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General Certificate of Education

Mathematics 6360

MFP2 Further Pure 2

Mark Scheme

2007 examination - January series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

Set and published by the Assessment and Qualifications Alliance.

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**.

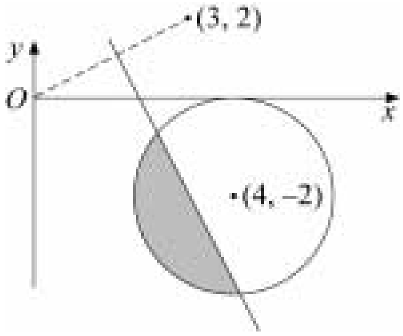
Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

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.

Jan 07

MFP2

Q	Solution	Marks	Total	Comments
1(a)	Use of $\cosh^2 x = 1 + \sinh^2 x$	M1		Must be correct for M1
	$4\sinh^2 x - 7\sinh x + 3 = 0$	A1		
	$(4\sinh x - 3)(\sinh x - 1) = 0$	A1√		Provided quadratic factorizes
	$\sinh x = \frac{3}{4}$ or 1	A1√	4	
(b)	Use of formula for $\sinh^{-1}$	M1		
	$x = \ln 2$ or $\ln\left(1+\sqrt{2}\right)$	A1√		
		A1√	3	
	Total		**7**	
2(a)				
(i)	**Circle**			
	Correct centre	B1		
	Correct radius	B1		
	Touching x-axis	B1	3	
(ii)	**Line**			
	Point $(3,2)$ indicated	B1		
	Line through $\left(1\frac{1}{2}, 1\right)$	B1√		
	Perpendicular to $(0,0) \rightarrow (3,2)$	B1	3	
(b)	Correct shaded area	B1	2	For shading inside the circle provided no other area is shaded
		B1√		Must be a circle and a straight line for second B1
	Total		**8**	

MFP2 (cont)

Q	Solution	Marks	Total	Comments
3(a)	$-k^3\mathrm{i}+2(1-\mathrm{i})(-k^2)+32(1+\mathrm{i})=0$	M1		Any form
	Equate real and imaginary parts:			
	$-k^3+2k^2+32=0$	A1		
	$-2k^2+32=0$	A1		
	$k=\pm 4$	A1		
	$k=+4$	E1	5	AG
(b)	Sum of roots is $-2(1-\mathrm{i})$	M1		Or $\alpha\beta\gamma=-(32+32\mathrm{i})$ Must be correct for M1
	Third root $2-2\mathrm{i}$	A1√	2	
	Total		**7**	
4(a)(i)	$\dfrac{\mathrm{d}}{\mathrm{d}t}\left(\dfrac{1}{\cosh t}\right)=-1(\cosh t)^{-2}\sinh t$	M1A1		Or $\dfrac{-2\left(\mathrm{e}^t-\mathrm{e}^{-t}\right)}{\left(\mathrm{e}^t+\mathrm{e}^{-t}\right)^2}$
	$=-\operatorname{sech} t\tanh t$	A1	3	AG
(ii)	Use of $\tanh^2 t=1-\operatorname{sech}^2 t$	M1		
	Printed result	A1	2	
(b)(i)	$\dot{x}=1-\operatorname{sech}^2 t \quad (\dot{y}=-\operatorname{sech} t\tanh t)$	B1		
	$\dot{x}^2+\dot{y}^2=\left(1-\operatorname{sech}^2 t\right)^2+\operatorname{sech}^2 t-\operatorname{sech}^4 t$	M1A1		Any form
	$=1-\operatorname{sech}^2 t=\tanh^2 t$	A1	4	AG
(ii)	$s=\int_0^t \tanh t\,\mathrm{d}t$	M1		Ignore limits for M1 and first A1
	$=\left[\ln\cosh t\right]_0^t$	A1		
	$=\ln\cosh t$	A1	3	AG
(iii)	$\mathrm{e}^s=\cosh t$	M1		
	$y=\mathrm{e}^{-s}$	A1	2	AG
(c)	$S=2\pi\int_0^t \operatorname{sech} t\tanh t\,\mathrm{d}t$	M1		Ignore limits for M1 and first A1
	$=2\pi\left[-\operatorname{sech} t\right]_0^t$	A1		
	$=2\pi(1-\operatorname{sech} t)$	A1		
	$=2\pi\left(1-\mathrm{e}^{-s}\right)$	A1	4	AG
	Total		**18**	

MFP2 (cont)

Q	Solution	Marks	Total	Comments
5(a)	Assume true for $n = k$			
	$(\cos\theta + \mathrm{i}\sin\theta)^{k+1}$			
	$= (\cos k\theta + \mathrm{i}\sin k\theta)(\cos\theta + \mathrm{i}\sin\theta)$	M1		
	Multiply out	A1		Any form
	$= \cos(k+1)\theta + \mathrm{i}\sin(k+1)\theta$	A1		
	True for $n = 1$ shown	B1		
	$P(k) \Rightarrow P(k+1)$ and $P(1)$ true	E1	5	Allow E1 only if previous 4 marks earned
(b)	$\left(\cos\frac{\pi}{6} + \mathrm{i}\sin\frac{\pi}{6}\right)^6 = \cos\frac{6\pi}{6} + \mathrm{i}\sin\frac{6\pi}{6}$	M1		
	$= -1$	A1	2	
(c)	$(\cos\theta + \mathrm{i}\sin\theta)(1 + \cos\theta - \mathrm{i}\sin\theta)$	M1		
	$= \cos\theta + \cos^2\theta - \mathrm{i}\sin\theta\cos\theta$ $+ \mathrm{i}\sin\theta + \mathrm{i}\sin\theta\cos\theta + \sin^2\theta$	A1		(Accept $-\mathrm{i}^2\sin^2\theta$) Or $\mathrm{e}^{\mathrm{i}\theta}\left(1 + \mathrm{e}^{-\mathrm{i}\theta}\right)$
	$= 1 + \cos\theta + \mathrm{i}\sin\theta$	A1	3	AG
(d)	$\theta = \frac{\pi}{6}$ used	M1		In the context of part (c)
	Part (c) raised to power 6	M1		
	Use of result in part (b)	A1		
	$\left(1 + \cos\frac{\pi}{6} + \mathrm{i}\sin\frac{\pi}{6}\right)^6 +$ $\left(1 + \cos\frac{\pi}{6} - \mathrm{i}\sin\frac{\pi}{6}\right)^6 = 0$	A1	4	AG
	Total		**14**	

MFP2 (cont)

Q	Solution	Marks	Total	Comments
6(a)	$1,\ \mathrm{e}^{\pm\frac{2\pi i}{3}}$	M1A1	2	M1 for any method which would lead to the correct answers Accept e^0 or e^{0i} Also accept answers written down correctly
(b)	Any correct method Shown for one root	M1 A1	2	AG
(c)(i)	$\frac{\omega}{\omega+1}=\frac{\omega}{-\omega^2}$	M1		ie use of result in (b)
	$=-\frac{1}{\omega}$	A1	2	AG
(ii)	$\frac{\omega^2}{\omega^2+1}=-\omega$	A1	1	AG
(iii)	$\left(\frac{\omega}{\omega+1}\right)^k+\left(\frac{\omega^2}{\omega^2+1}\right)^k=\left(-\frac{1}{\omega}\right)^k+(-\omega)^k$	M1A1		
	Use of $\omega=\mathrm{e}^{\frac{2\pi i}{3}}$	m1		
	$=(-1)^k\left(\mathrm{e}^{\frac{-2k\pi i}{3}}+\mathrm{e}^{\frac{2k\pi i}{3}}\right)$	A1		
	$=(-1)^k\,2\cos\frac{2k\pi}{3}$	A1	5	AG
	Total		**12**	

MFP2 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$\tan\left(\left(r+1\right)x - rx\right)$			
	$= \dfrac{\tan\left(r+1\right)x - \tan rx}{1+\tan\left(r+1\right)x\tan rx}$	M1A1		
	Multiplying up	A1		
	Printed result	A1	4	AG
(b)	$x = \dfrac{\pi}{50}$			
	$\tan\dfrac{\pi}{50}\tan\dfrac{2\pi}{50} = \dfrac{\tan\frac{2\pi}{50}}{\tan\frac{\pi}{50}} - \dfrac{\tan\frac{\pi}{50}}{\tan\frac{\pi}{50}} - 1$			
	$\tan\dfrac{2\pi}{50}\tan\dfrac{3\pi}{50} = \dfrac{\tan\frac{3\pi}{50}}{\tan\frac{\pi}{50}} - \dfrac{\tan\frac{2\pi}{50}}{\tan\frac{\pi}{50}} - 1$	M1A1		At least three lines to be shown Accept if x's used
	………………..			
	$\tan\dfrac{19\pi}{50}\tan\dfrac{20\pi}{50} = \dfrac{\tan\frac{20\pi}{50}}{\tan\frac{\pi}{50}} - \dfrac{\tan\frac{19\pi}{50}}{\tan\frac{\pi}{50}} - 1$			
	Clear cancellation	m1		
	Sum $= \dfrac{\tan\frac{20\pi}{50}}{\tan\frac{\pi}{50}} - \dfrac{\tan\frac{\pi}{50}}{\tan\frac{\pi}{50}} - 19$	A1		
	$= \dfrac{\tan\frac{2\pi}{5}}{\tan\frac{\pi}{50}} - 20$	A1	5	AG
	Total		**9**	
	TOTAL		**75**	