Question Number	Scheme	Notes	Marks
8.	$r = \sin\theta + \cos 2\theta$		
(a)	$y = r\sin\theta = \sin^2\theta + \sin\theta\cos 2\theta$ or e.g. $y = \sin\theta(\sin\theta + \cos 2\theta)$	Correct expression	B1
	$\frac{dy}{d\theta} = 2\sin\theta\cos\theta + \cos\theta\cos 2\theta - 2\sin\theta\sin 2\theta$ M1: **Correct** use of Chain and Product Rules (allow sign errors only) **on a correct expression** A1: Correct differentiation		M1A1
	$6\sin^2\theta - 2\sin\theta - 1 = 0$	Correct quadratic	A1
	$\sin\theta = \frac{2\pm\sqrt{28}}{12} \Rightarrow$ at P, $\sin\theta = \frac{2+\sqrt{28}}{12} \Rightarrow \theta = \sin^{-1}\frac{2+\sqrt{28}}{12} = 0.653067...$ $r = \sin\theta + \cos 2\theta = \frac{2+\sqrt{28}}{12} + \cos(2\times"0.653...")$ A complete method to find OP. Solves their 3TQ in $\sin\theta$, proceeds to obtain a value for θ and uses the given expression for r to find OP. **or** $\sin\theta = \frac{2\pm\sqrt{28}}{12} \Rightarrow$ at P, $\sin\theta = \frac{2+\sqrt{28}}{12} \Rightarrow \cos 2\theta = 1 - 2\left(\frac{2+\sqrt{28}}{12}\right)^2$ $r = \sin\theta + \cos 2\theta = \frac{1+\sqrt{7}}{6} + 1 - 2\left(\frac{1+\sqrt{7}}{6}\right)^2$ A complete method to find OP. Solves their 3TQ in $\sin\theta$, proceeds to obtain a value for $\cos 2\theta$ using a correct identity and adds their $\sin\theta$ value to find OP. **Dependent on the first method mark.**		**d**M1
	$OP = r = 0.8692...$	awrt 0.869	A1
			(6)

(b)	$\left(\sin\theta+\cos 2\theta\right)^2=\sin^2\theta+2\sin\theta\cos 2\theta+\cos^2 2\theta$ Attempt to find r^2. Allow poor squaring as long as there is the intention to square the bracket.		M1
	$\int\sin^2\theta\ \mathrm{d}\theta=\frac{1}{2}\theta-\frac{1}{4}\sin 2\theta$ $\int\cos^2 2\theta\ \mathrm{d}\theta=\frac{1}{2}\theta+\frac{1}{8}\sin 4\theta$	Attempts to integrate $\sin^2\theta$ to obtain $\alpha\theta+\beta\sin 2\theta$ and attempts to integrate $\cos^2 2\theta$ to obtain $\alpha\theta+\beta\sin 4\theta$. This may be implied by an expression of the form $\alpha\theta+\beta\sin 2\theta+\gamma\sin 4\theta$ **Dependent on the first method mark.**	**d**M1
	$\int 2\sin\theta\cos 2\theta\ \mathrm{d}\theta=\int 2\sin\theta\left(2\cos^2\theta-1\right)\mathrm{d}\theta$ $=\int\left(4\sin\theta\cos^2\theta-2\sin\theta\right)\mathrm{d}\theta=-\frac{4}{3}\cos^3\theta+2\cos\theta$ or $\int 2\sin\theta\cos 2\theta\ \mathrm{d}\theta=\int\left(\sin 3\theta-\sin\theta\right)\mathrm{d}\theta=-\frac{1}{3}\cos 3\theta+\cos\theta$ Fully correct strategy for integrating $(2)\sin\theta\cos 2\theta$ **Dependent on the first method mark.**		**d**M1
	$\int r^2\mathrm{d}\theta=\frac{1}{2}\left(\theta-\frac{1}{2}\sin 2\theta\right)+\cos\theta-\frac{1}{3}\cos 3\theta+\frac{1}{2}\left(\theta+\frac{1}{4}\sin 4\theta\right)$ or $\int r^2\mathrm{d}\theta=\frac{1}{2}\left(\theta-\frac{1}{2}\sin 2\theta\right)-\frac{4}{3}\cos^3\theta+2\cos\theta+\frac{1}{2}\left(\theta+\frac{1}{4}\sin 4\theta\right)$ Fully correct integration		A1
	$\frac{1}{2}\int_0^{\frac{\pi}{2}}r^2\mathrm{d}\theta=\ldots$	Fully correct method using a correct formula and evidence of use of the limits $\frac{\pi}{2}$ and 0 with subtraction. **Dependent on the <u>first</u> and <u>at least one of the subsequent</u> method marks.**	**dd**M1
	$=\frac{\pi}{4}-\frac{1}{3}$	Correct exact area. Allow equivalent exact expressions e.g. $\frac{1}{2}\left(\frac{\pi}{2}-\frac{2}{3}\right)$	A1
			(6)
			Total 12

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