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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6360

MFP2 Further Pure 2

Mark Scheme

2008 examination - January series

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Key to mark scheme and abbreviations used in marking

M	mark is for method
m or dM	mark is dependent on one or more M marks and is for method
A	mark is dependent on M or m marks and is for accuracy
B	mark is independent of M or m marks and is for method and accuracy
E	mark is for explanation

√ or ft or F	follow through from previous incorrect result	MC	mis-copy
CAO	correct answer only	MR	mis-read
CSO	correct solution only	RA	required accuracy
AWFW	anything which falls within	FW	further work
AWRT	anything which rounds to	ISW	ignore subsequent work
ACF	any correct form	FIW	from incorrect work
AG	answer given	BOD	given benefit of doubt
SC	special case	WR	work replaced by candidate
OE	or equivalent	FB	formulae book
A2,1	2 or 1 (or 0) accuracy marks	NOS	not on scheme
$-x$ EE	deduct x marks for each error	G	graph
NMS	no method shown	c	candidate
PI	possibly implied	sf	significant figure(s)
SCA	substantially correct approach	dp	decimal place(s)

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

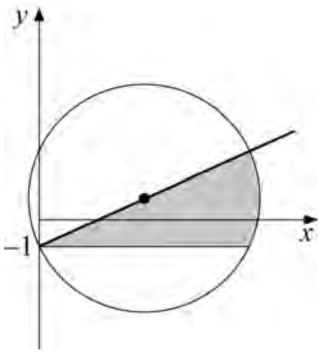
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

MFP2

Q	Solution	Marks	Total	Comments
1(a)	Any method for finding r or θ	M1		
	$r = 4\sqrt{2},\ \theta = \frac{\pi}{4}$	A1A1	3	
(b)	$z^5 = 4\sqrt{2}\,e^{\frac{\pi i}{4}}$			M1 needs some reference to $a + 2k\pi i$
	$z = \sqrt{2}e^{\frac{\pi i}{20} + \frac{2k\pi i}{5}}$	M1 A1F A1F		A1 for r, A1 for θ — incorrect r, θ part (a)
	$z = \sqrt{2}\,e^{\frac{\pi i}{20}},\ \sqrt{2}\,e^{\frac{9\pi i}{20}},\ \sqrt{2}\,e^{\frac{17\pi i}{20}},\ \sqrt{2}\,e^{\frac{-7\pi i}{20}},\ \sqrt{2}\,e^{\frac{-15\pi i}{20}}$	A2,1,0 F	5	Accept r in any form eg $32^{\frac{1}{10}}$ Correct but some answers outside range allow A1 ft incorrect r, θ in part (a)
	Total		**8**	
2(a)	Attempt to expand $(2r+1)^3 - (2r-1)^3$	M1		
	$(2r+1)^3$ or $(2r-1)^3$ expanded	A1		
	$24r^2 + 2$	A1	3	AG
(b)	$r=1 \quad 3^3 - 1^3 = 24\times1^2 + 2$ $r=2 \quad 5^3 - 3^3 = 24\times2^2 + 2$	M1A1		3 rows seen Do not allow M1 for $(2n+1)^3 - 1$ not equal to anything
	$r=n \quad (2n+1)^3 - (2n-1)^3 = 24\times n^2 + 2$			
	$(2n+1)^3 - 1 = 24\sum_{r=1}^{n} r^2 + 2n$	A1		
	$8n^3 + 12n^2 + 6n + 1 - 1 - 2n = 24\sum_{r=1}^{n} r^2$	M1		M1 for multiplication of bracket or taking $(2n+1)$ out as a factor
	$8n^3 + 12n^2 + 4n = 24\sum_{r=1}^{n} r^2$	A1		CAO
	$\sum_{r=1}^{n} r^2 = \frac{1}{6}n(n+1)(2n+1)$	A1	6	AG
	Total		**9**	

MFP2 (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	$z=-\mathrm{i}$ $\quad \lvert -2\sqrt{3}-2\mathrm{i}\rvert = \sqrt{12+4}=4$	M1		$\lvert -2\sqrt{3}-2\mathrm{i}\rvert$
		A1	2	4
(ii)	Centre of circle is $2\sqrt{3}+\mathrm{i}$	B1		Do not accept $(2\sqrt{3},1)$ unless attempt to solve using trig
	Substitute into line	M1		
	$\arg\left(2\sqrt{3}+2\mathrm{i}\right)=\dfrac{\pi}{6}$ shown	A1	3	
(b)				
	Circle: centre correct	B1		
	through $(0,-1)$	B1		
	Half line: through $(0,-1)$	B1		
	through centre of circle	B1	4	
(c)	Shading inside circle and below line	B1F		
	Bounded by $y=-1$	B1	2	
	Total		**11**	
4(a)(i)	$\sum\alpha=-\mathrm{i}$	B1	1	
(ii)	$\sum\alpha\beta=3$	B1	1	
(iii)	$\alpha\beta\gamma=1+\mathrm{i}$	B1	1	
(b)(i)	$\sum\alpha^2=\left(\sum\alpha\right)^2-2\sum\alpha\beta$ used	M1		Allow if sign error or 2 missing
	$=(-\mathrm{i})^2-2\times3$	A1F		
	$=-7$	A1F	3	ft errors in (a)
(ii)	$\sum\alpha^2\beta^2=\left(\sum\alpha\beta\right)^2-2\sum\alpha\beta\cdot\beta\gamma$	M1		Allow if sign error in 2 missing
	$=\left(\sum\alpha\beta\right)^2-2\alpha\beta\gamma\sum\alpha$	A1		
	$=9-2(1+\mathrm{i})(-\mathrm{i})$	A1F		ft errors in (a)
	$=7+2\mathrm{i}$	A1F	4	ft errors in (a)
(iii)	$\alpha^2\beta^2\gamma^2=(1+\mathrm{i})^2=2\mathrm{i}$	M1		
		A1F	2	ft sign error in $\alpha\beta\gamma$
(c)	$z^3+7z^2+(7+2\mathrm{i})z-2\mathrm{i}=0$	B1F		Correct numbers in correct places
		B1F	2	Correct signs
	Total		**14**	

MFP2 (cont)

Q	Solution	Marks	Total	Comments
5	Assume result true for $n=k$			
	Then $\sum_{r=1}^{k+1}(r^2+1)r!$			
	$=\left((k+1)^2+1\right)(k+1)!+k(k+1)!$	M1A1		
	Taking out $(k+1)!$ as factor	m1		
	$=(k+1)!\left(k^2+2k+1+1+k\right)$	A1		
	$=(k+1)(k+2)!$	A1		
	$k=1$ shown $(1^2+1)1!=2$, $1\times 2!=2$	B1		
	$P_k \Rightarrow P_{k+1}$ and P_1 true	E1	7	If all 6 marks earned
	Total		**7**	
6(a)(i)	$\cos 3\theta+\mathrm{i}\sin 3\theta=(\cos\theta+\mathrm{i}\sin\theta)^3$	M1		
	$=\cos^3\theta+3\mathrm{i}\cos^2\theta\sin\theta+3\mathrm{i}^2\cos\theta\sin^2\theta+\mathrm{i}^3\sin^3\theta$	A1		
	Real parts: $\cos 3\theta=\cos^3\theta-3\cos\theta\sin^2\theta$	A1	3	AG
(ii)	Imaginary parts: $\sin 3\theta=3\cos^2\theta\sin\theta-\sin^3\theta$	A1F	1	
(iii)	$\tan 3\theta=\frac{\sin 3\theta}{\cos 3\theta}$	M1		Used
	$=\frac{3\cos^2\theta\sin\theta-\sin^3\theta}{\cos^3\theta-3\sin^2\theta\cos\theta}$	A1F		Error in $\sin 3\theta$
	$=\frac{3\tan\theta-\tan^3\theta}{1-3\tan^2\theta}$			
	$=\frac{\tan^3\theta-3\tan\theta}{3\tan^2\theta-1}$	A1	3	AG
(b)(i)	$\tan\frac{3\pi}{12}=1$	B1		Used (possibly implied)
	$\tan\frac{\pi}{12}$ is a root of $1=\frac{x^3-3x}{3x^2-1}$	M1		Must be hence
	$x^3-3x^2-3x+1=0$	A1	3	
(ii)	Other roots are $\tan\frac{5\pi}{12}$, $\tan\frac{9\pi}{12}$	B1B1	2	
(c)	$\tan\frac{\pi}{12}+\tan\frac{5\pi}{12}+\tan\frac{9\pi}{12}=3$	M1		Must be hence
	$\tan\frac{\pi}{12}+\tan\frac{5\pi}{12}=4$	A1	2	
	Total		**14**	

MFP2 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$\frac{dy}{dx} = \frac{1}{\tanh\frac{x}{2}} \ldots$	B1		
	$\operatorname{sech}^2\frac{x}{2} \ldots$	B1		
	$\frac{1}{2}$	B1		
	$= \frac{1}{2\frac{\sinh\frac{x}{2}}{\cosh\frac{x}{2}}\cosh^2\frac{x}{2}}$	M1		OE ie expressing in $\sinh\frac{x}{2}$ and $\cosh\frac{x}{2}$
	$= \frac{1}{2\sinh\frac{x}{2}\cosh\frac{x}{2}}$			
	$= \frac{1}{\sinh x}$	M1		ie use of $\sinh 2A = 2\sinh A\cosh A$
	$= \operatorname{cosech} x$	A1	6	AG
	Alternative			
	$\ln\sinh\frac{x}{2} - \ln\cosh\frac{x}{2}$	(B1)		
	$\frac{1}{2}\frac{\cosh\frac{x}{2}}{\sinh\frac{x}{2}} - \frac{1}{2}\frac{\sinh\frac{x}{2}}{\cosh\frac{x}{2}}$	(B1B1)		
	$\frac{\cosh^2\frac{x}{2} - \sinh^2\frac{x}{2}}{2\sinh\frac{x}{2}\cosh\frac{x}{2}}$	(M1)		
	Use of $\sinh 2A = 2\sinh A\cosh A$	(M1)		
	result	(A1)		
(b)(i)	$s = \int_1^2 \sqrt{1 + \operatorname{cosech}^2 x}\, dx$	M1		
	$= \int_1^2 \coth x\, dx$	A1	2	AG
(ii)	$s = [\ln\sinh x]_1^2$	M1		needs to be correct
	$= \ln\sinh 2 - \ln\sinh 1$	A1		
	$= \ln\frac{2\sinh 1\cosh 1}{\sinh 1}$	A1F		must be seen
	$= \ln(2\cosh 1)$	A1	4	AG
	Total		**12**	
	TOTAL		**75**	