ $e^{3x} \left(3 \ln 2x + \frac{1}{x} \right)$	M1 A1 (2)
(b)	Quotient rule: $\frac{2 \cos x - (2x+1)(-\sin x)}{\cos^2 x}$ Correct unsimplified $\frac{2 \cos x + (2x+1) \sin x}{\cos^2 x}$	M1 A1 A1 (3)
Total for Question 1: 5 marks		

Question 2

5 marks

Part	Scheme	Marks
(a)	$\frac{3(x+2) - (3x-1)}{(x+2)^2}$ $= \frac{7}{(x+2)^2}$, so $a = 7$	M1 A1 (2)
(b)	$x = -1: y = -4$ and gradient 7 $y + 4 = 7(x + 1)$ $y = 7x + 3$	B1 M1 A1 (3)
Total for Question 2: 5 marks		



Question 3

5 marks

Part	Scheme	Marks
(a)	$\frac{dx}{dy} = 6 \sec^2 3y$	M1
	$\frac{dy}{dx} = \frac{1}{6 \sec^2 3y}$	A1
		(2)
(b)	$\sec^2 3y = 1 + \tan^2 3y$	M1
	$\tan 3y = \frac{x}{2}$, so $\sec^2 3y = 1 + \frac{x^2}{4}$	M1
	$\frac{1}{6 \left(1 + \frac{x^2}{4}\right)} = \frac{2}{3(x^2 + 4)}$ *	A1*
		(3)
Total for Question 3: 5 marks		

Question 4

5 marks

Part	Scheme	Marks
(a)	Product rule: $e^{-2x} - 2xe^{-2x}$	M1
	$(1 - 2x)e^{-2x}$	A1
	$= 0$ gives $x = \frac{1}{2}$ (as $e^{-2x} \neq 0$)	M1
	$\left(\frac{1}{2}, \frac{1}{2e}\right)$	A1
		(4)
(b)	$\frac{1}{2e}$	B1ft
		(1)
Total for Question 4: 5 marks		



Question 5

5 marks

Part	Scheme	Marks
	$g'(x) = \frac{2}{2x+1} - \frac{8}{(2x+1)^2}$ Both terms correct $= \frac{2(2x+1) - 8}{(2x+1)^2} = \frac{2(2x-3)}{(2x+1)^2}$ $(2x+1)^2 > 0$, so $g'(x) > 0$ when $2x-3 > 0$ $x > \frac{3}{2}$	M1 A1 M1 M1 A1 (5)
Total for Question 5: 5 marks		

Question 6

10 marks

Part	Scheme	Marks
(a)	Product rule: $2(x+1)e^{-2x} - 2(x+1)^2e^{-2x}$ Correct unsimplified $= 2(x+1)e^{-2x}(1 - (x+1)) = -2x(x+1)e^{-2x}$ *	M1 A1 A1* (3)
(b)	$x = 0$ or $x = -1$ $A(0, 1), B(-1, 0)$	M1 A1 (2)
(c)	$3 \times 0 - 2 = -2$	B1 (1)
(d)	The line $y = k$ must lie between the minimum value 0 and the maximum value 1 $0 < k < 1$	M1 A1 (2)
(e)	$f(1) = 4e^{-2}$ and $f'(1) = -4e^{-2}$ $y = 4e^{-2}(2-x)$	M1 A1 (2)
Total for Question 6: 10 marks		



Question 7

10 marks

Part	Scheme	Marks
(a)	Product rule with $\frac{d}{dx} \cos \frac{x}{2} = -\frac{1}{2} \sin \frac{x}{2}$ $f'(x) = 2 \cos \frac{x}{2} - x \sin \frac{x}{2}$	M1 A1 (2)
(b)	$x \sin \frac{x}{2} = 2 \cos \frac{x}{2}$ $x = \frac{2 \cos \frac{x}{2}}{\sin \frac{x}{2}} = 2 \cot \frac{x}{2} *$	M1 A1* (2)
(c)	$f(\pi) = 0$ and $f'(\pi) = -\pi$ Normal gradient $\frac{1}{\pi}$: $y - 0 = \frac{1}{\pi}(x - \pi)$ $y = \frac{x}{\pi} - 1$	B1 M1 A1 (3)
(d)	$P(\pi, 0)$ and $Q(0, -1)$ Area = $\frac{1}{2} \times \pi \times 1$ $\frac{\pi}{2}$	B1 M1 A1 (3)
Total for Question 7: 10 marks		



Question 8

10 marks

Part	Scheme	Marks
(a)	Quotient rule: $\frac{2 \cos 2x \cos 2x - (1 + \sin 2x)(-2 \sin 2x)}{\cos^2 2x}$ Correct unsimplified $= \frac{2(\cos^2 2x + \sin^2 2x) + 2 \sin 2x}{\cos^2 2x} = \frac{2(1 + \sin 2x)}{\cos^2 2x}$ $\cos^2 2x = 1 - \sin^2 2x = (1 - \sin 2x)(1 + \sin 2x)$ Cancels: $\frac{2}{1 - \sin 2x}^*$	M1 A1 M1 M1 A1* (5)
(b)	$x = \frac{\pi}{12}: y = \frac{1 + \frac{1}{2}}{\frac{\sqrt{3}}{2}} = \sqrt{3}$ and $\frac{dy}{dx} = \frac{2}{\frac{1}{2}} = 4$ $y - \sqrt{3} = 4\left(x - \frac{\pi}{12}\right)$ $y = 4x + \sqrt{3} - \frac{\pi}{3}$	B1 M1 A1 (3)
(c)	$\frac{dy}{dx} = \frac{2}{1 - \sin 2x}$ has numerator 2, which is never 0 so $\frac{dy}{dx} \neq 0$ anywhere: no stationary points (it is always positive)	B1 B1 (2)
Total for Question 8: 10 marks		



Question 9

10 marks

Part	Scheme	Marks
(a)	$\frac{x \times \frac{1}{x} - \ln x}{x^2}$	M1
	$f'(x) = \frac{1 - \ln x}{x^2}$	A1
		(2)
(b)	$\ln x = 1 \Rightarrow x = e: \left(e, \frac{1}{e}\right)$	M1
	Correct coordinates	A1
	$f'(x) > 0$ for $x < e$ and $f'(x) < 0$ for $x > e$, so a maximum	A1
		(3)
(c)	$\frac{1}{e}$ is the maximum value of f , and $\pi \neq e$	M1
	so $f(\pi) < f(e)$, i.e. $\frac{\ln \pi}{\pi} < \frac{1}{e}$	A1
		(2)
(d)	$e \ln \pi < \pi$	M1
	$\ln(\pi^e) < \pi = \ln(e^\pi)$	M1
	$\ln$ is increasing, so $\pi^e < e^\pi$ *	A1*
		(3)
Total for Question 9: 10 marks		



Question 10

11 marks

Part	Scheme	Marks
(a)	$\frac{dx}{dy} = e^{2y} + 2ye^{2y}$ $= (1 + 2y)e^{2y}$ $\frac{dy}{dx} = \frac{1}{(1 + 2y)e^{2y}}$	M1 A1 A1 (3)
(b)	$x = \frac{e}{2}$ Gradient $\frac{1}{2e}$ $y - \frac{1}{2} = \frac{1}{2e} \left(x - \frac{e}{2} \right)$ $y = \frac{x}{2e} + \frac{1}{4}$	B1 B1 M1 A1 (4)
(c)	$y = 0: \frac{x}{2e} = -\frac{1}{4}$ $x = -\frac{e}{2}$	M1 A1 (2)
(d)	Tangent parallel to the y-axis when $\frac{dx}{dy} = 0: y = -\frac{1}{2}$ $\left(-\frac{1}{2e}, -\frac{1}{2} \right)$	M1 A1 (2)
Total for Question 10: 11 marks		

