

GCE

Mathematics

Advanced GCE

Unit 4725: Further Pure Mathematics 1

Mark Scheme for June 2011

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1 (i)	$\begin{pmatrix} 4 & 4a \\ 12 & 0 \end{pmatrix}$	B1 B1 B1	3	3B seen or implied 2 elements correct Other 2 elements correct, a.e.f.,
(ii)	$\begin{pmatrix} 4+4a & 3a \\ 4 & 1 \end{pmatrix}$	M1 A1 5	2	Sensible attempt at matrix multiplication for AB or BA Obtain correct answer
2		B1 M1* DM1 A1 A1	5	Establish result true for $n = 1$ or 2 Add next term to given sum formula Combine with correct denominator Obtain correct expression convincingly Specific statement of induction conclusion, provided 1^{st} 4 marks earned
$3 k^2$ $k =$		B1 M1 A1	3	Obtain correct det Equate their det to 0 Obtain correct answers
4	$3 \times \frac{1}{6} \times 2n(2n+1)(4n+1) - \frac{1}{2} \times 2n$ $2n^{2} (4n+3)$	M1 A1 A1 M1 A2	6	Express as sum of two series Each term correct a.e.f. Attempt to factorise Completely correct answer, (A1 if one factor not found)
5 (i)	a = 2 arg $a = 60^{\circ}, \frac{\pi}{3}, 1.05$	B1 B1	2	Correct modulus Correct argument
(ii)		B1 B1 B1 B1* DB1	6	Circle Centre $(1,\sqrt{3})$ Through origin, centre $(\pm 1,\pm \sqrt{3})$ and another y intercept Vertical line Through a or their centre, with +ve gradient Correct half line

6		M1		Show correct expansion process for 3×3
		M1		or multiplication of \mathbf{C} and $\mathrm{adj}\mathbf{C}$ Correct evaluation of any 2×2
	$\det \mathbf{C} = \Delta = 5a - 5$	A1		Obtain correct answer
	$det C = \Delta - 3a - 3$	All		Obtain correct answer
	(5 4 1)	M1		Show correct process for adjoint entries
	$ \frac{1}{\Delta} \begin{pmatrix} 5 & -4 & 1 \\ -5 & 4a & -a \\ 5 & -3a-1 & 2a-1 \end{pmatrix} $	A1		Obtain at least 4 correct entries in adjoint
	$\begin{bmatrix} 5 & 1a & a \\ 5 & -3a-1 & 2a-1 \end{bmatrix}$	711		Count at least 1 correct charles in adjoint
	(3 34 1 24 1)	A1		Obtain completely correct adjoint
		B1		Divide their adjoint by their determinant
			7	3 3
		7		
7 (i)		B1	1	Obtain given answer correctly
(ii)	M1		Express at least 1 st two and last two
		A 1		terms using (i) 1 st two terms correct
		A1 A1		Last two terms correct
		M1		Show that correct terms cancel
	3 _ 1 1		_	
	$\frac{1}{2}$ $-\frac{1}{n}$ $-\frac{1}{(n+1)}$	A1	5	Obtain correct answer, a.e.f. in terms of n
(ii	i)	B1ft		Sum to infinity stated or implied or start at 1000 as in (ii)
		M1		S_{∞} – their (ii) with $n = 999$ or 1000
				or show correct cancelling
	1999 999000	A1	3	Obtain correct answer, a.e.f.
		9		(condone 0.002)
8 (i)		B1		(0,3) seen
. ,		B1		(3,0) seen
		B1	3	Square with A ' B' and C' positioned correctly
(ii)	$\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \mathbf{or} \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$	B1*		Reflection in $y = x$ or $y = -x$
(11)	$\begin{pmatrix} 1 & 0 \end{pmatrix}$ $\begin{pmatrix} -1 & 0 \end{pmatrix}$			
	$(3 \ 0) (-3 \ 0)$	DB1		Correct matrix, dep on stating reflection
	$\begin{pmatrix} 3 & 0 \\ 0 & 3 \end{pmatrix} \mathbf{or} \begin{pmatrix} -3 & 0 \\ 0 & -3 \end{pmatrix}$	B1*		Enlargement scale factor 3 or s.f3
		DB1	4	Correct matrix, dep on stating enlargement S.C. B2 for a pair of transformations consistent with their diagram.
		7		

9 (i) 16 + 30i B1 1 State correct value (ii) $a = -32$ M1 Use $a = -($ sum of roots) $b = 1156$ M1 Use $b = $ product of roots A1 4 Obtain correct answer M1 Substitute, expand and equate imag. parts of that no correct answer M1 Substitute, expand and equate imag. parts of that no obtain or parts of the par					
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	9 (i)	16 + 30i	B1	1	State correct value
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$b=1156 \hspace{1cm} \begin{array}{c ccccccccccccccccccccccccccccccccccc$	(11)	a = -32			
$b = 1156$ A1 4 Obtain correct answer M1 Substitute, expand and equate imag. parts Obtain $a = -32$ M1 Fequate real parts Obtain $b = -32$ Obtain $b = 1156$ (iii) M1 Attempt to equate real and imaginary parts of $(p+iq)^2 & 8 & 16 - 30i$ or root from (ii) $p^2 - q^2 = 16 \text{ and } pq = -15$ A1 Obtain both results cao Obtain $q = (\pm 1)^3 \text{ or } q = (\pm 3)$ Obtain $q = (\pm 1)^3 \text{ or } q = (\pm 3)$ A1 Obtain $q = (\pm 1)^3 \text{ or } q = (\pm 3)$ Obtain $q = (\pm 1)^3 \text{ or } q = (\pm 3)$ A1 Obtain $q = (\pm 1)^3 \text{ or } q = (\pm 3)$ A1 Obtain $q = (\pm 1)^3 \text{ or } q = (\pm 3)$ A1 Attempt at all 4 roots A1 7 State other two roots as complex nos 10 (i) $\frac{1}{u^2} + \frac{3}{u} + 2 = 0$ B1 Use substitution correctly EITHER M1 Rearrange M1 Square $\frac{9}{u^2} + \frac{12}{u} + 4 = \frac{1}{u^3}$ A1 Obtain correct equation $4u^3 + 12u^2 + 9u - 1 = 0$ A1 Obtain given answer OR $q = (2u^{\frac{3}{2}} + 3u^{\frac{1}{2}} + 1)(2u^{\frac{3}{2}} + 3u^{\frac{1}{2}} - 1) = 0$ M2 Multiply their equation in u by appropriate related expression Obtain given answer (ii) B1 Stated or imply that $u = \frac{1}{x^2}$ M1 Use $-\frac{b}{a}$ A1 Obtain correct answer M1 Use $-\frac{b}{a}$ A1 Obtain correct answer M1 Use $-\frac{b}{a}$ A1 Obtain correct answer M1 Use $-\frac{b}{a}$ A1 Obtain correct answer		u = 32			
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A1 Obtain a = -32 M1 Equate real parts Obtain b = 1156		<i>U</i> = 1130	AI	4	Obtain correct answer
A1 Obtain a = -32 M1 Equate real parts Obtain b = 1156			М1		Substitute expend and equate image parts
(iii) M1 Attempt to equate real and imaginary parts of $(p^2 + q^2)^2 \notin 16$ and $pq = -15$ M1 Obtain both results cao M1 Obtain pustratic in p^2 or q^2 M1 Solve to obtain $p = (\pm)5$ or $q = (\pm)3$ A1 Obtain 2 cornect answer					
(iii) (iii) M1 Attempt to equate real and imaginary parts of $(p+iq)^3$ & $16-30$ to root from (ii) $p^2-q^2=16$ and $pq=-15$ A1 Obtain both results can Obtain parts in p^2 or q^2 M1 Solve to obtain $p=(\pm)5$ or $q=(\pm)3$ A1 Obtain 2 correct answers as complex nos $\pm (5\pm 3i)$ M1 Attempt at all 4 roots A1 7 State other two roots as complex nos 10 (i) $\frac{1}{u^{\frac{3}{2}}}+\frac{3}{u}+2=0$ B1 Use substitution correctly EITHER M1 Rearrange M1 Square $\frac{9}{u^2}+\frac{12}{u}+4=\frac{1}{u^3}$ A1 Obtain correct equation $4u^2+12u^2+9u-1=0$ A1 Obtain given answer OR e. g. $(2u^{\frac{3}{2}}+3u^{\frac{3}{2}}+1)(2u^{\frac{3}{2}}+3u^{\frac{3}{2}}-1)=0$ M2 Multiply their equation in u by appropriate related expression A2 Obtain given answer (ii) B1 Stated or imply that $u=\frac{1}{x^2}$ M1 Use $-\frac{b}{a}$ A1 Obtain correct answer M1 Use $-\frac{c}{a}$ A1 Obtain correct answer					
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$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		r q 10 and pq 10			
$\frac{\pm (5 \pm 3i)}{\frac{1}{12}} = \frac{A1}{1} \qquad \text{Obtain 2 correct answers as complex nos}$ $\frac{M1}{A1} = \frac{A1}{1} \qquad \text{Attempt at all 4 roots}$ $\frac{A1}{12} = \frac{1}{12} = \frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{B1} \qquad \text{Use substitution correctly}$ $\frac{1}{12} = \frac{1}{12} + \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain correct equation}$ $\frac{1}{12} = \frac{1}{12} + \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain correct equation}$ $\frac{1}{12} = \frac{1}{12} + \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain given answer}$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain given answer}$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain given answer}$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain correct answer}$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain correct answer}$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain correct answer}$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain correct answer}$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain correct answer}$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain correct answer}$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain correct answer}$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain correct answer}$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain correct answer}$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain correct answer}$ $\frac{1}{12} = \frac{1}{12} = \frac{1}{12} \qquad \text{A1} \qquad \text{Obtain correct answer}$					
$\frac{\pm (5 \pm 3i)}{ \mathbf{I} ^2} + \frac{3}{u} + 2 = 0$ $EITHER$ $\frac{9}{u^2} + \frac{12}{u} + 4 = \frac{1}{u^3}$ $4u^3 + 12u^2 + 9u - 1 = 0$ $\mathbf{E}(\mathbf{I})$ $\mathbf{B}(\mathbf{I})$			M1		Solve to obtain $p = (\pm)5$ or $q = (\pm)3$
$\frac{1}{u^{\frac{1}{2}}} + \frac{3}{u} + 2 = 0$ $\frac{1}{u^{\frac{1}{2}}} + \frac{3}{u} + 2 = 0$ $EITHER$ $\frac{9}{u^{2}} + \frac{12}{u} + 4 = \frac{1}{u^{3}}$ $4u^{3} + 12u^{2} + 9u - 1 = 0$ $0R$ $e. g. (2u^{\frac{3}{2}} + 3u^{\frac{1}{2}} + 1)(2u^{\frac{3}{2}} + 3u^{\frac{1}{2}} - 1) = 0 B1 B1 A1 A1 A1 A1 A2 A1 A2 A3 A4 A3 A4 A4 A4 A4 A4 A5 A4 A4 A4 A4 A4 A4 A4 A4$			A1		Obtain 2 correct answers as complex nos
$\frac{1}{u^{\frac{1}{2}}} + \frac{3}{u} + 2 = 0$ $\frac{1}{u^{\frac{1}{2}}} + \frac{3}{u} + 2 = 0$ $EITHER$ $\frac{9}{u^{2}} + \frac{12}{u} + 4 = \frac{1}{u^{3}}$ $4u^{3} + 12u^{2} + 9u - 1 = 0$ $0R$ $e. g. (2u^{\frac{3}{2}} + 3u^{\frac{1}{2}} + 1)(2u^{\frac{3}{2}} + 3u^{\frac{1}{2}} - 1) = 0 B1 B1 A1 A1 A1 A1 A2 A1 A2 A3 A4 A3 A4 A4 A4 A4 A4 A5 A4 A4 A4 A4 A4 A4 A4 A4$					
10 (i) $ \frac{1}{u^{\frac{3}{2}}} + \frac{3}{u} + 2 = 0 $ B1 Use substitution correctly EITHER M1 Rearrange M1 Square $ \frac{9}{u^{2}} + \frac{12}{u} + 4 = \frac{1}{u^{3}} $ A1 Obtain correct equation $ 4u^{3} + 12u^{2} + 9u - 1 = 0 $ A1 5 Obtain given answer OR e. g. $(2u^{\frac{3}{2}} + 3u^{\frac{3}{2}} + 1)(2u^{\frac{3}{2}} + 3u^{\frac{3}{2}} - 1) = 0$ M2 Multiply their equation in u by appropriate related expression A2 Obtain given answer (ii) B1 Stated or imply that $u = \frac{1}{x^{2}}$ M1 Use $-\frac{b}{a}$ A1 Obtain correct answer M1 Use $\frac{c}{a}$ A1 Obtain correct answer			M1		
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EITHER M1 Rearrange M1 Square $ \frac{9}{u^2} + \frac{12}{u} + 4 = \frac{1}{u^3} $ A1 Obtain correct equation $ 4u^3 + 12u^2 + 9u - 1 = 0 $ A1 5 Obtain given answer OR e. g. $(2u^{\frac{3}{2}} + 3u^{\frac{3}{2}} + 1)(2u^{\frac{3}{2}} + 3u^{\frac{3}{2}} - 1) = 0$ M2 Multiply their equation in u by appropriate related expression A2 Obtain given answer (ii) B1 Stated or imply that $u = \frac{1}{x^2}$ M1 Use $-\frac{b}{a}$ -3 A1 Obtain correct answer M1 Use $\frac{c}{a}$ A1 Obtain correct answer	()				
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$4u^{3} + 12u^{2} + 9u - 1 = 0$ OR e. g. $(2u^{\frac{3}{2}} + 3u^{\frac{3}{2}} + 1)(2u^{\frac{3}{2}} + 3u^{\frac{3}{2}} - 1) = 0$ $M2$ $Multiply their equation in u by appropriate related expression Obtain \ \textbf{given} \ \textbf{answer} M1 Use - \frac{b}{a} -3 M1 Use - \frac{b}{a} M1 Use - \frac{c}{a} Use - \frac{c}{a$		0 12 1	1411		Square
$4u^{3} + 12u^{2} + 9u - 1 = 0$ OR e. g. $(2u^{\frac{3}{2}} + 3u^{\frac{3}{2}} + 1)(2u^{\frac{3}{2}} + 3u^{\frac{3}{2}} - 1) = 0$ $M2$ $Multiply their equation in u by appropriate related expression Obtain \ \textbf{given} \ \textbf{answer} M1 Use - \frac{b}{a} -3 M1 Use - \frac{b}{a} M1 Use - \frac{c}{a} Use - \frac{c}{a$		$\frac{9}{4} + \frac{12}{12} + 4 = \frac{1}{12}$	A 1		Obtain correct equation
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e. g. $(2u^{\frac{3}{2}} + 3u^{\frac{1}{2}} + 1)(2u^{\frac{3}{2}} + 3u^{\frac{1}{2}} - 1) = 0$ M2 Multiply their equation in u by appropriate related expression Obtain given answer (ii) B1 Stated or imply that $u = \frac{1}{x^2}$ M1 Use $-\frac{b}{a}$ -3 A1 Obtain correct answer M1 Use $\frac{c}{a}$ A1 5 Obtain correct answer		OP			
related expression Obtain given answer B1 Stated or imply that $u = \frac{1}{x^2}$ M1 Use $-\frac{b}{a}$ -3 A1 Obtain correct answer M1 Use $\frac{c}{a}$ M1 Use $\frac{c}{a}$ A1 5 Obtain correct answer					
(ii) B1 Stated or imply that $u = \frac{1}{x^2}$ M1 Use $-\frac{b}{a}$ -3 A1 Obtain correct answer M1 Use $\frac{c}{a}$ M1 Use $\frac{c}{a}$ A1 5 Obtain correct answer		e. g. $(2u^{2} + 3u^{2} + 1)(2u^{2} + 3u^{2} - 1) = 0$	M2		Multiply their equation in u by appropriate
(ii) B1 Stated or imply that $u = \frac{1}{x^2}$ M1 Use $-\frac{b}{a}$ -3 A1 Obtain correct answer M1 Use $\frac{c}{a}$ M1 Use $\frac{c}{a}$ A1 5 Obtain correct answer					related expression
(ii) B1 Stated or imply that $u = \frac{1}{x^2}$ M1 Use $-\frac{b}{a}$ -3 A1 Obtain correct answer M1 Use $\frac{c}{a}$ 9 A1 5 Obtain correct answer			A2		
M1 Use $-\frac{b}{a}$ A1 Obtain correct answer M1 Use $\frac{c}{a}$ M1 Use $\frac{c}{a}$ A1 5 Obtain correct answer					
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	(ii)		B1		Stated or imply that $u = \frac{1}{x^2}$
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$					b
A1 Obtain correct answer M1 Use $\frac{c}{a}$ A1 5 Obtain correct answer A1 5 Obtain correct answer			M1		
M1 Use $\frac{c}{a}$ $\frac{9}{4}$ A1 5 Obtain correct answer					
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$ \frac{9}{4} $ A1 5 Obtain correct answer			N / 1		Lica C
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