Question	Scheme	Marks	AOs
7(a)	Replaces $x^2 + y^2 \to r^2$ **and** $x \to r\cos\theta$ **and** $y \to r\sin\theta$	M1	2.1
	$r^4 = 6r^2\cos\theta\sin\theta$ or $r^2 = 6\cos\theta\sin\theta$	A1	1.1b
	$r^2 = 3\sin 2\theta$ * cso	A1*	1.1b
		(3)	
(b)	**Alternative 1 for the first three marks** $y^2 = r^2\sin^2\theta = 3\sin 2\theta\sin^2\theta$ $2y\dfrac{\mathrm{d}y}{\mathrm{d}\theta} = \alpha\cos 2\theta\sin^2\theta + \beta\sin 2\theta\sin\theta\cos\theta$	M1	3.1a
	$2y\dfrac{\mathrm{d}y}{\mathrm{d}\theta} = 6\cos 2\theta\sin^2\theta + 6\sin 2\theta\sin\theta\cos\theta$	A1	1.1b
	$6\cos 2\theta\sin^2\theta + 6\sin 2\theta\sin\theta\cos\theta = 0$ $6\cos 2\theta\sin^2\theta + 12\sin^2\theta\cos^2\theta = 0$ $6\sin^2\theta(\cos 2\theta + 2\cos^2\theta) = 0$ $6\sin^2\theta(4\cos^2\theta - 1) = 0$ $\sin^2\theta = 0 \implies \theta = \ldots$ or $\cos^2\theta = \frac{1}{4} \implies \theta = \ldots$	M1	3.1a
	Alternative 2 for the first three marks $y = r\sin\theta = \sqrt{3}\sin\theta(\sin 2\theta)^{\frac{1}{2}}$ $\dfrac{\mathrm{d}y}{\mathrm{d}\theta} = \alpha\cos\theta(\sin 2\theta)^{\frac{1}{2}} + \beta(\sin 2\theta)^{-\frac{1}{2}}\cos 2\theta\cos\theta$	M1	3.1a
	$\dfrac{\mathrm{d}y}{\mathrm{d}\theta} = \sqrt{3}\cos\theta(\sin 2\theta)^{\frac{1}{2}} + \sqrt{3}(\sin 2\theta)^{-\frac{1}{2}}\cos 2\theta\cos\theta$	A1	1.1b
	$\sqrt{3}\cos\theta(\sin 2\theta)^{\frac{1}{2}} + \sqrt{3}(\sin 2\theta)^{-\frac{1}{2}}\cos 2\theta\cos\theta = 0$ $\sqrt{3}\cos\theta\sin 2\theta + \sqrt{3}\cos 2\theta\cos\theta = 0$ $\sqrt{3}\cos\theta \times 2\sin\theta\cos\theta + \sqrt{3}(2\cos^2\theta - 1)\cos\theta = 0$ $\sqrt{3}\sin\theta(4\cos^2\theta - 1) = 0$ $\sin\theta = 0 \implies \theta = \ldots$ or $\cos^2\theta = \frac{1}{4} \implies \theta = \ldots$	M1	3.1a
	Alternative 3 for the first three marks $(x^2 + y^2)^2 = 6xy \Rightarrow x^4 + 2x^2y^2 + y^4 = 6xy$ $4x^3 + \alpha xy^2 + \beta x^2y\dfrac{\mathrm{d}y}{\mathrm{d}x} + 4y^3\dfrac{\mathrm{d}y}{\mathrm{d}x} = 6y + 6x\dfrac{\mathrm{d}y}{\mathrm{d}x}$	M1	3.1a
	$4x^3 + 4xy^2 + 4x^2y\dfrac{\mathrm{d}y}{\mathrm{d}x} + 4y^3\dfrac{\mathrm{d}y}{\mathrm{d}x} = 6y + 6x\dfrac{\mathrm{d}y}{\mathrm{d}x}$	A1	1.1b
	$4x^3 + 4xy^2 + 4x^2y(0) + 4y^3(0) = 6y + 6x(0)$ $4x^3 + 4xy^2 = 6y$ $4r^3\cos^3\theta + 4r\cos\theta \times r^2\sin^2\theta = 6r\sin\theta$ $4r^3\cos\theta[\cos^2\theta + \sin^2\theta] = 6r\sin\theta$ $4(3\sin 2\theta)\cos\theta - 6\sin\theta = 0$ $24\sin\theta\cos^2\theta - 6\sin\theta = 0$ $6\sin\theta\ [4\cos^2\theta - 1]$ $\sin\theta = 0 \implies \theta = \ldots$ or $\cos^2\theta = \frac{1}{4} \implies \theta = \ldots$	M1	3.1a

	For the final 6 marks		
	Deduces that $\theta = \frac{\pi}{3}$ is required	A1	2.2a
	Area bounded by the curve $= \frac{1}{2}\int_{\frac{\pi}{3}}^{\frac{\pi}{2}} 3\sin 2\theta \; d\theta = [\delta \cos 2\theta]_{\frac{\pi}{3}}^{\frac{\pi}{2}} = \ldots$ Note: $\delta = -\frac{3}{4}$	M1	1.1b
	$\left\{-\frac{3}{4}\cos\pi - \left(-\frac{3}{4}\cos\frac{2\pi}{3}\right)\right\} = \frac{3}{8}$	A1	1.1b
	Area of triangle $= \frac{1}{2}xy = \frac{1}{2}r^2 \sin\theta\cos\theta$ $= \frac{1}{2} \times 3\sin\frac{2\pi}{3}\sin\frac{\pi}{3}\cos\frac{\pi}{3} = \ldots$	M1	1.1b
	Finds the required area = area of triangle – area bounded by the curve $\left\{= \frac{9}{16} - \frac{3}{8}\right\}$	ddM1	3.1a
	$= \frac{3}{16}$	A1	1.1b
		(9)	
			(12 marks)

Notes:

(a)
M1: Replaces all Cartesian variables with polar variables
A1: A correct unsimplified polar equation
A1*: Correct polar equation achieved from correct work.

(b) Alternatives 1 and 2
M1: Writes y^2 or y in terms of trig and differentiates (implicitly) to the correct form
A1: Fully correct differentiation
M1: Uses correct trig work to solve $\frac{dy}{d\theta} = 0$ to achieve a value for θ

(b) Alternative 3
M1: Differentiates implicitly the Cartesian equation to the correct form
A1: Fully correct differentiation
M1: Uses correct polar equation and correct trig work to solve $\frac{dy}{dx} = 0$ to achieve a value for θ

(b) For the last 6 marks
A1: Deduces that $\theta = \frac{\pi}{3}$
M1: Applies area $= \frac{1}{2}\int_{\frac{\pi}{3}}^{\frac{\pi}{2}} r^2 \, d\theta$, integrates to a correct form and applies their lower limit and upper limits of $\frac{\pi}{2}$ correctly
A1: Correct area under the curve
M1: Correct method to find the area of triangle $= \frac{1}{2}xy$
ddM1: Dependent of previous two method marks. Fully correct method to find the required area. Finds the required area = area of triangle – area bounded by the curve
A1: Correct answer