Version 1.0: 0607

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6360

MFP2 Further Pure 2

Mark Scheme

2007 examination - June 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.

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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)	$f(r+1)-f(r)=r(r+1)^2-(r-1)r^2$	M1		
	$=r\left(r^2+2r+1-r^2+r\right)$	A1		any expanded form
	$=r(3r+1)$	A1	3	AG
(b)	$r=50$ $\quad f(51)-f(50)$ $r=51$ $\quad f(52)-f(51)$ $\}$ PI $r=99$ $\quad f(100)-f(99)$	M1A1		OE clearly shown. Accept $\sum_1^{99}-\sum_1^{49}$
	$\sum_{r=50}^{99} r(3r+1)=f(100)-f(50)$	m1		clear cancellation
	$=867500$	A1F	4	cao
	Total		**7**	
2(a)	$\sum\alpha\beta=6$	B1	1	
(b)(i)	Sum of squares <0 $\therefore$ not all real	E1		
	Coefficients real $\therefore$ conjugate pair	E1	2	
(ii)	$\left(\sum\alpha\right)^2=\sum\alpha^2+2\sum\alpha\beta$	M1A1		A1 for numerical values inserted
	$\left(\sum\alpha\right)^2=0$	A1F		
	$p=0$	A1F	4	cao
(c)(i)	$-1-3\text{i}$ is a root	B1		
	Use of appropriate relationship eg $\sum\alpha=0$	M1		M0 if $\sum\alpha^2$ used unless the root 2 is checked
	Third root 2	A1F	3	incorrect $p\surd$
(ii)	$q=-(-1-3\text{i})(-1+3\text{i})2$	M1		allow even if sign error
	$=-20$	A1F	2	ft incorrect 3rd root
	Total		**12**	
3	$(\cos\theta+\text{i}\sin\theta)^{15}=\cos15\theta+\text{i}\sin15\theta$	M1		or $=\text{e}^{15\text{i}\theta}$
	$\cos15\theta=0$ $\sin15\theta=-1$	m1A1		or $-\text{i}=\text{e}^{\frac{3\pi\text{i}}{2}}$ m1 for **both** R&I parts written down
	$15\theta=\dfrac{3\pi}{2}$ or 270°	A1F		
	$\theta=\dfrac{\pi}{10}$ or 18°	A1F	5	ft provided the value of 15θ is a correct value
	SC $\cos15\theta+\text{i}\sin15\theta=\text{i}$	(M1)		
	$\sin15\theta=-1$	(B1)		or for $\cos15\theta=0$
	$\theta=\dfrac{\pi}{10}$	(B1)	(3)	
	Total		**5**	

MFP2 (cont)

Q	Solution	Marks	Total	Comments
4(a)	$\frac{x}{1+x^2}+\tan^{-1}x$	B1B1	2	
(b)	$\int_0^1 \tan^{-1}x\,dx = \left[x\tan^{-1}x\right]_0^1 - \int_0^1 \frac{x\,dx}{1+x^2}$	M1		either use of part (a) or integration by parts. Allow if sign error
	$\int \frac{x\,dx}{1+x^2} = \frac{1}{2}\ln\left(1+x^2\right)$	M1A1F		ft on $\int \frac{x}{1-x^2}dx$
	$I = 1\ \tan^{-1}1 - \frac{1}{2}\ln 2$	M1		
	$= \frac{\pi}{4} - \ln\sqrt{2}$	A1	5	AG
	Total		**7**	
5(a)	Explanation	E2,1,0	2	E1 for $\mathrm{i} = \mathrm{e}^{\frac{\pi \mathrm{i}}{2}}$ or $\mathrm{i}z_1 = -y_1 + \mathrm{i}x_1$
(b)(i)	Perpendicular bisector of *AB* through *O*	B1 B1	2	
(ii)	half-line from *B* parallel to *OA*	B1 B1 B1	3	If L_2 is taken to be the line *AB* give B0
(c)	$(1+\mathrm{i})z_1$	M1A1	2	ft if L_2 taken as line *AB*
	Total		**9**	
6(a)	$\left(1-\frac{1}{(k+1)^2}\right)\times\frac{k+1}{2k} = \frac{(k+1)^2-1}{(k+1)^2}\times\frac{k+1}{2k}$	M1		
	$= \frac{k^2+2k}{(k+1)^2}\times\frac{k+1}{2k}$	A1		
	$= \frac{k+2}{2(k+1)}$	A1	3	AG
(b)	Assume true for $n = k$, then			
	$\left(1-\frac{1}{2^2}\right)\left(1-\frac{1}{3^2}\right)\ldots\left(1-\frac{1}{(k+1)^2}\right)$	M1		
	$= \frac{k+2}{2(k+1)}$	A1		
	True for $n = 2$ shown $1-\frac{1}{2^2}=\frac{3}{4}$	B1		
	$P_n \Rightarrow P_{n+1}$ and P_2 true	E1	4	only if the other 3 marks earned
	Total		**7**	

MFP2 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$\frac{dy}{dx} = \frac{2}{\sqrt{x}}$	B1		accept $2x^{-\frac{1}{2}}$ etc
	$\sqrt{1+\left(\frac{dy}{dx}\right)^2} = \sqrt{1+\frac{4}{x}}$	M1A1F		ft sign error in $\frac{dy}{dx}$
	$= \sqrt{\frac{x+4}{x}}$	A1	4	AG
(b)(i)	$x = 4\sinh^2\theta,\ dx = 8\sinh\theta\cosh\theta\, d\theta$	M1A1		M1 for any attempt at $\frac{dx}{d\theta}$
	$I = \int\sqrt{\frac{4\sinh^2\theta+4}{4\sinh^2\theta}}\ 8\sinh\theta\cosh\theta\, d\theta$	M1		
	$= \int\frac{2\cosh\theta}{2\sinh\theta}\ 8\sinh\theta\cosh\theta\, d\theta$	m1		ie use of $\cosh^2\theta - \sinh^2\theta = 1$
	$= \int 8\cosh^2\theta\, d\theta$	A1	5	AG
(ii)	Use of $2\cosh^2\theta = 1 + \cosh 2\theta$	M1		allow if sign error
	$I = \int 4(1+\cosh 2\theta)\, d\theta$	A1		oe
	$= 4\theta + 2\sinh 2\theta$	A1F		oe
	Use of $\sinh 2\theta = 2\sinh\theta\cosh\theta$	m1		
	$= 4\sinh^{-1}\frac{1}{2} + 4\times\frac{1}{2}\sqrt{1+\frac{1}{4}}$	A1F		
	$= 4\sinh^{-1}\frac{1}{2} + \sqrt{5}$	A1	6	AG
	Total		**15**	

MFP2 (cont)

Q	Solution	Marks	Total	Comments
8(a)(i)	$z^3 = \dfrac{4 \pm \sqrt{16-32}}{2}$	M1		
	$= 2 \pm 2\mathrm{i}$	A1	2	AG
(ii)	$2+2\mathrm{i} = 2\sqrt{2}\mathrm{e}^{\frac{\pi \mathrm{i}}{4}}$, $2-2\mathrm{i} = 2\sqrt{2}\mathrm{e}^{\frac{-\pi \mathrm{i}}{4}}$	M1 A1A1		M1 for either result or for one of $r = 2\sqrt{2}$, $\theta = \pm\dfrac{\pi}{4}$ $\left(r = 2\sqrt{2}\ \text{A1},\ \theta = \pm\dfrac{\pi}{4}\ \text{A1}\right)$
	$z = \sqrt{2}\mathrm{e}^{\frac{\pi \mathrm{i}}{12} + \frac{2k\pi \mathrm{i}}{3}}$ or $\sqrt{2}\mathrm{e}^{\frac{-\pi \mathrm{i}}{12} + \frac{2k\pi \mathrm{i}}{3}}$	M1		M1 for either
	$z = \sqrt{2}\,\mathrm{e}^{\frac{\pm\pi \mathrm{i}}{12}}$, $\sqrt{2}\mathrm{e}^{\frac{\pm 3\pi \mathrm{i}}{4}}$, $\sqrt{2}\mathrm{e}^{\frac{\pm 7\pi \mathrm{i}}{12}}$	A2,1,0 F	6	allow A1 for any 3 correct ft errors in $\pm\dfrac{\pi}{4}$
(b)	Multiplication of brackets	M1		
	Use of $\mathrm{e}^{\mathrm{i}\theta} + \mathrm{e}^{-\mathrm{i}\theta} = 2\cos\theta$	A1	2	AG
(c)	$\left(z - \sqrt{2}\mathrm{e}^{\frac{\pi \mathrm{i}}{12}}\right)\left(z - \sqrt{2}\mathrm{e}^{-\frac{\pi \mathrm{i}}{12}}\right)$			
	$= z^2 - 2\sqrt{2}\cos\frac{\pi}{12}\, z + 2$	M1A1F		PI
	Product is $\left(z^2 - 2\sqrt{2}\cos\frac{\pi}{12}\, z + 2\right)$ $\left(z^2 - 2\sqrt{2}\cos\frac{7\pi}{12}\, z + 2\right)$ $\left(z^2 - 2\sqrt{2}\cos\frac{3\pi}{4}\, z + 2\right)$	A1F	3	$\left(\text{or } z^2 + 2z + 2\right)$
	Total		**13**	
	TOTAL		**75**	