



GCE

Mathematics

Advanced GCE

Unit 4727: Further Pure Mathematics 3

Mark Scheme for June 2012

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All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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4727

Mark Scheme

June 2012

Annotations and abbreviations

Annotation in scoris	Meaning
✓and ✕	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Highlighting	
Other abbreviations in mark scheme	Meaning
E1	Mark for explaining
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*	Method mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working

4727

Mark Scheme

June 2012

Subject-specific Marking Instructions for GCE Mathematics Pure strand

- a. Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

- b. An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

- c. The following types of marks are available.

M

A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A

Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B

Mark for a correct result or statement independent of Method marks.

E

A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

4727

Mark Scheme

June 2012

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

- d. When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep *' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.
- e. The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

- f. Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.
- g. Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

4727**Mark Scheme****June 2012**

- h. For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

Question		Answer	Marks	Guidance	
1		<p>METHOD 1</p> $\mathbf{b} = [1, -3, 4] \times [3, 1, 2] = [-10, 10, 10]$ $= k[-1, 1, 1]$ $\Rightarrow \mathbf{r} = [1, 4, 2] + t[-1, 1, 1]$ <p>METHOD 2</p> $[x, y, z] \cdot [1, -3, 4] = 0 \Rightarrow x - 3y + 4z = 0$ $[x, y, z] \cdot [3, 1, 2] = 0 \Rightarrow 3x + y + 2z = 0$ <p>Solving $\Rightarrow [x, y, z] = \mathbf{b} = k[-1, 1, 1]$</p> $\Rightarrow \mathbf{r} = [1, 4, 2] + t[-1, 1, 1]$	<p>M1</p> <p>M1</p> <p>A1</p> <p>B1 FT</p> <p>[4]</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>B1FT</p>	<p>For attempt to find vector product of directions</p> <p>Correct calculation of vector product</p> <p>For correct \mathbf{b}.</p> <p>For correct equation. FT from \mathbf{b}</p> <p>For an equation from l_2 perpendicular to normal of plane and an equation from l_2 perpendicular to l_1</p> <p>For correct equation. FT. from \mathbf{b}</p>	<p>Allow 1 error</p> <p>Must show “$\mathbf{r} =$”</p>
2	(i)	$z^4 = 4\left(\frac{1}{2} + i\frac{\sqrt{3}}{2}\right) = 4 \operatorname{cis} \frac{1}{3}\pi$ $z = \sqrt[4]{4} \operatorname{cis}\left(k\frac{\pi}{12}\right), \quad k = 1, 7, 13, 19$	<p>B1</p> <p>M1</p> <p>A1</p> <p>A1</p> <p>B1</p> <p>[5]</p>	<p>For $\arg(z^4) = \frac{1}{3}\pi$ soi</p> <p>For dividing $\arg(z^4)$ by 4</p> <p>For any 2 correct values of k</p> <p>For all 4 values of k and no extras. Ignore values outside range</p> <p>For modulus of all stated roots = $\sqrt[4]{4}$</p> <p>SR For $\arg(z^4) = \frac{1}{6}\pi$ award B0 M1 A1 FT for all $\operatorname{cis}\left(k\frac{\pi}{24}\right), k = 1, 13, 25, 37, A0 B0/B1$</p>	<p>For second A1, must be in correct form.</p> <p>Don't accept 1.41.. or $\sqrt[4]{4}$</p>

4727

Mark Scheme

June 2012

Question		Answer	Marks	Guidance
2	(ii)		<p>B1</p> <p>B1</p> <p>B1</p> <p>[3]</p>	<p>For roots forming a square, centre O, on equal-scale axes.</p> <p>For z^4 and only one root in first quadrant with arguments in ratio approximately 3:1</p> <p>For $z^4 : z \approx 4:\sqrt{2}$ (allow (2,4):1)</p> <p>Must be roots distinct from z^4</p> <p>Penalise once use of points not lines</p> <p>For all four roots</p>
3		<p>Integrating factor = $e^{\int \cot x \, dx} = e^{\ln \sin x} = \sin x$</p> <p>$\Rightarrow \frac{d}{dx}(y \sin x) = 2x \sin x$</p> <p>$\Rightarrow y \sin x = -2x \cos x + \int 2 \cos x \, dx$</p> <p>$\Rightarrow y \sin x = -2x \cos x + 2 \sin x (+c)$</p> <p>$(\frac{1}{6}\pi, 2) \Rightarrow c = \frac{1}{6}\pi\sqrt{3}$</p> <p>$\Rightarrow y = -2x \cot x + 2 + \frac{1}{6}\pi\sqrt{3} \operatorname{cosec} x$</p>	<p>M1</p> <p>A1</p> <p>M1</p> <p>M1*</p> <p>A1</p> <p>A1</p> <p>M1dep*</p> <p>A1 FT</p> <p>A1</p> <p>[9]</p>	<p>For IF = $e^{\pm \ln \sin x}$ OR $e^{\pm \ln \cos x}$</p> <p>For simplified IF</p> <p>For $\frac{d}{dx}(y \cdot \text{their IF}) = 2x \cdot \text{their IF}$</p> <p>For attempt to integrate RHS using parts for $\int x \begin{cases} \sin x \\ \cos x \end{cases} dx$</p> <p>For correct RHS 1st stage</p> <p>oe</p> <p>For substituting $(\frac{1}{6}\pi, 2)$ into their GS (with c)</p> <p>For correctly finding c (FT from GS)</p> <p>For correct solution AEF of standard notation $y = f(x)$</p> <p>(Must use $u = (2)x$)</p> <p>$c = 0.907$</p>

4727

Mark Scheme

June 2012

Question		Answer	Marks	Guidance
4	(i)	$\begin{array}{c ccccc} H & e & r & r^2 & r^3 \\ \hline e & e & r & r^2 & r^3 \\ r & r & r^2 & r^3 & e \\ r^2 & r^2 & r^3 & e & r \\ r^3 & r^3 & e & r & r^2 \end{array}$	B2	For correct table for H
		$\begin{array}{c ccccc} K & e & p & q & pq \\ \hline e & e & p & q & pq \\ p & p & e & pq & q \\ q & q & pq & e & p \\ pq & pq & q & p & e \end{array}$	B2	For correct table for K
			[4]	SR In both tables allow B1 for 1 or 2 errors
4	(ii)	Identity = b	B1 [1]	For correct identity
4	(iii)	G is isomorphic to H	B1	For H identified as isomorphic to G (may be implied by table)
		$\begin{array}{c c c} G & H & H \\ \hline a & r^2 & r^2 \\ b & e & e \\ c & r & r^3 \\ d & r^3 & r \end{array}$	B1	For $a \leftrightarrow r^2$ at least once
			B1	For $c, d \leftrightarrow r, r^3$ either way
			B1	For $c, d \leftrightarrow r, r^3$ both ways and b corresponds to e explicit. Award fourth B1 only for completely correct answer. If none of last 3 marks gained, then SC1 for order of all elements of G and H
		[4]		
5	(i)	METHOD 1		z may be used for $e^{i\theta}$ throughout
		$\sin^3 \theta \cos^2 \theta = \left(\frac{e^{i\theta} - e^{-i\theta}}{2i} \right)^3 \left(\frac{e^{i\theta} + e^{-i\theta}}{2} \right)^2$	B1	For $\left(\frac{e^{i\theta} - e^{-i\theta}}{2i} \right)$ OR $\left(\frac{e^{i\theta} + e^{-i\theta}}{2} \right)$ soi
		$= -\frac{1}{32i} (z^3 - 3z + 3z^{-1} - z^{-3})(z^2 + 2 + z^{-2})$	M1	For expanding brackets (binomial theorem or otherwise)
			M1	For full expansion with 12 terms.
			B1	For $-\frac{1}{32i}$
			M1	For grouping terms
		$= -\frac{1}{32i} \left((z^5 - z^{-5}) - (z^3 - z^{-3}) - 2(z - z^{-1}) \right)$		This step, oe, is needed for the final mark
		$= -\frac{1}{16} \left(\frac{z^5 - z^{-5}}{2i} - \frac{z^3 - z^{-3}}{2i} - 2 \frac{z - z^{-1}}{2i} \right)$		
		$= -\frac{1}{16} (\sin 5\theta - \sin 3\theta - 2 \sin \theta)$	A1	For simplification to AG WWW
		[6]		two brackets expanded soi by alternate method Can be seen at any stage oe includes replacing $z^5 - z^{-5}$ with $2i \sin 5\theta$ etc

4727

Mark Scheme

June 2012

Question		Answer	Marks	Guidance	
		<p>METHOD 2</p> $\sin^3 \theta \cos^2 \theta = \sin^3 \theta - \sin^5 \theta$ $2i \sin \theta = z - \frac{1}{z}$ $-8i \sin^3 \theta = z^3 - 3z + \frac{3}{z} - \frac{1}{z^3}$ $= (z^3 - \frac{1}{z^3}) - (3z - \frac{3}{z})$ $= 2i \sin 3\theta - 6i \sin \theta$ $32i \sin^5 \theta = z^5 - 5z^3 + 10z - \frac{10}{z} + \frac{5}{z^3} - \frac{1}{z^5}$ $= (z^5 - \frac{1}{z^5}) - (5z^3 - \frac{5}{z^3}) + (10z - \frac{10}{z})$ $= 2i \sin 5\theta - 10i \sin 3\theta + 20i \sin \theta$ $\sin^3 \theta \cos^2 \theta$ $= -\frac{1}{32i} (4(2i \sin 3\theta - 6i \sin \theta) + (2i \sin 5\theta - 10i \sin 3\theta + 20i \sin \theta))$ $= -\frac{1}{16} (\sin 5\theta - 5 \sin 3\theta + 4 \sin \theta - 12 \sin \theta)$ $= -\frac{1}{16} (\sin 5\theta - \sin 3\theta - 2 \sin \theta)$	<p>B1</p> <p>M1</p> <p>M1</p> <p>B1</p> <p>B1</p> <p>A1</p>	<p>For RHS</p> <p>*</p> <p>For grouping terms</p> <p>For RHS of this line and line * above</p> <p>For $-\frac{1}{32i}$</p> <p>For ag www</p>	
5	(ii)	$\sin^3 \theta \cos^2 \theta = 0 \Rightarrow \sin \theta = 0 \text{ OR } \cos \theta = 0$ $\Rightarrow \theta = r\pi \text{ OR } \theta = (2r+1)\frac{1}{2}\pi$ $\Rightarrow \theta = \frac{n\pi}{2}$	<p>M1</p> <p>A1</p> <p>A1</p> <p>[3]</p>	<p>For either equation Accept also $\sin \theta = \pm 1$</p> <p>For either solution, AEF including a list of the first few</p> <p>For both of above solutions leading to general solution in form of AG where $k = 2$</p>	<p>Can be implied by the A mark plus at least $\sin^3 \theta = 0$ or similar. At least 2 in list (and no wrong solution)</p>

Question		Answer	Marks	Guidance	
6	(i)	METHOD 1 $m^2 + 4m = 0 \Rightarrow m = 0, -4$ CF = $A + Be^{-4x}$ PI $y = pe^{2x} \Rightarrow 4p + 8p = 12$ $\Rightarrow p = 1$ GS $y = A + Be^{-4x} + e^{2x}$ METHOD 2 Integrating $\Rightarrow \frac{dy}{dx} + 4y = 6e^{2x} + c$ IF $e^{4x} \Rightarrow \frac{d}{dx}(ye^{4x}) = 6e^{6x} + ce^{4x}$ $\Rightarrow ye^{4x} = e^{6x} + \frac{1}{4}ce^{4x} + B$ $\Rightarrow y = e^{2x} + A + Be^{-4x}$	M1 A1 B1 M1 A1 B1 FT [6] M1 B1 B1√ M1 A1 A1	For attempt to solve correct auxiliary equation For correct CF For PI of correct form seen For differentiating PI and substituting For correct p For using GS = CF + PI with 2 arbitrary constants in GS and none in PI For attempt to integrate equation For $+c$ included For correct IF. f.t. from their DE For multiplying through by their IF and attempting to integrate For correct integration both sides, including $+B$ For correct solution	Beware poor use of pxe^{2x} Scores maximum of M1 A1 B0 M1 A0 B0 Must include “y =”
		6	(ii)	$\frac{dy}{dx} = -4Be^{-4x} + 2e^{2x}$ $\left(0, \frac{dy}{dx} = 6\right) \Rightarrow -4B + 2 = 6 \Rightarrow B = -1$ $(y \approx e^{2x} \Rightarrow) A = 0$ $\Rightarrow y = -e^{-4x} + e^{2x}$	M1 A1 B1 A1 [4]
7	(i)	$\mathbf{m} = \mathbf{v} + \frac{1}{2}(\mathbf{w} - \mathbf{v}) \Rightarrow$ $\vec{UM} = \mathbf{v} + \frac{1}{2}(\mathbf{w} - \mathbf{v}) - \mathbf{u} = \frac{1}{2}(\mathbf{v} + \mathbf{w} - 2\mathbf{u})$	M1 A1 [2]	For using vector triangle, or equivalent, for M For correct expression AG SR Allow use of ratio theorem	$\vec{UM} = \vec{UV} + \vec{VM}$ $= (\mathbf{v} - \mathbf{u}) + \frac{1}{2}(\mathbf{w} - \mathbf{v})$ Minimum $-\mathbf{u} + \frac{1}{2}(\mathbf{v} + \mathbf{w})$

4727

Mark Scheme

June 2012

Question		Answer	Marks	Guidance	
7	(ii)	<p>METHOD 1 (first 3 marks)</p> <p>\vec{UM} is $\mathbf{r} = \mathbf{u} + \frac{1}{2}t(\mathbf{v} + \mathbf{w} - 2\mathbf{u})$</p> <p>$t = \frac{2}{3} \Rightarrow \mathbf{u} + \frac{1}{3}(\mathbf{v} + \mathbf{w} - 2\mathbf{u}) = \frac{1}{3}(\mathbf{u} + \mathbf{v} + \mathbf{w})$</p> <p>METHOD 2 (first 3 marks)</p> <p>$\vec{UG} = \frac{1}{3}(\mathbf{u} + \mathbf{v} + \mathbf{w}) - \mathbf{u} = \frac{1}{3}(\mathbf{v} + \mathbf{w} - 2\mathbf{u})$</p> <p>OR</p> <p>$\vec{MG} = \frac{1}{3}(\mathbf{u} + \mathbf{v} + \mathbf{w}) - \frac{1}{2}(\mathbf{v} + \mathbf{w}) = -\frac{1}{6}(\mathbf{v} + \mathbf{w} - 2\mathbf{u})$</p> <p>$\Rightarrow U, G, M$ collinear</p> <p>By symmetry of \vec{OG} in $\mathbf{u}, \mathbf{v}, \mathbf{w}$</p> <p>$G$ also lies on VN, WP</p> <p>$\Rightarrow UM, VN, WP$ intersect at G</p>	<p>M1*</p> <p>M1*</p> <p>A1</p> <p>M1*</p> <p>M1*</p> <p>A1</p> <p>B1</p> <p>B1dep*</p> <p>[5]</p>	<p>For equation of UM</p> <p>For attempt to find a suitable value of t</p> <p>For $t = \frac{2}{3}$ and G obtained AG</p> <p>For finding directions of UG or MG</p> <p>For comparing with UM</p> <p>For showing G lies on UM AG</p> <p>For use of symmetry, or by repeating method for UM twice more.</p> <p>For complete reasoning to AG</p>	
7	(iii)	<p>Line is $\mathbf{r} = \frac{1}{3}(\mathbf{u} + \mathbf{v} + \mathbf{w}) + t(\mathbf{u} - \mathbf{v}) \times (\mathbf{u} - \mathbf{w})$ (etc)</p>	<p>B1</p> <p>B1</p> <p>[2]</p>	<p>For $r = \frac{1}{3}(\mathbf{u} + \mathbf{v} + \mathbf{w}) + t \times$ "any vector"</p> <p>For a correct \mathbf{n}, using any 2 of $\pm(\mathbf{u} - \mathbf{v}), \pm(\mathbf{v} - \mathbf{w}), \pm(\mathbf{w} - \mathbf{u})$</p>	<p>Allow $\vec{UV} \times \vec{VW}$ or similar</p>

4727

Mark Scheme

June 2012

Question		Answer	Marks	Guidance	
7	(iv)	<p>METHOD 1 $\mathbf{n} = [1, 0, -1] \times [0, 1, -1]$ (etc) = $k[1, 1, 1]$</p> <p>UVW is $\mathbf{r} \cdot \mathbf{n} = [1, 0, 0] \cdot [1, 1, 1] = 1$</p> <p>$\Rightarrow d = \frac{1}{\sqrt{3}}$</p> <p>METHOD 2 UVW is $x + y + z = 1$ (from given $\mathbf{u}, \mathbf{v}, \mathbf{w}$)</p> <p>$\Rightarrow d = \frac{1}{\sqrt{3}}$</p> <p>METHOD 3 $\vec{OG} = \frac{1}{3}(\mathbf{u} + \mathbf{v} + \mathbf{w})$</p> <p>$\Rightarrow OG = \sqrt{\frac{1}{9} + \frac{1}{9} + \frac{1}{9}}$</p> <p>$\Rightarrow d = \frac{1}{\sqrt{3}}$</p>	<p>M1*</p> <p>M1dep *</p> <p>A1</p> <p>[3]</p> <p>M2</p> <p>A1</p> <p>M1*</p> <p>M1dep *</p> <p>A1</p>	<p>For attempt to find \mathbf{n}</p> <p>For substituting a point</p> <p>For correct d</p> <p>For attempt to find cartesian equation</p> <p>For correct d</p> <p>For stating or implying \vec{OG} is d</p> <p>For finding magnitude</p> <p>For correct d</p>	<p>May see use of $\frac{ p \cdot \mathbf{n} - d }{ \mathbf{n} }$</p>

4727

Mark Scheme

June 2012

Question		Answer	Marks	Guidance	
8	(i)	For R , $\cos^2 \theta + \sin^2 \theta = 1 \Rightarrow ad-bc = 1 (\Rightarrow R \subset M)$	B1	For showing $R \subset M$	Must demonstrate use of compound angles or explain rotations.
		$R(\theta)R(\phi) = R(\theta + \phi)$ and hence closed, since $\cos \theta \cos \phi - \sin \theta \sin \phi = \cos(\theta + \phi)$ and $\pm (\cos \theta \sin \phi + \sin \theta \cos \phi) = \pm \sin(\theta + \phi)$	M1	For multiplying 2 distinct elements	
			A1	For obtaining $R(\theta)R(\phi) \in R$	
		Identity $\theta = 0 \Rightarrow \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \in R$	B1	For identity element related to $\theta = 0$	
		Inverse $R(-\theta) = \begin{pmatrix} \cos \theta & \sin \theta \\ -\sin \theta & \cos \theta \end{pmatrix}$	B1	For inverse element ...	
		$= \begin{pmatrix} \cos(-\theta) & -\sin(-\theta) \\ \sin(-\theta) & \cos(-\theta) \end{pmatrix}$	B1	...converted to form of elements of R	
		SR For use of $(a, b \in R \Rightarrow ab^{-1} \in R) \Leftrightarrow R$ is a subgroup of M	[6]		
		For R , $\cos^2 \theta + \sin^2 \theta = 1 \Rightarrow R \subset M$	B1	For showing $R \subset M$	
		$R(\theta)R(\phi)^{-1} = \begin{pmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{pmatrix} \begin{pmatrix} \cos(-\phi) & -\sin(-\phi) \\ \sin(-\phi) & \cos(-\phi) \end{pmatrix}$	B1	For considering $R(\theta)R(\phi)^{-1}$	
		$= \begin{pmatrix} \cos(\theta - \phi) & -\sin(\theta - \phi) \\ \sin(\theta - \phi) & \cos(\theta - \phi) \end{pmatrix} \in R$	B1	For correct inverse	
Set is non-empty	M1	For multiplying elements			
	A1	For correct product			
	B1	Can be implied by identity element related to $\theta = 0$			

4727

Mark Scheme

June 2012

Question		Answer	Marks	Guidance	
8	(ii)	For $\theta = \frac{1}{3}k\pi$ elements are	B1	For $\theta = \frac{1}{3}\pi$ soi	Allow degrees instead of radians.
		$\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}, \begin{pmatrix} \frac{1}{2} & -\frac{1}{2}\sqrt{3} \\ \frac{1}{2}\sqrt{3} & \frac{1}{2} \end{pmatrix}, \begin{pmatrix} -\frac{1}{2} & -\frac{1}{2}\sqrt{3} \\ \frac{1}{2}\sqrt{3} & -\frac{1}{2} \end{pmatrix},$	M1	For using “their θ ” in $\begin{pmatrix} \cos k\theta & \sin k\theta \\ -\sin k\theta & \cos k\theta \end{pmatrix}$ for at least 2 values of k , or lists all 6 values of θ	
		$\begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}, \begin{pmatrix} -\frac{1}{2} & \frac{1}{2}\sqrt{3} \\ -\frac{1}{2}\sqrt{3} & -\frac{1}{2} \end{pmatrix}, \begin{pmatrix} \frac{1}{2} & \frac{1}{2}\sqrt{3} \\ -\frac{1}{2}\sqrt{3} & \frac{1}{2} \end{pmatrix}$	A1	For identity and one other element other than (-I)	
			A1	For 2 more elements	
			A1	For all 6 elements correct	
			[5]		

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Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
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