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Mark Scheme (Results)

June 2011

GCE Further Pure FP1 (6667) Paper 1

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EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

   - M marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
   - A marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
   - B marks are unconditional accuracy marks (independent of M marks)
   - Marks should not be subdivided.

3. Abbreviations

   These are some of the traditional marking abbreviations that will appear in the mark schemes and can be used if you are using the annotation facility on ePEN.

   - bod – benefit of doubt
   - ft – follow through
   - the symbol ^ will be used for correct ft
   - cao – correct answer only
   - cso - correct solution only. There must be no errors in this part of the question to obtain this mark
   - isw – ignore subsequent working
   - awrt – answers which round to
   - SC: special case
   - oe – or equivalent (and appropriate)
   - dep – dependent
   - indep – independent
   - dp decimal places
   - sf significant figures
   - * The answer is printed on the paper
   - ⌊ The second mark is dependent on gaining the first mark

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6667 Further Pure Mathematics FP1
Mark Scheme

Question Number	Scheme	Notes	Marks
1.	$f(x) = 3^x + 3x - 7$		
(a)	$f(1) = -1$ $f(2) = 8$	Either any one of f(1) = -1 or f(2) = 8.	M1
	Sign change (positive, negative) (and $f(x)$ is continuous) therefore (a **root)** α is between $x = 1$ and $x = 2$.	Both values correct, sign change and conclusion	A1
			(2)
(b)	$f(1.5) = 2.696152423...$ $\{\Rightarrow 1 \,,, \alpha \,,, 1.5\}$	f(1.5) = awrt 2.7 (or truncated to 2.6)	B1
	$f(1.25) = 0.698222038...$ $\Rightarrow 1 \,,, \alpha \,,, 1.25$	Attempt to find $f(1.25)$.	M1
		$f(1.25)$ = awrt 0.7 with $1 \,,, \alpha \,,, 1.25$ or $1 < \alpha < 1.25$ or $[1, 1.25]$ or $(1, 1.25)$. or equivalent in words.	A1
	In (b) there is no credit for linear interpolation and a correct answer with no working scores no marks.		(3)
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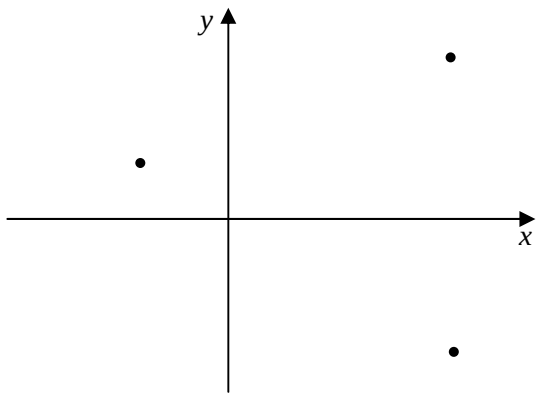
Question Number	Scheme	Notes	Marks
2. (a)	$\lvert z_1\rvert = \sqrt{(-2)^2 + 1^2} = \sqrt{5} = 2.236...$	$\sqrt{5}$ or awrt 2.24	B1 (1)
(b)	$\arg z = \pi - \tan^{-1}\left(\frac{1}{2}\right)$	$\tan^{-1}\left(\frac{1}{2}\right)$ or $\tan^{-1}\left(\frac{2}{1}\right)$ or $\cos^{-1}\left(\frac{2}{\sqrt{5}}\right)$ or $\sin^{-1}\left(\frac{2}{\sqrt{5}}\right)$ or $\sin^{-1}\left(\frac{1}{\sqrt{5}}\right)$ or $\cos^{-1}\left(\frac{1}{\sqrt{5}}\right)$	M1
	$= 2.677945045... = 2.68$ (2 dp)	awrt 2.68	A1 oe (2)
	Can work in degrees for the method mark (arg z = 153.4349488°)		
	$\arg z = \tan^{-1}\left(\frac{1}{-2}\right) = -0.46$ on its own is M0 but $\pi + \tan^{-1}\left(\frac{1}{-2}\right) = 2.68$ scores M1A1 $\pi - \tan^{-1}\left(\frac{1}{-2}\right) =$ is M0 as is $\pi - \tan\left(\frac{1}{2}\right)$ (2.60)		
(c)	$z^2 - 10z + 28 = 0$		
	$z = \frac{10 \pm \sqrt{100 - 4(1)(28)}}{2(1)}$	An attempt to use the quadratic formula (usual rules)	M1
	$= \frac{10 \pm \sqrt{100 - 112}}{2}$		
	$= \frac{10 \pm \sqrt{-12}}{2}$		
	$= \frac{10 \pm 2\sqrt{3}\,i}{2}$	Attempt to simplify their $\sqrt{-12}$ in terms of i. E.g. i $\sqrt{12}$ or i $\sqrt{3\times 4}$	M1
	If their b^2-4ac >0 then only the first M1 is available.		
	So, $z = 5 \pm \sqrt{3}\,i$. $\{p = 5,\ q = 3\}$	$5 \pm \sqrt{3}\,i$	A1 oe (3)
	Correct answers with no working scores full marks. **See appendix for alternative solution by completing the square**		
(d)		Note that the points are $(-2, 1)$, $(5, \sqrt{3})$ and $(5, -\sqrt{3})$.	
		The point $(-2, 1)$ plotted correctly on the Argand diagram with/without label.	B1
		The distinct points z_2 and z_3 plotted correctly and symmetrically about the x-axis on the Argand diagram with/without label.	B1 $\sqrt{}$ (2)
	The points must be correctly placed relative to each other. If you are in doubt about awarding the marks then consult your team leader or use review.		
	NB the second B mark in (d) depends on having obtained complex numbers in (c)		
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Question Number	Scheme	Notes	Marks
3. (a)	$\mathbf{A} = \begin{pmatrix} 1 & \ddot{O}2 \\ \ddot{O}2 & -1 \end{pmatrix}$		
(i)	$\mathbf{A}^2 = \begin{pmatrix} 1 & \ddot{O}2 \\ \ddot{O}2 & -1 \end{pmatrix}\begin{pmatrix} 1 & \ddot{O}2 \\ \ddot{O}2 & -1 \end{pmatrix}$		
	$= \begin{pmatrix} 1+2 & \ddot{O}2-\ddot{O}2 \\ \ddot{O}2-\ddot{O}2 & 2+1 \end{pmatrix}$	A correct method to multiply out two matrices. Can be implied by two out of four correct elements.	M1
	$= \begin{pmatrix} 3 & 0 \\ 0 & 3 \end{pmatrix}$	Correct answer	A1
			(2)
(ii)	**Enlargement**; scale factor 3, centre $(0, 0)$.	**Enlargement**;	B1;
		scale factor **3**, centre **(0, 0)**	B1
	Allow 'from' or 'about' for centre and 'O' or 'origin' for (0, 0)		
			(2)
(b)	$\mathbf{B} = \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$		
	Reflection; in the line $y = -x$.	**Reflection**;	B1;
		y = −x	B1
	Allow 'in the axis' 'about the line' $y = -x$ etc.		
	The question does not specify a <u>single</u> transformation so we would need to accept any combinations that are correct e.g. Anticlockwise rotation of 90° about the origin followed by a reflection in the *x*-axis is acceptable. In cases like these, the combination has to be <u>completely</u> correct and scored as B2 (no part marks). If in doubt consult your Team Leader.		(2)
(c)	$\mathbf{C} = \begin{pmatrix} k+1 & 12 \\ k & 9 \end{pmatrix}$, k is a constant.		
	$\mathbf{C}$ is singular $\Rightarrow$ $\det \mathbf{C} = 0$. (Can be implied)	$\det \mathbf{C} = 0$	B1
	Special Case $\frac{1}{9(k+1)-12k} = 0$ **B1(implied)M0A0**		
	$9(k+1) - 12k\ (= 0)$	Applies $9(k+1) - 12k$	M1
	$9k + 9 = 12k$		
	$9 = 3k$		
	$k = 3$	$k = 3$	A1
	***k* = 3 with no working can score full marks**		(3)
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Question Number	Scheme	Notes	Marks
4.	$f(x) = x^2 + \frac{5}{2x} - 3x - 1, \quad x \neq 0$		
(a)	$f(x) = x^2 + \frac{5}{2}x^{-1} - 3x - 1$		
	$f'(x) = 2x - \frac{5}{2}x^{-2} - 3 \{+0\}$	At least two of the four terms differentiated correctly.	M1
		Correct differentiation. (Allow any correct unsimplified form)	A1
	$\left\{f'(x) = 2x - \frac{5}{2x^2} - 3\right\}$		(2)
(b)	$f(0.8) = 0.8^2 + \frac{5}{2(0.8)} - 3(0.8) - 1 (= 0.365) \left(= \frac{73}{200}\right)$	A correct numerical expression for f(0.8)	B1
	$f'(0.8) = -5.30625 \left(= \frac{-849}{160}\right)$	Attempt to insert $x = 0.8$ into their f'(x). Does not require an evaluation. (If $f'(0.8)$ is incorrect for their derivative and there is no working score M0)	M1
	$\alpha_2 = 0.8 - \left(\frac{"0.365"}{"-5.30625"}\right)$	Correct application of Newton-Raphson using their values. Does not require an evaluation.	M1
	$= 0868786808...$		
	$= 0.869$ (3dp)	0.869	A1 **cao**
	A correct answer only with no working scores no marks. N-R must be seen. Ignore any further applications of N-R		(4)
	A derivative of $2x - 5(2x)^{-2} - 3$ is quite common and leads to f'(0.8) = -3.353125 and a final answer of 0.909. This would normally score M1A0B1M1M1A0 (4/6) Similarly for a derivative of $2x - 10x^{-2} - 3$ where the corresponding values are f'(0.8) = -17.025 and answer 0.821		
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