Question	Scheme	Marks	AOs
3	$3(1-\sin\theta)=1+\sin\theta \Rightarrow \sin\theta=\dfrac{1}{2} \Rightarrow \theta=...$	M1	3.1a
	$\theta=\dfrac{\pi}{6}\left(\text{or }\dfrac{5\pi}{6}\right)$	A1	1.1b
	Use of $\dfrac{1}{2}\int(1+\sin\theta)^2\,\mathrm{d}\theta$ or $\dfrac{1}{2}\int\{3(1-\sin\theta)\}^2\,\mathrm{d}\theta$	M1	1.1a
	$\left(\dfrac{1}{2}\right)\int\left[(1+\sin\theta)^2-9(1-\sin\theta)^2\right]\mathrm{d}\theta$ $=\left(\dfrac{1}{2}\right)\int\left[1+2\sin\theta+\sin^2\theta-9+18\sin\theta-9\sin^2\theta\right]\mathrm{d}\theta$ or $\int(1+\sin\theta)^2\,\mathrm{d}\theta=\int\left(1+2\sin\theta+\sin^2\theta\right)\mathrm{d}\theta$ **and** $\int 9(1-\sin\theta)^2\,\mathrm{d}\theta=9\int\left(1-2\sin\theta+\sin^2\theta\right)\mathrm{d}\theta$	M1 A1	2.1 1.1b
	$\int\sin^2\theta\,\mathrm{d}\theta=\dfrac{1}{2}\int(1-\cos2\theta)\,\mathrm{d}\theta \Rightarrow$ $\int\left[(1+\sin\theta)^2-9(1-\sin\theta)^2\right]\mathrm{d}\theta=2\sin2\theta-12\theta-20\cos\theta$	M1 A1	3.1a 1.1b
	$A=\dfrac{1}{2}\int_{\frac{\pi}{6}}^{\frac{5\pi}{6}}\left[(1+\sin\theta)^2-9(1-\sin\theta)^2\right]\mathrm{d}\theta$ or $A=2\times\dfrac{1}{2}\int_{\frac{\pi}{6}}^{\frac{\pi}{2}}\left[(1+\sin\theta)^2-9(1-\sin\theta)^2\right]\mathrm{d}\theta$ $=\dfrac{1}{2}\left\{\left(-\sqrt{3}-10\pi+10\sqrt{3}\right)-\left(\sqrt{3}-2\pi-10\sqrt{3}\right)\right\}=...$	DM1	3.1a
	$=9\sqrt{3}-4\pi$	A1	1.1b
		(9)	
(9 marks)			

Notes

M1: Realises that the angles at the intersection are required and solves $C_1 = C_2$ to obtain a value for θ

A1: Correct value for θ. Must be in radians – if given in degrees you may need to check later to see if they convert to radians before substitution.

M1: Evidence selecting the correct polar area formula on either curve

M1: Fully expands both expressions for r^2 either as parts of separate integrals or as one complete integral. (Can be scored from incorrect polar area formula, e.g. missing the ½)

A1: Correct expansions for both curves (may be unsimplified)

M1: Selects the correct strategy by applying the correct double angle identity in order to reach an integrable form and attempting the integration of at least one of the curves.

A1: Correct integration (of both integrals if done separately),

FYI: If done separately the correct integrals are

$$\int (1+\sin\theta)^2 \, d\theta = \theta - 2\cos\theta + \frac{1}{2}\left(\theta - \frac{1}{2}\sin 2\theta\right) = \frac{3}{2}\theta - 2\cos\theta - \frac{1}{4}\sin 2\theta \text{ and}$$

$$\int 9(1-\sin\theta)^2 \, d\theta = 9\theta + 18\cos\theta + \frac{9}{2}\left(\theta - \frac{1}{2}\sin 2\theta\right) = \frac{27}{2}\theta + 18\cos\theta - \frac{9}{4}\sin 2\theta$$

DM1: Depends on all previous M's. For a fully correct strategy with appropriate limits correctly applied to their integral or integrals and terms combined if necessary. Make sure that if limits of $\frac{\pi}{6}$ and $\frac{\pi}{2}$ are used that the area is doubled as part of the strategy.

A1: Correct area