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General Certificate of Education (A-level)
January 2011

Mathematics MFP1

(Specification 6360)

Further Pure 1

Mark Scheme

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Key to mark scheme abbreviations

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
CAO	correct answer only
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
A2,1	2 or 1 (or 0) accuracy marks
$-x$ EE	deduct x marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
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.

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.

MFP1

Q	Solution	Marks	Total	Comments
1(a)	$\alpha + \beta = 6$, $\alpha\beta = 18$	B1B1	2	
(b)	Sum of new roots = $6^2 - 2(18) = 0$	M1A1F		ft wrong value(s) in (a)
	Product = $18^2 = 324$	B1F		ditto
	Equation $x^2 + 324 = 0$	A1F	4	'= 0' needed here; ft wrong value(s) for sum/product
(c)	α^2 and β^2 are $\pm 18\mathrm{i}$	B1	1	
	Total		**7**	
2(a)	$\int 2x^{-3}\,\mathrm{d}x = -x^{-2}$ $(+\,c)$	M1A1		M1 for correct index
	$\int_p^q 2x^{-3}\,\mathrm{d}x = p^{-2} - q^{-2}$	A1F	3	OE; ft wrong coefficient of x^{-2}
(b)(i)	As $p \to 0$, $p^{-2} \to \infty$, so no value	B1		
(ii)	As $q \to \infty$, $q^{-2} \to 0$, so value is ¼	M1A1F	3	ft wrong coefficient of x^{-2} or reversal of limits
	Total		**6**	
3(a)(i)	$\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$	B1	1	
(ii)	$\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$	B1	1	
(b)(i)	$\mathbf{AB} = \begin{bmatrix} -20 & 14 \\ 14 & -10 \end{bmatrix}$	M1A1	2	M1A0 if 3 entries correct
(ii)	$\mathbf{A} + \mathbf{B} = \begin{bmatrix} 0 & 5 \\ -5 & 0 \end{bmatrix}$	B1		
	$(\mathbf{A} + \mathbf{B})^2 = \begin{bmatrix} -25 & 0 \\ 0 & -25 \end{bmatrix}$	B1		
	... $= -25\mathbf{I}$	B1F	3	ft if c's $(\mathbf{A} + \mathbf{B})^2$ is of the form $k\mathbf{I}$
(c)(i)	Rot'n 90° clockwise, enlargem't SF 5	B2, 1	2	OE
(ii)	Rotation 180°, enlargement SF 25	B2, 1F	2	Accept 'enlargement SF −25'; ft wrong value of k
(iii)	Enlargement SF 625	B2, 1F	2	B1 for pure enlargement; ft ditto
	Total		**13**	
4	$\sin\left(-\frac{\pi}{6}\right) = -\frac{1}{2}$	B1		OE; dec/deg penalised at 6th mark
	$\sin\left(-\frac{5\pi}{6}\right) = -\frac{1}{2}$	B1F		OE; ft wrong first value
	Use of $2n\pi$	M1		(or $n\pi$) at any stage
	Going from $4x - \frac{2\pi}{3}$ to x	m1		including division of all terms by 4
	GS $x = \frac{\pi}{8} + \frac{1}{2}n\pi$ or $x = -\frac{\pi}{24} + \frac{1}{2}n\pi$	A1A1	6	OE
	Total		**6**	

MFP1(cont)

Q	Solution	Marks	Total	Comments
5(a)(i)	${z_1}^2 = \frac{1}{4} - \mathrm{i} + \mathrm{i}^2 = -\frac{3}{4} - \mathrm{i}$	M1A1	2	M1 for use of $\mathrm{i}^2 = -1$
(ii)	LHS $= -\frac{3}{4} - \mathrm{i} + \frac{1}{2} + \mathrm{i} + \frac{1}{4} = 0$	M1A1	2	AG; M1 for z^* correct
(b)	LHS $= -\frac{3}{4} + \mathrm{i} + \frac{1}{2} - \mathrm{i} + \frac{1}{4} = 0$	M1A1	2	AG; M1 for ${z_2}^2$ correct
(c)	z real $\Rightarrow z^* = z$	M1		Clearly stated
	Discr't zero or correct factorisation	A1	2	AG
	Total		**8**	
6(a)	Sketch of ellipse	M1		centred at origin
	Correct relationship to circle	A1		
	Coords $(\pm 2\sqrt{2}, 0), (0, \pm\sqrt{2})$	B2,1	4	Accept $\sqrt{8}$ for $2\sqrt{2}$; B1 for any 2 of $x = \pm 2\sqrt{2}$, $y = \pm\sqrt{2}$ allow B1 if all correct except for use of decimals (at least one DP)
(b)(i)	Replacing x by $\frac{x}{2}$	M1		or by $2x$
	E is $\left(\frac{x}{2}\right)^2 + y^2 = 2$	A1	2	OE
(ii)	Tangent is $\frac{x}{2} + y = 2$	M1A1	2	M1 for complete valid method
	Total		**8**	
7(a)	Denom never zero, so no vert asymp	E1		
	Horizontal asymptote is $y = 0$	B1	2	
(b)	$x - 4 = k(x^2 + 9)$	M1		
	Hence result clearly shown	A1	2	AG
(c)	Real roots if $b^2 - 4ac \geq 0$	E1		PI (at any stage)
	Discriminant = $1 - 4k(9k + 4)$	M1		
	... $= -(36k^2 + 16k - 1)$	m1		m1 for expansion
	... $= -(18k - 1)(2k + 1)$	m1		m1 for correct factorisation
	Result (AG) clearly justified	A1	5	eg by sketch or sign diagram
(d)	$k = -\frac{1}{2} \Rightarrow -\frac{1}{2}x^2 - x - \frac{1}{2} = 0$	M1A1		or equivalent using $k = \frac{1}{18}$
	... $\Rightarrow (x+1)^2 = 0 \Rightarrow x = -1$	A1		
	$k = \frac{1}{18} \Rightarrow \frac{1}{18}x^2 - x + \frac{9}{2} = 0$	A1		
	... $\Rightarrow (x-9)^2 = 0 \Rightarrow x = 9$	A1		
	SPs are $\left(-1, -\frac{1}{2}\right), \left(9, \frac{1}{18}\right)$	A1	6	correctly paired
	Total		**15**	

MFP1(cont)

Q	Solution	Marks	Total	Comments
8(a)	$x_2 = 50 - \dfrac{50^3 + 2(50^2) + 50 - 100\ 000}{3(50^2) + 4(50) + 1}$	B1 B1		For numerator (PI by value 30050) For denominator (PI by value 7701)
	$x_2 \approx 46.1$	B1	3	Allow AWRT 46.1
8(b)(i)	$\Sigma r(3r + 1) = 3\Sigma r^2 + \Sigma r$ $\ldots = 3\left(\frac{1}{6}n\right)(n+1)(2n+1) + \frac{1}{2}n(n+1)$ $\ldots = \frac{1}{2}n(n+1)(2n+1+1)$ $\ldots = n(n + 1)^2$ convincingly shown	M1 m1 m1m1 A1	5	 correct formulae substituted m1 for each factor (n and n + 1) AG
(ii)	Correct expansion of $n(n + 1)^2$	B1	1	and conclusion drawn (AG)
(c)	Attempt at value of S_{46} Attempt at value of S_{45} $S_{45} < 100000 < S_{46}$, so $N = 46$ **Alternative method** Root of equation in (a) is 45.8 So lowest integer value is 46	M1 m1 A1 (B3)	 3	 Allow AWRT 45.7 or 45.8
	Total		**12**	
	TOTAL		**75**	