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General Certificate of Education

Mathematics 6360

MFP1 Further Pure 1

Mark Scheme

2009 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.

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М	mark is for method			
m or dM	mark is dependent on one or more M marks and is for method			
А	mark is dependent on M or m marks and is for accuracy			
В	mark is independent of M or m marks and is for method and accuracy			
Е	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 <i>x</i> 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)	

Key to mark scheme and abbreviations used in marking

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.

Q	Solution	Marks	Total	Comments
1	First increment is 0.2, so $y \approx 1.2$	B1B1		PI; variations possible here
	Second increment is $0.2\sqrt{1+0.2^2}$	M1		
	$\approx 0.203\ 961$, so $y \approx 1.403\ 96$	A2,1F	5	A1 if accuracy lost; ft num error
	Total		5 5	
2(a)	Other root is 2 – 3i	B1	1	
(b)	Sum of roots $= 4$	B1F		ft error in (a)
(6)	So $b = -4$	B1F		ft wrong value for sum
	Product is 13	B1		
	So $c = 13$	B1F	4	ft wrong value for product
	Alternative:			
	Substituting $2 + 3i$ into equation	M1		
	Equating R and I parts	ml		
	12 + 3b = 0, so $b = -4$	A1		
	-5 + 2b + c = 0, so $c = 13$	A1F	(4)	ft wrong value for <i>b</i>
	Total		5	
3	$\tan\frac{\pi}{3} = \sqrt{3}$	B1		Decimals/degrees penalised at 5 th mark
	Introduction of $n\pi$	M1		(or $2n\pi$) at any stage
	Going from $\frac{\pi}{2} - 3x$ to x	m1		Including dividing all terms by 3
	$x = \frac{\pi}{18} + \frac{1}{3}n\pi$	A2,1F	5	Allow +, - or ±; A1 with dec/deg; ft wrong first solution
	Total		5	
4(a)	$S_n = 3\Sigma r^2 - 3\Sigma r + \Sigma 1$	M1		
	Correct expressions substituted	m1		At least for first two terms
	Correct expansions	A1		
	$\Sigma 1 = n$	B1	-	
	Answer convincingly obtained	A1	5	AG
(b)	$S_{2n} - S_n$ attempted	M1		Condone $S_{2n} - S_{n+1}$ here
	Answer $7n^3$	A1	2	
	Total		7	

5(a)(i) $\mathbf{A} + \mathbf{B} = \begin{bmatrix} 0 & 2k \\ 2k & 0 \end{bmatrix}$ B11(ii) $\mathbf{A}^2 = \begin{bmatrix} 2k^2 & 0 \\ 0 & 2k^2 \end{bmatrix}$ B2,12B1 if three entries correct(b) $(\mathbf{A} + \mathbf{B})^2 = = \begin{bmatrix} 4k^2 & 0 \\ 0 & 4k^2 \end{bmatrix}$ B2,1B2,1B1 if three entries correct $\mathbf{B}^2 = \mathbf{A}^2$, hence resultB1B14(c)(i) \mathbf{A}^2 is an enlargement (centre <i>O</i>)M1B1(iii)Scale factor is now $\sqrt{2}$ B1Condone $2k^2$ (iii)Scale factor is now $\sqrt{2}$ B1B1 × 3(iii)Scale factor is now $\sqrt{2}$ B1B1 × 3(iii)Intersections at (1, 0) and (3, 0)B11(iiii)At least one branch approaching asymptotesB1 × 3(b) $0 < x < 1, 2 < x < 3$ B1,812(b) $0 < x < 1, 2 < x < 3$ M1A1(2)(correct algebraic methodM1A1(2)(correct relationship establishedm1A1eg $\frac{r - a}{c} = \frac{b - a}{c - d}$ (b) $c = f(a) = 24, d = f(b) = -21$ B1,B1B1,B1(iii) $\beta = 20^{\frac{1}{2} = 2,714(4)$ M1A1Allow AWRT 2.53; ft small error(iii) $\beta = 20^{\frac{1}{2} = 2,714(4)$ M1A1Allow AWRT 2.71(iii) $\beta = 20^{\frac{1}{2} = 2,714(4)$ M1A1Allow and 2A differentiation and 2A difference and	MFP1 (cont		Morilya	Total	Commonto
(ii) $A^2 = \begin{bmatrix} 2k^2 & 0 \\ 0 & 2k^2 \end{bmatrix}$ $B^2 = A^2$, hence result (b) $(A + B)^2 = = \begin{bmatrix} 4k^2 & 0 \\ 0 & 4k^2 \end{bmatrix}$ $B^2 = A^2$, hence result B1B1 4 (c)(i) A^2 is an enlargement (centre <i>O</i>) with SF 2 (ii) Scale factor is now $\sqrt{2}$ Minor line is $y = x \tan 22\frac{1}{2}^{0}$ Minor line is $y = x \tan 22\frac{1}{2}^{0}$ Minor line is $y = x \tan 22\frac{1}{2}^{0}$ Minor line is $y = x \tan 22\frac{1}{2}^{0}$ (ii) Intersections at (1, 0) and (3, 0) B1 1 (iii) At least one branch approaching asymptotes Each branch $B1 \times 3$ (b) $0 < x < 1, 2 < x < 3$ Alternative: Complete correct algebraic method Correct relationship established Hence result convincingly shown A1 4 (b) $(x = f(a) = 24, d = f(b) = -21$ $g = \frac{38}{15} (\approx 2.5333)$ (ii) $\beta = 20^{\frac{1}{2}} = 2.714(4)$ $g = -20^{\frac{1}{2}} = 2.714(4)$	Q	Solution	Marks	Total	Comments
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	5(a)(i)	$\mathbf{A} + \mathbf{B} = \begin{bmatrix} 0 & 2k \\ 2k & 0 \end{bmatrix}$	B1	1	
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(c)(i) A^2 is an enlargement (centre O)M1 A12Condone $2k^2$ (ii)Scale factor is now $\sqrt{2}$ B1 Mirror line is $y = x \tan 22 \frac{1}{2}^\circ$ Condone $\sqrt{2}k$ (iii)Scale factor is now $\sqrt{2}$ B1 MIA1Condone $\sqrt{2}k$ (iii)Asymptotes $x = 0, x = 2, y = 1$ B1×33(iii)Intersections at (1, 0) and (3, 0)B11(iii)At least one branch approaching asymptotesB11Each branchB1×34(b) $0 < x < 1, 2 < x < 3$ B1,B12Alternative: Complete correct algebraic methodM1A1(2)(iii)Use of similar triangles or algebraM1 m1A1Some progress needed(b)(i) $c = f(a) = 24, d = f(b) = -21$ $r = \frac{38}{15}$ (≈ 2.5333)B1F B1F3(iii) $\beta = 20^{\frac{1}{3}} \approx 2.714(4)$ So $\beta - r \approx 0.181 \approx 0.18$ (AG)M1A1Allow AWRT 2.71 Allow only 2dp if earlier values to 3dp	(b)	$(\mathbf{A} + \mathbf{B})^2 = = \begin{bmatrix} 4k^2 & 0\\ 0 & 4k^2 \end{bmatrix}$			B1 if three entries correct
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6(a)(i)Asymptotes $x = 0, x = 2, y = 1$ B1×33(ii)Intersections at (1, 0) and (3, 0)B11(iii)At least one branch approaching asymptotesB11Each branchB1×34(b) $0 < x < 1, 2 < x < 3$ B1,B12Alternative: Complete correct algebraic methodM1A1(2)Total107(a)Use of similar triangles or algebraM1Hence result convincingly shownA14(b)(i) $c = f(a) = 24, d = f(b) = -21$ $r = \frac{315}{15} (\approx 2.5333)$ B1,B1 B1,B1 B1,B13(ii) $\beta = 20^{\frac{1}{3}} \approx 2.714(4)$ So $\beta - r \approx 0.181 \approx 0.18$ (AG)M1A1 A1Allow AWRT 2.71 Allow only 2dp if earlier values to 3dp					
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(iii)At least one branch approaching asymptotesB1Each branchB1×34(b) $0 < x < 1, 2 < x < 3$ B1,B12Alternative: Complete correct algebraic methodM1A1(2)Total107(a)Use of similar triangles or algebra Correct relationship establishedM1 m1A1Some progress needed egHence result convincingly shownA14(b)(i) $c = f(a) = 24, d = f(b) = -21$ $r = \frac{38}{15}$ (≈ 2.5333)B1,B1 B1F3(ii) $\beta = 20^{\frac{1}{3}} \approx 2.714(4)$ So $\beta - r \approx 0.181 \approx 0.18$ (AG)M1A1 A1Allow AWRT 2.71 Allow only 2dp if earlier values to 3dp					
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(b) $0 < x < 1, 2 < x < 3$ B1,B12Allow B1 if one repeated error occurs, eg \leq for <	(iii)	· · · ·	B1		
Alternative: Complete correct algebraic methodM1A1(2)Total107(a)Use of similar triangles or algebraM1Some progress needed egCorrect relationship establishedm1A1eg $r - a = b - a \\ c - d$ Hence result convincingly shownA14AG(b)(i) $c = f(a) = 24, d = f(b) = -21$ B1,B1< B1F3 $r = \frac{38}{15} (\approx 2.5333)$ B1F3Allow AWRT 2.53; ft small error(ii) $\beta = 20^{\frac{1}{3}} \approx 2.714(4)$ So $\beta - r \approx 0.181 \approx 0.18$ (AG)M1A1 A1Allow AWRT 2.71 Allow only 2dp if earlier values to 3dp		Each branch	B1×3	4	
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Complete correct algebraic methodM1A1(2)Total107(a)Use of similar triangles or algebraM1Some progress neededCorrect relationship establishedm1A1eg $\frac{r-a}{c} = \frac{b-a}{c-d}$ Hence result convincingly shownA14AG(b)(i) $c = f(a) = 24$, $d = f(b) = -21$ B1,B1B1F $r = \frac{38}{15}$ (≈ 2.5333)B1F3Allow AWRT 2.53; ft small error(ii) $\beta = 20^{\frac{1}{3}} \approx 2.714(4)$ M1A1Allow AWRT 2.71So $\beta - r \approx 0.181 \approx 0.18$ (AG)A13Allow only 2dp if earlier values to 3dp		Alternative:			
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Correct relationship established m1A1 Hence result convincingly shown A1 (b)(i) $c = f(a) = 24, d = f(b) = -21$ $r = \frac{38}{15}$ (≈ 2.5333) B1F 3 (ii) $\beta = 20^{\frac{1}{3}} \approx 2.714(4)$ So $\beta - r \approx 0.181 \approx 0.18$ (AG) M1A1 A1 M1A1 M1A		Total			
(b)(i) Hence result convincingly shown $A1 = 4 = AG$ $c = f(a) = 24, \ d = f(b) = -21 = B1,B1 = B1,B$	7(a)	Use of similar triangles or algebra	M1		· ·
(b)(i) Hence result convincingly shown $A1 = 4 = AG$ $c = f(a) = 24, \ d = f(b) = -21 = B1,B1 = B1,B$		Correct relationship established	m1A1		eg $\frac{r-a}{c} = \frac{b-a}{c-d}$
(ii) $r = \frac{38}{15} (\approx 2.5333)$ B1F 3 Allow AWRT 2.53; ft small error $\beta = 20^{\frac{1}{3}} \approx 2.714(4)$ So $\beta - r \approx 0.181 \approx 0.18$ (AG) Allow AWRT 2.71 Allow only 2dp if earlier values to 3dp		Hence result convincingly shown	A1	4	
(ii) $ \beta = 20^{\frac{1}{3}} \approx 2.714(4) $ So $\beta - r \approx 0.181 \approx 0.18$ (AG) M1A1 Allow AWRT 2.71 Allow only 2dp if earlier values to 3dp	(b)(i)		B1,B1		
So $\beta - r \approx 0.181 \approx 0.18$ (AG) A1 3 Allow only 2dp if earlier values to 3dp		$r = \frac{38}{15} (\approx 2.5333)$	B1F	3	Allow AWRT 2.53; ft small error
So $\beta - r \approx 0.181 \approx 0.18$ (AG) A1 3 Allow only 2dp if earlier values to 3dp		1			
So $\beta - r \approx 0.181 \approx 0.18$ (AG) A1 3 Allow only 2dp if earlier values to 3dp	(ii)	$\beta = 20^{\frac{1}{3}} \approx 2.714(4)$	M1A1		Allow AWRT 2.71
			A1	3	Allow only 2dp if earlier values to 3dp
		Total		10	

MFP1 (cont)				
Q	Solution	Marks	Total	Comments
8(a)	$\int x^{-\frac{3}{4}} dx = 4x^{\frac{1}{4}} (+ c)$	M1A1		M1 if index correct
	This tends to ∞ as $x \to \infty$, so no value	A1F	3	ft wrong coefficient
(b)	$\int x^{-\frac{5}{4}} dx = -4x^{-\frac{1}{4}} (+ c)$ $\int_{-1}^{\infty} x^{-\frac{5}{4}} dx = 0 - (-4) = 4$	M1A1		M1 if index correct
	$\int_{1}^{\infty} x^{-\frac{5}{4}} \mathrm{d}x = 0 - (-4) = 4$	A1F	3	ft wrong coefficient
(c)	Subtracting 4 leaves ∞ , so no value	B1F	1	ft if <i>c</i> has 'no value' in (a) but has a finite answer in (b)
	Total		7	
9(a)	Asymptotes are $y = \pm \sqrt{2}x$	M1A1	2	M1A0 if correct but not in required form
(b)	Asymptotes correct on sketch	B1F		With gradients steeper than 1; ft from $y = \pm mx$ with $m > 1$
	Two branches in roughly correct positions Approaching asymptotes correctly	B1 B1	3	Asymptotes $y = \pm mx$ needed here
(c)(i)	Elimination of y Clearing denominator correctly $x^2 - 2cx - (c^2 + 2) = 0$	M1 M1 m1A1	4	Convincingly found (AG)
(ii)	Discriminant = $8c^2 + 8$ > 0 for all <i>c</i> , hence result	B1 E1	2	Accept unsimplified OE
(iii)	Solving gives $x = c \pm \sqrt{2(c^2 + 1)}$	M1A1		
	$y = x + c = 2c \pm \sqrt{2(c^2 + 1)}$	A1	3	Accept $y = c + \frac{2c \pm \sqrt{8c^2 + 8}}{2}$
	Total		14	
	TOTAL		75	

MFP1 (cont)