Question Number	Scheme	Marks
3(a)	$y = r\sin\theta = \sin\theta + \sin\theta\cos\theta$ OR $r\sin\theta = \sin\theta + \frac{1}{2}\sin 2\theta$	B1
	$\frac{\mathrm{d}y}{\mathrm{d}\theta} = \cos\theta - \sin^2\theta + \cos^2\theta$ OR $\frac{\mathrm{d}y}{\mathrm{d}\theta} = \cos\theta + \cos 2\theta$ $0 = \cos\theta + 2\cos^2\theta - 1 \quad = (2\cos\theta - 1)(\cos\theta + 1)$	M1
	$\cos\theta = \frac{1}{2}$ $(\cos\theta = -1$ outside range for $\theta)$ $\theta = \frac{\pi}{3}$	M1
	A is $\left(1\frac{1}{2}, \frac{\pi}{3}\right)$	A1 (4)
3(b)	Area $= \frac{1}{2}\int_0^{\frac{\pi}{3}} (1+\cos\theta)^2 \mathrm{d}\theta$	B1
	$= \frac{1}{2}\int \left(1 + 2\cos\theta + \frac{1}{2}(\cos 2\theta + 1)\right)\mathrm{d}\theta$	M1A1
	$= \frac{1}{2}\left[\frac{3}{2}\theta + 2\sin\theta + \frac{1}{4}\sin 2\theta\right]_0^{\frac{\pi}{3}}$	dM1A1
	$= \frac{\pi}{4} + \frac{\sqrt{3}}{2} + \frac{\sqrt{3}}{16} = \frac{\pi}{4} + \frac{9\sqrt{3}}{16}$	A1 (6)
		[10]

(a)

B1 Use of $r\sin\theta$ Award if not seen explicitly but a correct result following use of double angle formula is seen.

M1 Differentiate $r\sin\theta$ or $r\cos\theta$

M1 Set $\frac{\mathrm{d}(r\sin\theta)}{\mathrm{d}\theta} = 0$ and solve the resulting equation. Only the solution used need be shown.

A1 Correct coordinates of A

(b)B1 Use of Area $= \frac{1}{2}\int r^2 \mathrm{d}\theta$ with $r = 1 + \cos\theta,$ limits not needed.

M1 Attempt $(1+\cos\theta)^2$ (minimum accepted is $(1 + k\cos\theta + \cos^2\theta)$) and change $\cos^2\theta$ to an expression in $\cos 2\theta$ using $\cos^2\theta = \frac{1}{2}(\pm\cos 2\theta \pm 1)$

A1 Correct integrand; limits not needed. $\frac{1}{2}$ may be missing.

dM1 Attempt to integrate all terms. $\cos 2\theta \to \pm\frac{1}{k}\sin 2\theta$ $k = \pm 1$ or ± 2 Limits not needed.
Depends on the previous M mark

A1 Correct integration and correct limits seen

A1 Substitute correct limits and obtain the correct answer in the required form.

Question Number	Scheme	Marks
	Alternative for (b) *using integration by parts* (Very rare but may be seen)	
	Area $= \frac{1}{2}\int_0^{\frac{\pi}{3}} (1+\cos\theta)^2 \mathrm{d}\theta$	B1
	$= \frac{1}{2}\left[\int (1+2\cos\theta)\mathrm{d}\theta + \int \cos^2\theta \mathrm{d}\theta\right]$	
	$= \frac{1}{2}\left[\int (1+2\cos\theta)\mathrm{d}\theta + \cos\theta\sin\theta + \int \sin^2\theta \mathrm{d}\theta\right]$	M1A1
	$= \frac{1}{2}\left[\theta + 2\sin\theta + \sin\theta\cos\theta + \int (1-\cos^2\theta)\mathrm{d}\theta\right]_0^{\frac{\pi}{3}}$	
	$= \frac{1}{2}\left[\theta + 2\sin\theta + \frac{1}{2}(\sin\theta\cos\theta + \theta)\right]_0^{\frac{\pi}{3}}$	dM1A1
	$= \frac{\pi}{4} + \frac{\sqrt{3}}{2} + \frac{\sqrt{3}}{16} = \frac{\pi}{4} + \frac{9\sqrt{3}}{16}$	A1
B1	Use of Area $= \frac{1}{2}\int r^2 \mathrm{d}\theta$ with $r = 1+\cos\theta$, limits not needed.	
M1	Attempt $(1+\cos\theta)^2$ (minimum accepted is $(1+k\cos\theta+\cos^2\theta)$) and attempt first stage of $\int \cos^2\theta \mathrm{d}\theta$ by parts. Reach $\int \cos^2\theta \mathrm{d}\theta = \cos\theta\sin\theta \pm \int \sin^2\theta \mathrm{d}\theta$ Limits not needed	
A1	Correct so far. Limits not needed.	
dM1	Attempt to integrate all terms. $\int (1+2\cos\theta)\mathrm{d}\theta$ **and** attempt to complete $\int \cos^2\theta \mathrm{d}\theta$ using Pythagoras identity. Limits not needed. Depends on the previous M mark	
A1A1	As main scheme	