Question Number	Scheme	Marks
6 (a)	$\dfrac{\mathrm{d}(r\sin\theta)}{\mathrm{d}\theta} = 4a\cos\theta + 4a\cos^2\theta - 4a\sin^2\theta$ or $4a\cos\theta + 4a\cos 2\theta$ oe (Or allow $\dfrac{\mathrm{d}(r\cos\theta)}{\mathrm{d}\theta} = -4a\sin\theta - 8a\cos\theta\sin\theta$ or $-4a\sin\theta - 4a\sin 2\theta$)	M1
	E.g. $4a\cos\theta + 4a\cos^2\theta - 4a\sin^2\theta = 0 \Rightarrow \cos\theta + \cos^2\theta - (1-\cos^2\theta) = 0$	M1
	$2\cos^2\theta + \cos\theta - 1 = 0$ terms in any order	A1
	$(2\cos\theta - 1)(\cos\theta + 1) = 0 \Rightarrow \cos\theta = ...$	ddM1
	$\left(\cos\theta = \dfrac{1}{2} \Rightarrow\right) \theta = \dfrac{\pi}{3}$ $(\theta = \pi$ need not be seen$)$	A1
	$r = 4a \times \dfrac{3}{2} = 6a$	A1 (6)
(b)	$\text{Area} = \dfrac{1}{2}\int r^2 \mathrm{d}\theta = \dfrac{1}{2}\int_{\frac{\pi}{6}}^{\frac{\pi}{3}} 16a^2(1+\cos\theta)^2 \,\mathrm{d}\theta$	
	$= \dfrac{16a^2}{2}\int_{\frac{\pi}{6}}^{\frac{\pi}{3}} (1 + 2\cos\theta + \cos^2\theta)\mathrm{d}\theta$	M1
	$= 8a^2\int_{\frac{\pi}{6}}^{\frac{\pi}{3}} \left(1 + 2\cos\theta + \dfrac{1}{2}(\cos 2\theta + 1)\right)\mathrm{d}\theta$	M1
	$= 8a^2\left[\theta + 2\sin\theta + \dfrac{1}{2}\left(\dfrac{1}{2}\sin 2\theta + \theta\right)\right]_{\frac{\pi}{6}}^{\frac{\pi}{3}}$	dM1A1
	$8a^2\left[\dfrac{\pi}{3} + \sqrt{3} + \dfrac{1}{4}\times\dfrac{\sqrt{3}}{2} + \dfrac{\pi}{6} - \left(\dfrac{\pi}{6} + 1 + \dfrac{1}{4}\times\dfrac{\sqrt{3}}{2} + \dfrac{\pi}{12}\right)\right]$	A1
	$8a^2\left[\dfrac{\pi}{4} + \sqrt{3} - 1\right]$	
	$\text{Area } R = 8a^2\left[\dfrac{\pi}{4} + \sqrt{3} - 1\right] - 6a^2\left(1 + \dfrac{\sqrt{3}}{2}\right) = a^2\left(2\pi + 5\sqrt{3} - 14\right)$	M1A1 (7)
		[13]
	Notes	
(a) **M1**	Attempt the differentiation of $r\sin\theta$ using product rule or $\sin 2\theta = 2\sin\theta\cos\theta$ **OR** for this mark only allow differentiation of $r\cos\theta$, inc use of product rule, chain rule or $\cos^2\theta = \dfrac{1}{2}(1 \pm \cos 2\theta)$ Allow errors in coefficients as long as the form is correct.	
M1	Sets their derivative of $r\sin\theta$ equal to zero and achieves a quadratic expression in $\cos\theta$	
A1	Correct 3 term quadratic in $\cos\theta$ (any multiple, including a)	
ddM1	Dep on both M marks. Solve their quadratic (usual rules) giving one or two roots	
A1	Correct quadratic solved to give $\theta = \dfrac{\pi}{3}$	

	Notes
A1*	Correct r obtained from an intermediate step. Accept as shown in scheme, or $r = 4a\left(1+\cos\frac{\pi}{3}\right) = 6a$ or equivalent in stages. No need to see coordinates together in brackets
(b)	Note : first 4 marks of (b) do not require limits.
M1	Use of correct area formula, $\frac{1}{2}$ may be seen later, inc squaring the bracket to obtain 3 terms - limits need not be shown.
M1	Use double angle formula (formula to be of form $\cos^2\theta = \pm\frac{1}{2}(\cos 2\theta \pm 1)$) to obtain an integrable function - limits need not be shown, $\frac{1}{2}$ from area formula may be missing,
dM1	Attempt the integration $\cos\theta \to \pm k\sin\theta$ and $\cos 2\theta \to \pm m\sin 2\theta$ - limits not needed – dep on 2nd M mark but not the first. Note if only two terms arise from squaring allow for $\cos 2\theta \to \pm m\sin 2\theta$
A1	Correct integration – substitution of limits not required (NB Not follow through)
A1	Include the $\frac{1}{2}$ and substitute the correct limits in a correct integral. Note may be attempted via integral from 0 to $\frac{\pi}{3}$ minus integral from 0 to $\frac{\pi}{6}$ - but attempts at sector formula for the latter is A0.
M1	Attempt the area of the triangle - accept valid attempt even if not subtracted from area. E.g. attempts $\frac{1}{2}OA.OB\sin\frac{\pi}{6}$
A1	Correct final answer in the demanded the form.