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Mark Scheme (Results)

January 2007

GCE

GCE Mathematics

Core Mathematics C3 (6665)

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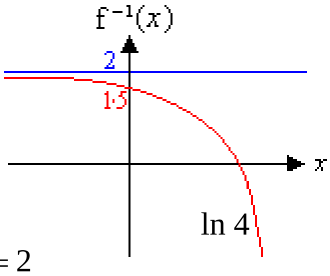
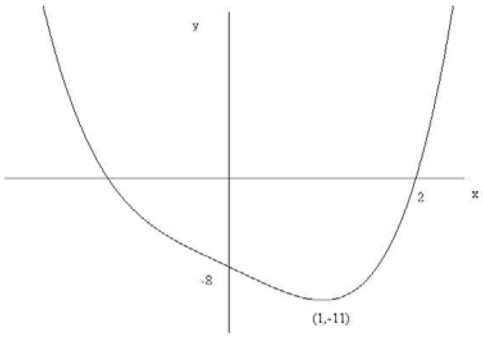
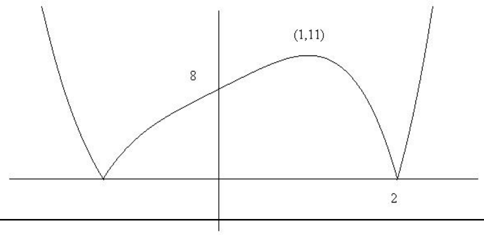
Mark Scheme

Question Number	Scheme	Marks
1.	(a) $\sin 3\theta = \sin(2\theta+\theta) = \sin 2\theta\cos\theta + \cos 2\theta\sin\theta$	B1
	$= 2\sin\theta\cos^2\theta + (1-2\sin^2\theta)\sin\theta$	B1 B1
	$= 2\sin\theta - 2\sin^3\theta + \sin\theta - 2\sin^3\theta$	M1
	$= 3\sin\theta - 4\sin^3\theta$ * cso	A1 **(5)**
	(b) $\sin 3\theta = 3\times\frac{\sqrt{3}}{4} - 4\left(\frac{\sqrt{3}}{4}\right)^3 = \frac{3\sqrt{3}}{4} - \frac{3\sqrt{3}}{16} = \frac{9\sqrt{3}}{16}$ or exact equivalent	M1 A1 **(2)**
		[7]
2.	(a) $\mathrm{f}(x) = \frac{(x+2)^2, -3(x+2)+3}{(x+2)^2}$	M1 A1, A1
	$= \frac{x^2+4x+4-3x-6+3}{(x+2)^2} = \frac{x^2+x+1}{(x+2)^2}$ * cso	A1 **(4)**
	(b) $x^2+x+1 = \left(x+\frac{1}{2}\right)^2 + \frac{3}{4}$, >0 for all values of x.	M1 A1, A1 **(3)**
	(c) $\mathrm{f}(x) = \frac{\left(x+\frac{1}{2}\right)^2+\frac{3}{4}}{(x+2)^2}$	
	Numerator is positive from (b)	
	$x \neq -2 \Rightarrow (x+2)^2 > 0$ (Denominator is positive)	
	Hence $\mathrm{f}(x) > 0$	B1 **(1)**
		[8]
	Alternative to (b)	
	$\frac{\mathrm{d}}{\mathrm{d}x}(x^2+x+1) = 2x+1 = 0 \Rightarrow x = -\frac{1}{2} \Rightarrow x^2+x+1 = \frac{3}{4}$	M1 A1
	A parabola with positive coefficient of x^2 has a minimum $\Rightarrow x^2+x+1>0$	A1 **(3)**
	Accept equivalent arguments	

Question Number	Scheme	Marks
3.	(a) $y=\frac{\pi}{4} \Rightarrow x=2\sin\frac{\pi}{4}=2\times\frac{1}{\sqrt{2}}=\sqrt{2} \Rightarrow P\in C$	B1 **(1)**
	Accept equivalent (reversed) arguments. In any method it must be clear that $\sin\frac{\pi}{4}=\frac{1}{\sqrt{2}}$ or exact equivalent is used.	
	(b) $\frac{dx}{dy}=2\cos y$ *or* $1=2\cos y\frac{dy}{dx}$	M1 A1
	$\frac{dy}{dx}=\frac{1}{2\cos y}$ May be awarded after substitution	M1
	$y=\frac{\pi}{4} \Rightarrow \frac{dy}{dx}=\frac{1}{\sqrt{2}}$ ∗ cso	A1 **(4)**
	(c) $m'=-\sqrt{2}$	B1
	$y-\frac{\pi}{4}=-\sqrt{2}\left(x-\sqrt{2}\right)$	M1 A1
	$y=-\sqrt{2}x+2+\frac{\pi}{4}$	A1 **(4)**
		[9]
4.	(i) $\frac{dy}{dx}=\frac{\left(9+x^2\right)-x\left(2x\right)}{\left(9+x^2\right)^2}$ $\left(=\frac{9-x^2}{\left(9+x^2\right)^2}\right)$	M1 A1
	$\frac{dy}{dx}=0 \Rightarrow 9-x^2=0 \Rightarrow x=\pm3$	M1 A1
	$\left(3,\frac{1}{6}\right),\left(-3,-\frac{1}{6}\right)$ Final two A marks depend on second M only	A1, A1 **(6)**
	(ii) $\frac{dy}{dx}=\frac{3}{2}\left(1+e^{2x}\right)^{\frac{1}{2}}\times2e^{2x}$	M1 A1 A1
	$x=\frac{1}{2}\ln3 \Rightarrow \frac{dy}{dx}=\frac{3}{2}\left(1+e^{\ln3}\right)^{\frac{1}{2}}\times2e^{\ln3}=3\times4^{\frac{1}{2}}\times3=18$	M1 A1 **(5)**
		[11]

Question Number	Scheme	Marks
5.	(a) $R^2 = \left(\sqrt{3}\right)^2 + 1^2 \Rightarrow R = 2$	M1 A1
	$\tan\alpha = \sqrt{3} \Rightarrow \alpha = \frac{\pi}{3}$ accept awrt 1.05	M1 A1 **(4)**
	(b) $\sin\left(x + \text{ their } \alpha\right) = \frac{1}{2}$	M1
	$x + \text{ their } \alpha = \frac{\pi}{6}\ \left(\frac{5\pi}{6}, \frac{13\pi}{6}\right)$	A1
	$x = \frac{\pi}{2}, \frac{11\pi}{6}$ accept awrt 1.57, 5.76	M1 A1 **(4)**
		[8]
	The use of degrees loses only one mark in this question. Penalise the first time it occurs in an answer and then ignore.	

Question Number	Scheme		Marks	
6.	(a) $y = \ln(4-2x)$			
	$e^y = 4-2x$ leading to $x = 2-\frac{1}{2}e^y$	Changing subject and removing ln	M1 A1	
	$y = 2-\frac{1}{2}e^x \quad \Rightarrow \quad f^{-1} \mapsto 2-\frac{1}{2}e^x$ ✱	cso	A1	
	Domain of f^{-1} is		B1	**(4)**
	(b) Range of f^{-1} is $f^{-1}(x) < 2$ (and $f^{-1}(x) \in$)		B1	**(1)**
	(c) 	Shape 1.5 ln 4	B1 B1 B1	
	$y = 2$		B1	**(4)**
	(d) $x_1 \approx -0.3704, \quad x_2 \approx -0.3452$	cao	B1, B1	**(2)**
	If more than 4 dp given in this part a maximum on one mark is lost. Penalise on the first occasion.			
	(e) $x_3 = -0.354\,030\,19\ \ldots$ $x_4 = -0.350\,926\,88\ \ldots$ $x_5 = -0.352\,017\,61\ \ldots$			
	$x_6 = -0.351\,633\,86\ \ldots$	Calculating to at least x_6 to at least four dp	M1	
	$k \approx -0.352$	cao	A1	**(2)** **[13]**
	Alternative to (e) $k \approx -0.352$	Found in any way		
	Let $g(x) = x + \frac{1}{2}e^x$			
	$g(-0.3515) \approx +0.0003, \quad g(-0.3525) \approx -0.001$		M1	
	Change of sign (and continuity) $\Rightarrow k \in (-0.3525, -0.3515)$			
	$\Rightarrow k = -0.352$ (to 3 dp)		A1	**(2)**

Question Number	Scheme	Marks
7.	(a) $\text{f}(-2) = 16 + 8 - 8\ (= 16) > 0$	B1
	$\text{f}(-1) = 1 + 4 - 8\ (= -3) < 0$	B1
	Change of sign (and continuity) $\Rightarrow$ root in interval $(-2, -1)$	B1ft **(3)**
	ft their calculation as long as there is a sign change	
	(b) $\frac{dy}{dx} = 4x^3 - 4 = 0 \quad \Rightarrow \quad x = 1$	M1 A1
	Turning point is $(1, -11)$	A1 **(3)**
	(c) $a = 2, b = 4, c = 4$	B1 B1 B1 **(3)**
	(d) 	
	Shape	B1
	ft their turning point in correct quadrant only	B1 ft
	2 and −8	B1 **(3)**
	(e) 	
	Shape	B1 **(1)**
		[13]

Question Number	Scheme	Marks
8.	(i) $\sec^2 x - \csc^2 x = (1+\tan^2 x) - (1+\cot^2 x)$	M1 A1
	$= \tan^2 x - \cot^2 x$ ✱ cso	A1 **(3)**
	(ii)(a) $y = \arccos x \Rightarrow x = \cos y$	B1
	$x = \sin\left(\frac{\pi}{2} - y\right) \Rightarrow \arcsin x = \frac{\pi}{2} - y$	B1 **(2)**
	Accept $\arcsin x = \arcsin \cos y$	
	(b) $\arccos x + \arcsin x = y + \frac{\pi}{2} - y = \frac{\pi}{2}$	B1 **(1)**
		[6]
	Alternatives for (i)	
	$\sec^2 x - \tan^2 x = 1 = \csc^2 x - \cot^2 x$	M1 A1
	Rearranging $\sec^2 x - \csc^2 x = \tan^2 x - \cot^2 x$ ✱ cso	A1 **(3)**
	$\left(\text{LHS} = \frac{1}{\cos^2 x} - \frac{1}{\sin^2 x} = \frac{\sin^2 x - \cos^2 x}{\cos^2 x \sin^2 x}\right)$	
	RHS $= \frac{\sin^2 x}{\cos^2 x} - \frac{\cos^2 x}{\sin^2 x} = \frac{\sin^4 x - \cos^4 x}{\cos^2 x \sin^2 x} = \frac{(\sin^2 x - \cos^2 x)(\sin^2 x + \cos^2 x)}{\cos^2 x \sin^2 x}$	M1
	$= \frac{\sin^2 x - \cos^2 x}{\cos^2 x \sin^2 x}$	A1
	$=$ LHS ✱ or equivalent	A1 **(3)**