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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	3	
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 4: Trigonometric Addition Formulae

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

Question 1

5 marks

Part	Scheme	Marks
(a)	$\sin(45^\circ + 30^\circ) = \frac{\sqrt{2}}{2} \times \frac{\sqrt{3}}{2} + \frac{\sqrt{2}}{2} \times \frac{1}{2}$ $= \frac{\sqrt{6} + \sqrt{2}}{4} *$	M1 A1* (2)
(b)	$\sin A = \frac{3}{5}, \cos A = \frac{4}{5}, \sin B = \frac{5}{13}, \cos B = \frac{12}{13}$ $\sin(A - B) = \frac{3}{5} \times \frac{12}{13} - \frac{4}{5} \times \frac{5}{13}$ $\frac{16}{65}$	B1 M1 A1 (3)
Total for Question 1: 5 marks		

Question 2

5 marks

Part	Scheme	Marks
	$2(1 - 2\sin^2 x) + 5\sin x = 3$ $4\sin^2 x - 5\sin x + 1 = 0$ $(4\sin x - 1)(\sin x - 1) = 0$ $\sin x = 1: x = 90^\circ$ $14.5^\circ, 90^\circ, 165.5^\circ$	M1 A1 M1 A1 A1 (5)
Total for Question 2: 5 marks		



Question 3

5 marks

Part	Scheme	Marks
(a)	$R = \sqrt{5^2 + 12^2} = 13$ $\tan \alpha = \frac{12}{5}$ $13 \sin(x - 67.38^\circ)$	B1 M1 A1 (3)
(b)	Maximum 13 $x - 67.38^\circ = 90^\circ$: $x = 157.38^\circ$	B1ft B1ft (2)
Total for Question 3: 5 marks		

Question 4

5 marks

Part	Scheme	Marks
(a)	$\frac{1 - (1 - 2 \sin^2 \theta)}{2 \sin \theta \cos \theta}$ $= \frac{2 \sin^2 \theta}{2 \sin \theta \cos \theta}$ $= \frac{\sin \theta}{\cos \theta} = \tan \theta \quad *$	M1 A1 A1* (3)
(b)	$\theta = 15^\circ$: $\frac{1 - \frac{\sqrt{3}}{2}}{\frac{1}{2}}$ $2 - \sqrt{3}$	M1 A1 (2)
Total for Question 4: 5 marks		

Question 5

5 marks

Part	Scheme	Marks
	$\frac{\tan x - 1}{1 + \tan x} = 6 \tan x$ (using $\tan \frac{\pi}{4} = 1$) $6 \tan^2 x + 5 \tan x + 1 = 0$ $(3 \tan x + 1)(2 \tan x + 1) = 0$ $\tan x = -\frac{1}{3}$ or $-\frac{1}{2}$ $x = 2.68, 2.82$ <i>Both solutions lie in the second quadrant, as $\tan x < 0$ and $0 \leq x < \pi$.</i>	M1 A1 M1 A1 A1 (5)
Total for Question 5: 5 marks		



Question 6

10 marks

Part	Scheme	Marks
(a)	$R = \sqrt{13}$ $R \cos \alpha = 2, R \sin \alpha = 3$, so $\tan \alpha = \frac{3}{2}$ $\sqrt{13} \cos(x + 0.983)$	B1 M1 A1 (3)
(b)	(i) Maximum when $f(x) = -\sqrt{13}$: $\frac{12}{10 - \sqrt{13}}$ $\frac{12}{10 - \sqrt{13}} \left(= \frac{4(10 + \sqrt{13})}{29} \right)$ (ii) $x + 0.983 = \pi$ $x = 2.159$ <i>Using the maximum of f (giving $\frac{12}{10 + \sqrt{13}}$, the minimum of g) scores M0.</i>	M1 A1 M1 A1 (4)
(c)	$\cos(x + 0.983) = \frac{1}{\sqrt{13}}$, with $0.983 < x + 0.983 < 2\pi + 0.983$ $x + 0.983 = 1.290$ or $2\pi - 1.290$ $x = 0.307, 4.011$	M1 M1 A1 (3)
Total for Question 6: 10 marks		



Question 7

10 marks

Part	Scheme	Marks
(a)	$\cos(2x+x) = \cos 2x \cos x - \sin 2x \sin x$ $= (2\cos^2 x - 1) \cos x - 2\sin^2 x \cos x$ $= 2\cos^3 x - \cos x - 2(1 - \cos^2 x) \cos x$ $= 4\cos^3 x - 3\cos x$ *	M1 M1 A1 A1* (4)
(b)	$4\cos^3 x - \cos x = 0 \Rightarrow \cos x (4\cos^2 x - 1) = 0$ $\cos x = 0$ or $\cos x = \pm \frac{1}{2}$ Two correct solutions $x = \frac{\pi}{3}, \frac{\pi}{2}, \frac{2\pi}{3}$ <i>Dividing by $\cos x$ loses $x = \frac{\pi}{2}$.</i>	M1 A1 A1 A1 (4)
(c)	$4\left(\frac{1}{3}\right)^3 - 3 \times \frac{1}{3}$ $\frac{23}{27}$	M1 A1 (2)
Total for Question 7: 10 marks		



Question 8

10 marks

Part	Scheme	Marks
(a)	$R = 5$ $\tan \alpha = \frac{4}{3}$ $5 \sin(\theta - 0.9273)$	B1 M1 A1 (3)
(b)	Maximum depth $10 + 5 = 15 \text{ m}$ $\frac{\pi t}{6} - 0.9273 = \frac{\pi}{2} \Rightarrow t = 4.771$ $04:46$	B1 M1 A1 (3)
(c)	$5 \sin\left(\frac{\pi t}{6} - 0.9273\right) = 2$, so $\sin(\dots) = 0.4$ $\frac{\pi t}{6} - 0.9273 = 0.4115$ or $\pi - 0.4115$ $t = 2.557$ or $t = 6.985$ $02:33$ and $06:59$	M1 M1 A1 A1 (4)
Total for Question 8: 10 marks		

Question 9

10 marks

Part	Scheme	Marks
(a)	$\frac{1}{\sin 2x} + \frac{\cos 2x}{\sin 2x} = \frac{1 + \cos 2x}{\sin 2x}$ $1 + \cos 2x = 2 \cos^2 x$ and $\sin 2x = 2 \sin x \cos x$ $\frac{2 \cos^2 x}{2 \sin x \cos x}$ $= \frac{\cos x}{\sin x} = \cot x$ *	M1 M1 A1 A1* (4)
(b)	With $x = 2\theta$: $\cot 2\theta = \sqrt{3}$, so $\tan 2\theta = \frac{1}{\sqrt{3}}$ $0 < 2\theta < \pi$ gives $2\theta = \frac{\pi}{6}$ only $\theta = \frac{\pi}{12}$	M1 M1 A1 (3)
(c)	$x = \frac{\pi}{8}$: $\cot \frac{\pi}{8} = \operatorname{cosec} \frac{\pi}{4} + \cot \frac{\pi}{4}$ $= \sqrt{2} + 1$ $1 + \sqrt{2}$, i.e. $a = 1$, $b = 2$	M1 A1 A1 (3)
Total for Question 9: 10 marks		



Question 10

10 marks

Part	Scheme	Marks
(a)	$R = 2$ $\tan \alpha = \frac{1}{\sqrt{3}}$ $2 \cos \left(x - \frac{\pi}{6} \right)$	B1 M1 A1 (3)
(b)	$2 \cos \left(2x - \frac{\pi}{6} \right) = -1$, so $\cos \left(2x - \frac{\pi}{6} \right) = -\frac{1}{2}$ $-\frac{\pi}{6} \leq 2x - \frac{\pi}{6} \leq \frac{11\pi}{6}$: $2x - \frac{\pi}{6} = \frac{2\pi}{3}$ or $\frac{4\pi}{3}$ One correct solution $x = \frac{5\pi}{12}, \frac{3\pi}{4}$	M1 M1 A1 A1 (4)
(c)	$2 \cos \left(x - \frac{\pi}{6} \right)$ takes every value between -2 and 2 twice over one period $k = \pm 2$ gives only one solution (a maximum or minimum), $ k > 2$ gives none $-2 < k < 2$	M1 M1 A1 (3)
Total for Question 10: 10 marks		

