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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	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	3	

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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 8: Numerical Methods

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

Question 1

5 marks

Part	Scheme	Marks
(a)	$f(2) = -3$ and $f(3) = 13$ Sign change and f is continuous, so there is a root between 2 and 3	M1 A1 (2)
(b)	$x^3 = 3x + 5 \Rightarrow x = \sqrt[3]{3x + 5}$ *	B1* (1)
(c)	$x_2 = 2.2240$ $x_3 = 2.2684, x_4 = 2.2770$	M1 A1 (2)
Total for Question 1: 5 marks		

Question 2

5 marks

Part	Scheme	Marks
(a)	$f(1) = -2.28$ and $f(2) = 1.39$ Sign change, f continuous, so a root in $[1, 2]$	M1 A1 (2)
(b)	Interval $[1.7485, 1.7495]$ $f(1.7485) = -0.0025$ and $f(1.7495) = 0.0022$ Sign change, f continuous, so $\alpha = 1.749$ to 3 d.p. *	M1 A1 A1* (3)
Total for Question 2: 5 marks		



Question 3

5 marks

Part	Scheme	Marks
(a)	$f(1.9) = -7$ and $f(2.1) = 13$: opposite signs	B1 (1)
(b)	f is not continuous on the interval It has a vertical asymptote at $x = 2$, where the sign changes without passing through zero	B1 B1 (2)
(c)	$\frac{1}{x-2} = -3 \Rightarrow x-2 = -\frac{1}{3}$ $x = \frac{5}{3}$	M1 A1 (2)
Total for Question 3: 5 marks		

Question 4

5 marks

Part	Scheme	Marks
(a)	$x_2 = 0.8$ $x_3 = 0.728, x_4 = 0.706$ (0.7060)	M1 A1 (2)
(b)	$x_2 = 4.65, x_3 = 4.9245$ The values move away from β (they diverge), so the formula cannot find β	B1 B1 (2)
(c)	e.g. $x = 5 - \frac{3}{x}$ (or $x = \sqrt{5x-3}$)	B1 (1)
Total for Question 4: 5 marks		



Question 5

5 marks

Part	Scheme	Marks
(a)	α is a root of $g(x) = \ln x + x - 3 = 0$ $g(2) = -0.307$ and $g(3) = 1.099$ Sign change, g continuous for $x > 0$, so $2 < \alpha < 3$	B1 M1 A1 (3)
(b)	$x_2 = 2.3069$ $x_3 = 2.1641$	M1 A1 (2)
Total for Question 5: 5 marks		

Question 6

11 marks

Part	Scheme	Marks
(a)	$e^x + 2x$	B1 (1)
(b)	Tangent through the origin: $\frac{y_P}{x_P} = \text{gradient}$, so $e^\alpha + \alpha^2 = \alpha(e^\alpha + 2\alpha)$ $e^\alpha + \alpha^2 = \alpha e^\alpha + 2\alpha^2$ $e^\alpha(1 - \alpha) - \alpha^2 = 0$ *	M1 A1 A1* (3)
(c)	$h(0.5) = 0.574$ and $h(1) = -1$ Sign change, continuous, so $0.5 < \alpha < 1$	M1 A1 (2)
(d)	$1 - x = x^2 e^{-x} \Rightarrow x = 1 - x^2 e^{-x}$ *	B1* (1)
(e)	$x_2 = 0.7567$ $x_3 = 0.7313$	M1 A1 (2)
(f)	Interval $[0.7385, 0.7395]$: $h(0.7385) = 0.0019$, $h(0.7395) = -0.0011$ Sign change, continuous, so $\alpha = 0.739$ (3 d.p.)	M1 A1 (2)
Total for Question 6: 11 marks		



Question 7

10 marks

Part	Scheme	Marks
(a)	Product rule $f'(x) = 2x \cos x - x^2 \sin x$	M1 A1 (2)
(b)	$2x \cos x = x^2 \sin x \Rightarrow \tan x = \frac{2}{x}$ (as $x \neq 0$) $x = \arctan\left(\frac{2}{x}\right)$ (as $0 < x < \frac{\pi}{2}$) *	M1 A1* (2)
(c)	$x_2 = 1.1071$ $x_3 = 1.0652$ $x_4 = 1.0814$	M1 A1 A1 (3)
(d)	Interval $[1.0765, 1.0775]$ $f'(1.0765) = 0.0013$ and $f'(1.0775) = -0.0021$ Sign change, f' continuous, so $\beta = 1.077$ (3 d.p.)	M1 A1 A1 (3)
Total for Question 7: 10 marks		



Question 8

10 marks

Part	Scheme	Marks
(a)	$\frac{dC}{dt} = 8(-0.2e^{-0.2t} + e^{-t}) = 0$ $e^{0.8t} = 5$ $t = \frac{\ln 5}{0.8} = \frac{5}{4} \ln 5 \text{ hours}$	M1 A1 A1 (3)
(b)	$e^{-0.2T} - e^{-T} = 0.25 \Rightarrow e^{-0.2T} = 0.25 + e^{-T}$ $-0.2T = \ln(0.25 + e^{-T})$, so $T = -5 \ln(0.25 + e^{-T})$ *	M1 A1* (2)
(c)	$T_2 = 6.8821$ $T_3 = 6.9110$	M1 A1 (2)
(d)	$T \approx 6.912 \text{ hours}$ $6.912 - 0.394 = 6.518 \text{ hours}$ 6 hours 31 minutes	B1 M1 A1 (3)
Total for Question 8: 10 marks		



Question 9

10 marks

Part	Scheme	Marks
(a)	$f(1.2) = -1.03$ and $f(1.4) = 1.60$ Sign change, f continuous on $[1.2, 1.4]$, so a root	M1 A1 (2)
(b)	$f(1.5) = 9.60$ and $f(1.6) = -39.0$ $\tan x$ has an asymptote at $x = \frac{\pi}{2} = 1.5708$ in the interval: f is not continuous there	B1 B1 (2)
(c)	$x_2 = \arctan 3.9$ $x_2 = 1.3198$ $x_3 = 1.3234$	M1 A1 A1 (3)
(d)	Interval $[1.3235, 1.3245]$ $f(1.3235) = -0.0095$ and $f(1.3245) = 0.0042$ Sign change, continuous, so the root is 1.324 (3 d.p.)	M1 A1 A1 (3)
Total for Question 9: 10 marks		



Question 10

11 marks

Part	Scheme	Marks
(a)	$x = e^y - 2 \Rightarrow y = \ln(x+2)$ $f^{-1}(x) = \ln(x+2)$ Domain $x > -2$ (the range of f)	M1 A1 B1 (3)
(b)	The graphs are reflections in $y = x$, so they meet on it: $e^x - 2 = x$ $h(1) = -0.28$ and $h(2) = 3.39$ for $h(x) = e^x - x - 2$ Sign change, continuous, so $1 < \alpha < 2$	B1 M1 A1 (3)
(c)	$x_2 = 1.0986$ $x_3 = 1.1310$	M1 A1 (2)
(d)	$x_2 = -1.8347, x_3 = -1.8403$ $\ln(x+2)$ has gradient $\frac{1}{x+2} \approx 6$ near β , so that formula moves away from β $e^x - 2$ has gradient $e^x \approx 0.16$ near β (less than 1), so it converges to β	B1 B1 B1 (3)
Total for Question 10: 11 marks		

