

Question Number	Scheme	Marks
8(a)	3π	B1
		(1)
(b)	$\frac{dy}{dx} = \frac{-2 \sin t}{6 - 6 \cos 2t}$	M1 A1
	$= \frac{-2 \sin t}{6 - 6(1 - 2 \sin^2 t)} = \frac{-2 \sin t}{12 \sin^2 t} = -\frac{1}{6} \operatorname{cosec} t$	M1 A1*
		(4)
(c)	$P = \left(\frac{3\pi}{2} - 3, \sqrt{2} \right)$	B1
	E.g. $y - \sqrt{2} = -\frac{\sqrt{2}}{6} \left(0 - \left(\frac{3\pi}{2} - 3 \right) \right) \Rightarrow y = \dots$ or $\sqrt{2} = -\frac{\sqrt{2}}{6} \left(\frac{3\pi}{2} - 3 \right) + c \Rightarrow c = \dots$	M1
	$\frac{\pi\sqrt{2}}{4} + \frac{\sqrt{2}}{2} \text{ o.e}$	A1
		(3)

(d)(i)	Attempts $y^2 \frac{dx}{dt} = 4 \cos^2 t (6 - 6 \cos 2t)$	M1 A1
	$= (2 \cos 2t + 2)(6 - 6 \cos 2t) = 6(2 - 2 \cos^2 2t) = 6(2 - (1 + \cos 4t))$	dM1
	Volume $= \int_0^{\frac{\pi}{2}} \pi y^2 \frac{dx}{dt} dt = \int_0^{\frac{\pi}{2}} 6\pi(1 - \cos 4t) dt$	A1
(ii)	$\left[6\pi t - \frac{6\pi \sin 4t}{4} \right]_0^{\frac{\pi}{2}}, = 3\pi^2$	M1, A1
		(6)
		(14 marks)

Question Number	Scheme	Marks
6(a)	$\frac{dy}{dx} = 6 \cos t \times \frac{1}{-8 \sin t} = k \frac{\cos t}{\sin t}$	M1
	$\frac{dy}{dx} = -\frac{3}{4} \cot \left(\frac{\pi}{3} \right) = -\frac{\sqrt{3}}{4}$	dM1A1
		(3)
Mark (a) and (b) together.		

(b)	$(6, 3\sqrt{3}-3)$	B1B1
	$-\frac{\sqrt{3}}{4} \rightarrow \frac{4}{\sqrt{3}}$	B1ft
	$y-3\sqrt{3}+3 = \frac{4}{\sqrt{3}}(x-6)$ or $y = \frac{4}{\sqrt{3}}x + c \Rightarrow -3\sqrt{3}+3 = \frac{4}{\sqrt{3}} \times 6 + c \Rightarrow c = (-3-5\sqrt{3})$	M1
	When $y=0$ $-3\sqrt{3}+3 = \frac{4}{\sqrt{3}}(x-6) \Rightarrow x = \dots$	dM1
	$\left(\frac{15+3\sqrt{3}}{4}, 0\right)$	A1
		(6)
(h)		

(c)	$x = 8\cos t + 2 \Rightarrow \cos t = \frac{x-2}{8} \quad y = 6\sin t - 3 \Rightarrow \sin t = \frac{y+3}{6}$	M1
	$\frac{(x-2)^2}{64} + \frac{(y+3)^2}{36} = 1$	A1
		(2)
		(11 marks)

Question Number	Scheme	Marks
8(a)	A and B are where $y = 0$ so $t^3 - 9t = 0 \Rightarrow t(t^2 - 9) = 0 \Rightarrow t = 3$ (0 and -3) Substitutes $t = 3$ in $x = 3^2 + 2 \times 3 = 15$ B(15, 0) $A = (3, 0)$	M1 A1* B1 (3)
8(a) ALT	Uses answer $x = 15$: $t^2 + 2t = 15 \Rightarrow t = 3$ (-5) Substitutes $t = 3$ in $y = t^3 - 9t = 27 - 27 = 0$ ✓ B(15, 0) $A = (3, 0)$	M1 A1* B1 (3)
(b)	$\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}} = \frac{3t^2 - 9}{2t + 2}$ Substitutes $t = 3$ into $\frac{dy}{dx} = \frac{3t^2 - 9}{2t + 2} \Rightarrow \frac{dy}{dx} = \frac{9}{4}$ Uses their $\frac{9}{4}$ with (15, 0) to produce tangent equation $9x - 4y - 135 = 0$	M1 A1 dM1 A1 (4)
(c)	Substitutes $x = t^2 + 2t$, $y = t^3 - 9t$, into their $9x - 4y - 135 = 0$ $\Rightarrow 9(t^2 + 2t) - 4(t^3 - 9t) - 135 = 0$ $\Rightarrow 4t^3 - 9t^2 - 54t + 135 = 0$ $\Rightarrow (t^2 - 6t + 9)(4t + 15) = 0$ $t = -\frac{15}{4}$ Coordinates of X are $\left(\frac{105}{16}, -\frac{1215}{64}\right)$	M1 dM1 A1 dM1 A1 (5) (12 marks)

Question Number	Scheme	Marks
2 (a)	E.g. $x = \frac{t-1}{2t+1} \Rightarrow t = \frac{x+1}{1-2x}$ or $y = \frac{6}{2t+1} \Rightarrow t = \frac{6-y}{2y}$	M1
	E.g. $y = \frac{6}{2t+1} \Rightarrow y = \frac{6}{2 \times \left(\frac{x+1}{1-2x} \right) + 1}$ or $t = \frac{6-y}{2y} \Rightarrow x = \frac{\frac{6-y}{2y} - 1}{2 \times \frac{6-y}{2y} + 1}$	A1
	E.g. $y = \frac{6}{2 \times \left(\frac{x+1}{1-2x} \right) + 1} \Rightarrow y = \frac{6(1-2x)}{2 \times (x+1) + 1(1-2x)} = ax+b$	dM1
	E.g. $y = \frac{6(1-2x)}{3}, y = 2(1-2x)$ oe so linear *	A1*
		(4)
(b)	$y = 2(1-2x)$ and $y = x+12 \Rightarrow 2(1-2x) = x+12 \Rightarrow x = \dots$	M1
	$x = -2$	A1cao
		(2)

Question Number	Scheme	Marks
10(a)	$\frac{dx}{dt} = 6t$ o.e.	B1
	$\text{Area} = \left(\int \sin t \sin 2t \times 6t \, dt \right) \int \sin t \times 2 \sin t \cos t \times 6t \, dt$	M1
	$= 12 \int_0^{\frac{\pi}{2}} t \sin^2 t \cos t \, dt$	A1
		(3)
(b)	$= (12) \left[\frac{t}{3} \sin^3 t \right]_0^{\frac{\pi}{2}} - (12) \int_0^{\frac{\pi}{2}} \frac{1}{3} \sin^3 t \, dt$	M1
	$= (12) \left[\frac{t}{3} \sin^3 t \right]_0^{\frac{\pi}{2}} - \left(\frac{12}{3} \right) \int_0^{\frac{\pi}{2}} \sin t (1 - \cos^2 t) \, dt$	M1
	$= \left[4t \sin^3 t + 4 \cos t - \frac{4}{3} \cos^3 t \right]_0^{\frac{\pi}{2}}$	A1
	$= 2\pi - \left(4 - \frac{4}{3} \right)$	M1
	$= 2\pi - \frac{8}{3}$	A1
		(5)
		Total 8

Question Number	Scheme	Marks
3(a)	$x = \frac{t+15}{t+4} \Rightarrow t = \frac{15-4x}{x-1}$ $y = \frac{5}{t+2} \Rightarrow y = \frac{5}{\frac{15-4x}{x-1} + 2}$ $y = \frac{5(x-1)}{15-4x+2(x-1)}$ $g(x) = \frac{5x-5}{13-2x} \quad 1 < x < \frac{15}{4}$	M1 M1 dM1 A1B1 (5)
(b)	$0 < g(x) < \frac{5}{2}$	M1A1 (2) (7 marks)

Question Number	Scheme	Notes	Marks
9(a)	$V = \pi \int y^2 dx = \pi \int y^2 \frac{dx}{d\theta} d\theta$ $= \pi \int (3 \sin \theta - \sin 2\theta)^2 (-5 \sin \theta) d\theta$	Applies $V = \pi \int y^2 \frac{dx}{d\theta} d\theta$ with or without the π	M1
	$= \pi \int (3 \sin \theta - 2 \sin \theta \cos \theta)^2 (-5 \sin \theta) d\theta$	Applies $\sin 2\theta = 2 \sin \theta \cos \theta$	M1
		Fully correct integral in terms of $\sin \theta$ and $\cos \theta$ only (π not needed)	A1
	$= \pi \int \sin^2 \theta (3 - 2 \cos \theta)^2 (-5 \sin \theta) d\theta$ $V = -5\pi \int \sin^3 \theta (3 - 2 \cos \theta)^2 d\theta$ $V = -5\pi \int_{\pi}^0 \sin^3 \theta (3 - 2 \cos \theta)^2 d\theta$ $V = 5\pi \int_0^{\pi} \sin^3 \theta (3 - 2 \cos \theta)^2 d\theta^*$	Completes correctly with correct limits and no incorrect statements previously. The factor of π must be present throughout.	A1*
			(4)
(b)	$u = \cos \theta \Rightarrow V = 5\pi \int \sin^3 \theta (3 - 2u)^2 \frac{du}{-\sin \theta}$	Applies the substitution correctly	M1
	$\theta = 0 \Rightarrow u = 1, \theta = \pi \Rightarrow u = -1$	Attempts to change θ limits to u limits	M1
	$V = -5\pi \int \sin^2 \theta (3 - 2u)^2 du = -5\pi \int (1 - u^2)(3 - 2u)^2 du$ Correct integral in terms of u only		A1
	$(1 - u^2)(3 - 2u)^2 = (1 - u^2)(9 - 12u + 4u^2)$ $= 9 - 12u - 5u^2 + 12u^3 - 4u^4$	Attempt to expand	M1
		Correct expansion	A1
	$V = 5\pi \int_{-1}^1 (9 - 12u - 5u^2 + 12u^3 - 4u^4) du$ $= 5\pi \left[9u - 6u^2 - \frac{5u^3}{3} + 3u^4 - \frac{4u^5}{5} \right]_{-1}^1 = \dots$ Integrates and applies their u limits		M1
	$= \frac{196}{3} \pi$	Cao	A1
			(7)
			Total 11

Question	Scheme	Marks
9(a)	$\frac{dx}{dt} = \sec t \tan t \text{ and } \frac{dy}{dt} = \sqrt{3} \sec^2 \left(t + \frac{\pi}{3} \right)$	B1
	$\left(\frac{dy}{dx} \right) \frac{dy}{dt} \div \frac{dx}{dt} = \frac{\sqrt{3} \sec^2 \left(t + \frac{\pi}{3} \right)}{\sec t \tan t} \text{ oe}$	M1 A1
		(3)

(b)	$t = \frac{\pi}{3} \Rightarrow x = 2, y = -3$	B1
	$t = \frac{\pi}{3} \Rightarrow \frac{dy}{dx} = \frac{\sqrt{3} \sec^2 \frac{2\pi}{3}}{\sec \frac{\pi}{3} \tan \frac{\pi}{3}} = \dots (= 2)$	M1
	Tangent is $y + 3 = 2(x - 2) \Rightarrow y = 2x - 7$ cso	M1A1
		(4)
(c)	$y = \sqrt{3} \frac{\tan t \pm \tan \frac{\pi}{3}}{1 \pm \tan t \tan \frac{\pi}{3}}$	M1
	$x^2 = \sec^2 t = 1 + \tan^2 t \Rightarrow \tan t = \sqrt{x^2 - 1} \Rightarrow y = \sqrt{3} \frac{\sqrt{x^2 - 1} + \sqrt{3}}{1 - \sqrt{3}\sqrt{x^2 - 1}}$	M1 A1
	$= \sqrt{3} \frac{\sqrt{x^2 - 1} + \sqrt{3}}{1 - \sqrt{3}\sqrt{x^2 - 1}} \times \frac{1 + \sqrt{3}\sqrt{x^2 - 1}}{1 + \sqrt{3}\sqrt{x^2 - 1}} = \dots$	
	$= \sqrt{3} \frac{\sqrt{x^2 - 1} + \sqrt{3}(x^2 - 1) + \sqrt{3} + 3\sqrt{x^2 - 1}}{1 - (3x^2 - 3)} = \frac{\dots\sqrt{x^2 - 1} + \dots x^2}{4 - 3x^2}$	M1
	$= \frac{3x^2 + 4\sqrt{3x^2 - 3}}{4 - 3x^2}$	A1
		(5)

Question	Scheme	Marks
5(a)	$y = \frac{2}{t(3-t)} = 1 \Rightarrow 2 = 3t - t^2 \Rightarrow t = \dots$	M1
	$(t^2 - 3t + 2 = (t-1)(t-2) = 0 \Rightarrow) a = 1, b = 2$	A1
		(2)
(b)	Area under curve $= \int_{t=1}^{t=2} y \, dx = \int_1^2 y \frac{dx}{dt} dt = \int_1^2 \frac{2}{t(3-t)} \times (2t+2) dt$	M1 A1
	$t = 1 \Rightarrow x = 3, \quad t = 2 \Rightarrow x = 8$	B1
	So area of R $= 1 \times (8-3) - \int_1^2 \frac{2}{t(3-t)} \times (2t+2) dt$	M1
	$= 5 - 4 \int_1^2 \frac{t+1}{t(3-t)} dt$	A1
		(5)

(c)(i)	$\frac{t+1}{t(3-t)} = \frac{A}{t} + \frac{B}{3-t}$	M1
	$\Rightarrow t+1 = A(3-t) + Bt$	
	E.g. $t=0 \Rightarrow 1=3A \Rightarrow A=\frac{1}{3}$; $t=3 \Rightarrow 4=3B \Rightarrow B=\frac{4}{3}$	M1
	$\frac{t+1}{t(3-t)} = \frac{1}{3t} + \frac{4}{3(3-t)}$	A1
	$\int \frac{t+1}{t(3-t)} dt = \int \frac{1}{3t} + \frac{4}{3(3-t)} dt = \frac{1}{3} \ln t - \frac{4}{3} \ln(3-t)$	M1
	Area = $5 - 4 \left[\frac{1}{3} \ln t - \frac{4}{3} \ln(3-t) \right]_1^2 = 5 - 4 \left(\frac{1}{3} \ln 2 - \frac{4}{3} \ln 1 - \frac{1}{3} \ln 1 + \frac{4}{3} \ln 2 \right)$ $= 5 - 4 \left(\frac{1}{3} \ln 2 + \frac{4}{3} \ln 2 \right)$	dM1
(ii)	$= 5 - \frac{20}{3} \ln 2$	A1
		(6)
	(13 marks)	

Question	Scheme	Marks
7(a)	$\frac{dx}{dt} = \cos t + 6 \cos t \sin t$ $\frac{dy}{dt} = 3 \cos t - 2 \sin t$	B1B1
	$\frac{dy}{dx} = \frac{dy}{dt} \times \frac{dt}{dx} = \frac{3 \cos t - 2 \sin t}{\cos t + 6 \cos t \sin t} = \frac{3 \cos \pi - 2 \sin \pi}{\cos \pi + 6 \cos \pi \sin \pi} = 3$ *	M1A1*
		(4)
(b)	When $t = \pi$, $x = -3$, $y = -2$	B1
	$y - "-2" = 3(x - "-3")$	M1
	$y = 3x + 7$	A1
		(3)
(c)	$y = 3x + 7 \Rightarrow 3 \sin t + 2 \cos t = 3(\sin t - 3 \cos^2 t) + 7$ or $y = 3(x + 3 \cos^2 t) + 2 \cos t \Rightarrow 3x + 7 = 3x + 9 \cos^2 t + 2 \cos t$	M1
	$\Rightarrow 9 \cos^2 t + 2 \cos t - 7 = 0$ *	A1*
		(2)
(d)	$\cos t = \frac{7}{9}$	B1
	$y = 3 \times \frac{\sqrt{32}}{9} + 2 \times \frac{7}{9} = \frac{4\sqrt{2}}{3} + \frac{14}{9}$	M1A1
		(3)
	(12 marks)	

Question Number	Scheme	Marks
6(a)	$4y^2 + 3x = 6ye^{-2x}$	
	$4y^2 + 3x \rightarrow 8y \frac{dy}{dx} + 3$	B1
	$6ye^{-2x} \rightarrow -12ye^{-2x} + 6e^{-2x} \frac{dy}{dx}$	M1 A1
	$8y \frac{dy}{dx} + 3 = -12ye^{-2x} + 6e^{-2x} \frac{dy}{dx} \Rightarrow \frac{dy}{dx} = \frac{12ye^{-2x} + 3}{6e^{-2x} - 8y}$ oe	M1 A1
		(5)
(b)	Sets $x = 0$ in $4y^2 + 3x = 6ye^{-2x} \Rightarrow y = \frac{3}{2}$ oe	B1
	Substitutes $\left(0, \frac{3}{2}\right)$ in their $\frac{dy}{dx} = \frac{12ye^{-2x} + 3}{6e^{-2x} - 8y} = \left(\frac{7}{-2}\right)$	M1
	$m_N = -1 \div \frac{7}{-2} \Rightarrow y = \frac{2}{7}x + \frac{3}{2}$	dM1
	$y = \frac{2}{7}x + \frac{3}{2}$ oe e.g. $y = \frac{6}{21}x + \frac{3}{2}$	A1
		(4)
		(9 marks)

Question Number	Scheme	Marks
5	$4y^2 \rightarrow 8y \frac{dy}{dx}$	M1
	$e^{xy} \rightarrow \left(y + x \frac{dy}{dx}\right)e^{xy}$ or e.g. $e^{xy} \rightarrow ye^{xy} + x \frac{dy}{dx} e^{xy}$	M1
	$2 + 8y \frac{dy}{dx} = 3 \left(y + x \frac{dy}{dx}\right)e^{xy}$	A1
	$2 = 3 \times \frac{9}{2} \times \frac{dy}{dx} \Rightarrow \frac{dy}{dx} = \frac{4}{27}$	M1
	$y = \frac{4}{27} \left(x - \frac{9}{2}\right) \Rightarrow 4x - 27y - 18 = 0$	dM1A1
		(6)
		(6 marks)

Question Number	Scheme	Marks
8 (a)	At $t = \frac{\pi}{4}$ $P = \left(\frac{1}{2}, 2\right)$	B1
	$\frac{dy}{dx} = \frac{dy/dt}{dx/dt} = \frac{2\sec^2 t}{2\sin t \cos t} = 4$ when $t = \frac{\pi}{4}$	M1 A1
	Equation of l : $y - 2 = -\frac{1}{4}\left(x - \frac{1}{2}\right) \Rightarrow 8y - 16 = -2x + 1 \Rightarrow 8y + 2x = 17^*$	dM1 A1 * cso
		(5)
(b)	$\int y \frac{dx}{dt} dt = \int 2 \tan t \times 2 \sin t \cos t dt$	M1
	$= \int 4 \sin^2 t dt$	A1
	$= \int 2 - 2 \cos 2t dt = 2t - \sin 2t$	dM1 A1
	Total area of $S = \left[2t - \sin 2t\right]_0^{\frac{\pi}{4}} + \frac{1}{2} \times 8 \times 2 = \frac{\pi}{2} - 1 + 8 = \frac{\pi}{2} + 7$	M1 A1
		(6)
		(11 marks)

Question Number	Scheme	Marks
1	Attempts to get t in terms of x or y . E.g. $x = \frac{t}{t-3} \Rightarrow t = \frac{3x}{x-1}$ Forms a Cartesian equation and makes progress to making y the subject E.g. $y = \frac{1}{t} + 2 \Rightarrow y = \frac{x-1}{3x} + 2$ $\Rightarrow y = \frac{7x-1}{3x}$	M1 dM1 A1 (3) (3 marks)

Question Number	Scheme	Marks
8(a)	$x = 2$	B1
		(1)
(b)	$(2.5, 1.5)$	B1
		(1)
(c)	$\frac{dy}{dx} = \frac{1 + \frac{1}{t^2}}{1 - \frac{1}{t^2}}$	M1
	$t = 2 \Rightarrow \frac{dy}{dx} = \frac{5}{3} \Rightarrow y - 1.5 = -\frac{3}{5}(x - 2.5)$	dM1
	$3x + 5y = 15^*$	A1*
		(3)

(d)	l crosses x -axis at $x = 5$	B1
	$\frac{1}{3} \pi \times 1.5^2 (5 - 2.5) \left(= \frac{15}{8} \pi \right)$	M1
	$V = \pi \int y^2 dx = \pi \int y^2 \frac{dx}{dt} dt = \pi \int \left(t - \frac{1}{t} \right)^2 \left(1 - \frac{1}{t^2} \right) dt$	M1
	$\pi \int \left(t^2 - 2 + \frac{1}{t^2} \right) \left(1 - \frac{1}{t^2} \right) dt = \pi \int \left(t^2 + \frac{3}{t^2} - \frac{1}{t^4} - 3 \right) dt = \dots$	M1
	$\pi \left[\frac{t^3}{3} - \frac{3}{t} + \frac{1}{3t^3} - 3t \right]$	A1
	$\pi \left[\frac{t^3}{3} - \frac{3}{t} + \frac{1}{3t^3} - 3t \right]_1^2 = \pi \left(\left(\frac{8}{3} - \frac{3}{2} + \frac{1}{24} - 6 \right) - \left(\frac{1}{3} - 3 + \frac{1}{3} - 3 \right) \right)$	M1
	$V = \frac{13}{24} \pi + \frac{15}{8} \pi = \frac{29}{12} \pi$ Cao	A1
		(7)
		Total 12

Question Number	Scheme	Marks
8(a)	$x = 2$	B1
		(1)
(b)	$(2.5, 1.5)$	B1
		(1)
(c)	$\frac{dy}{dx} = \frac{1 + \frac{1}{t^2}}{1 - \frac{1}{t^2}}$	M1
	$t = 2 \Rightarrow \frac{dy}{dx} = \frac{5}{3} \Rightarrow y - 1.5 = -\frac{3}{5}(x - 2.5)$	dM1
	$3x + 5y = 15^*$	A1*
		(3)

(d)	l crosses x -axis at $x = 5$	B1
	$\frac{1}{3} \pi \times 1.5^2 (5 - 2.5) \left(= \frac{15}{8} \pi \right)$	M1
	$V = \pi \int y^2 dx = \pi \int y^2 \frac{dx}{dt} dt = \pi \int \left(t - \frac{1}{t} \right)^2 \left(1 - \frac{1}{t^2} \right) dt$	M1
	$\pi \int \left(t^2 - 2 + \frac{1}{t^2} \right) \left(1 - \frac{1}{t^2} \right) dt = \pi \int \left(t^2 + \frac{3}{t^2} - \frac{1}{t^4} - 3 \right) dt = \dots$	M1
	$\pi \left[\frac{t^3}{3} - \frac{3}{t} + \frac{1}{3t^3} - 3t \right]$	A1
	$\pi \left[\frac{t^3}{3} - \frac{3}{t} + \frac{1}{3t^3} - 3t \right]_1^2 = \pi \left(\left(\frac{8}{3} - \frac{3}{2} + \frac{1}{24} - 6 \right) - \left(\frac{1}{3} - 3 + \frac{1}{3} - 3 \right) \right)$	M1
	$V = \frac{13}{24} \pi + \frac{15}{8} \pi = \frac{29}{12} \pi$ Cao	A1
		(7)
		Total 12

Question Number	Scheme	Marks
4(a)	$k = 2$ or $x > 2$	B1
	$t = \frac{1}{x-2} \Rightarrow y = \frac{1 - \frac{2}{x-2}}{3 + \frac{1}{x-2}}$	M1 A1
	$\frac{1 - \frac{2}{x-2}}{3 + \frac{1}{x-2}} = \frac{x-2-2}{\dots}$ or $\frac{\dots}{3(x-2)+1}$	A1 (M1 on EPEN)
	$y = \frac{x-4}{3x-5}$	A1
		(5)
(b)	$-2 < g < \frac{1}{3}$	M1 A1
		(2)
		(7 marks)

Question Number	Scheme	Marks
5 (a)	$\frac{dy}{dx} = \frac{dy}{dx} \frac{dt}{dt} = \frac{16 \sec^2 t \tan t}{2 \sec^2 t} = 8 \tan t$	M1 A1
	At $x = 3$, $\tan t = -1 \Rightarrow$ Gradient $= -8$	dM1 A1 (4)
(b)	Attempts to use $1 + \tan^2 t = \sec^2 t \Rightarrow 1 + \frac{(x-5)^2}{4} = \frac{y}{8}$	M1 A1
	$y = 2(x-5)^2 + 8$	A1 (3)
(c)	8,, f,, 32	M1 A1
		(2) (9 marks)

Question Number	Scheme	Marks
6 (a)	For correct parameter $t = \frac{\pi}{4}$ or x coordinate at P $x = 4$	B1
	$\frac{dy}{dx} = \frac{dy}{dx} \frac{dt}{dt} = \frac{-4 \sin 2t}{3 \sec^2 t}$	M1 A1
	Equation of tangent $y - 0 = -\frac{2}{3}(x - 4) \Rightarrow y = -\frac{2}{3}x + \frac{8}{3}$	dM1 A1 (5)
		(1)
(b)	$k = 1 - \sqrt{3}$	B1 (1)
(c)	-1,, f,, 2	M1 A1
		(2) (8 marks)

Question Number	Scheme	Marks
8(a)	3π	B1
		(1)
(b)	$\frac{dy}{dx} = \frac{-2 \sin t}{6 - 6 \cos 2t}$	M1 A1
	$= \frac{-2 \sin t}{6 - 6(1 - 2 \sin^2 t)} = \frac{-2 \sin t}{12 \sin^2 t} = -\frac{1}{6} \operatorname{cosec} t$	M1 A1*
		(4)
(c)	$P = \left(\frac{3\pi}{2} - 3, \sqrt{2} \right)$	B1
	E.g. $y - \sqrt{2} = -\frac{\sqrt{2}}{6} \left(0 - \left(\frac{3\pi}{2} - 3 \right) \right) \Rightarrow y = \dots$ or $\sqrt{2} = -\frac{\sqrt{2}}{6} \left(\frac{3\pi}{2} - 3 \right) + c \Rightarrow c = \dots$	M1
	$\frac{\pi\sqrt{2}}{4} + \frac{\sqrt{2}}{2} \text{ o.e}$	A1
		(3)

(d)(i)	Attempts $y^2 \frac{dx}{dt} = 4 \cos^2 t (6 - 6 \cos 2t)$	M1 A1
	$= (2 \cos 2t + 2)(6 - 6 \cos 2t) = 6(2 - 2 \cos^2 2t) = 6(2 - (1 + \cos 4t))$	dM1
	Volume $= \int_0^{\frac{\pi}{2}} \pi y^2 \frac{dx}{dt} dt = \int_0^{\frac{\pi}{2}} 6\pi(1 - \cos 4t) dt$	A1
(ii)	$\left[6\pi t - \frac{6\pi \sin 4t}{4} \right]_0^{\frac{\pi}{2}}, = 3\pi^2$	M1, A1
		(6)
		(14 marks)

Question Number	Scheme	Notes	Marks
2(a)	$\frac{x}{y} = t$	Cao	B1
			(1)
(b)	$y = \frac{\left(\frac{x}{y}\right)^3}{2\left(\frac{x}{y}\right)+1}$ or $x = \frac{\left(\frac{x}{y}\right)^4}{2\left(\frac{x}{y}\right)+1}$	Uses the y coordinate to obtain y in terms of x and y or uses the x coordinate to obtain x in terms of y and x	M1
	$y = \frac{x^3}{2xy^2+y^3} \Rightarrow y(2xy^2+y^3) = x^3$ or $x = \frac{x^4}{2xy^3+y^4} \Rightarrow x(2xy^3+y^4) = x^4$	Uses correct algebra to eliminate the fractions	M1
	$x^3 - 2xy^3 - y^4 = 0^*$	Cso	A1*
			(3)
			Total 4

Question Number	Scheme	Marks
2 (a)	E.g. $x = \frac{t-1}{2t+1} \Rightarrow t = \frac{x+1}{1-2x}$ or $y = \frac{6}{2t+1} \Rightarrow t = \frac{6-y}{2y}$	M1
	E.g. $y = \frac{6}{2t+1} \Rightarrow y = \frac{6}{2 \times \left(\frac{x+1}{1-2x}\right)+1}$ or $t = \frac{6-y}{2y} \Rightarrow x = \frac{\frac{6-y}{2y}-1}{2 \times \frac{6-y}{2y}+1}$	A1
	E.g. $y = \frac{6}{2 \times \left(\frac{x+1}{1-2x}\right)+1} \Rightarrow y = \frac{6(1-2x)}{2 \times (x+1)+1(1-2x)} = ax+b$	dM1
	E.g. $y = \frac{6(1-2x)}{3}, y = 2(1-2x)$ oe so linear *	A1*
		(4)
(b)	$y = 2(1-2x)$ and $y = x+12 \Rightarrow 2(1-2x) = x+12 \Rightarrow x = \dots$	M1
	$x = -2$	A1cao
		(2)

Question Number	Scheme	Marks
3(a)	$x = \frac{t+15}{t+4} \Rightarrow t = \frac{15-4x}{x-1}$ $y = \frac{5}{t+2} \Rightarrow y = \frac{5}{\frac{15-4x}{x-1} + 2}$ $y = \frac{5(x-1)}{15-4x+2(x-1)}$ $g(x) = \frac{5x-5}{13-2x} \quad 1 < x < \frac{15}{4}$	M1 M1 dM1 A1B1 (5)
(b)	$0 < g(x) < \frac{5}{2}$	M1A1 (2) (7 marks)

Question Number	Scheme	Marks
5	$4y^2 \rightarrow 8y \frac{dy}{dx}$	M1
	$e^{xy} \rightarrow \left(y + x \frac{dy}{dx}\right) e^{xy} \text{ or e.g. } e^{xy} \rightarrow ye^{xy} + x \frac{dy}{dx} e^{xy}$	M1
	$2 + 8y \frac{dy}{dx} = 3 \left(y + x \frac{dy}{dx}\right) e^{xy}$	A1
	$2 = 3 \times \frac{9}{2} \times \frac{dy}{dx} \Rightarrow \frac{dy}{dx} = \frac{4}{27}$	M1
	$y = \frac{4}{27} \left(x - \frac{9}{2}\right) \Rightarrow 4x - 27y - 18 = 0$	dM1A1
		(6)
		(6 marks)

Question	Scheme	Marks
9(a)	$\frac{dx}{dt} = \sec t \tan t \text{ and } \frac{dy}{dt} = \sqrt{3} \sec^2 \left(t + \frac{\pi}{3}\right)$	B1
	$\left(\frac{dy}{dx} = \right) \frac{dy}{dt} \div \frac{dx}{dt} = \frac{\sqrt{3} \sec^2 \left(t + \frac{\pi}{3}\right)}{\sec t \tan t} \text{ oe}$	M1 A1
		(3)

(b)	$t = \frac{\pi}{3} \Rightarrow x = 2, y = -3$	B1
	$t = \frac{\pi}{3} \Rightarrow \frac{dy}{dx} = \frac{\sqrt{3} \sec^2 \frac{2\pi}{3}}{\sec \frac{\pi}{3} \tan \frac{\pi}{3}} = \dots (=2)$	M1
	Tangent is $y + 3 = 2(x - 2) \Rightarrow y = 2x - 7$ cso	M1A1
		(4)
(c)	$y = \sqrt{3} \frac{\tan t \pm \tan \frac{\pi}{3}}{1 \pm \tan t \tan \frac{\pi}{3}}$	M1
	$x^2 = \sec^2 t = 1 + \tan^2 t \Rightarrow \tan t = \sqrt{x^2 - 1} \Rightarrow y = \sqrt{3} \frac{\sqrt{x^2 - 1} + \sqrt{3}}{1 - \sqrt{3}\sqrt{x^2 - 1}}$	M1 A1
	$= \sqrt{3} \frac{\sqrt{x^2 - 1} + \sqrt{3}}{1 - \sqrt{3}\sqrt{x^2 - 1}} \times \frac{1 + \sqrt{3}\sqrt{x^2 - 1}}{1 + \sqrt{3}\sqrt{x^2 - 1}} = \dots$	
	$= \sqrt{3} \frac{\sqrt{x^2 - 1} + \sqrt{3}(x^2 - 1) + \sqrt{3} + 3\sqrt{x^2 - 1}}{1 - (3x^2 - 3)} = \frac{\dots\sqrt{x^2 - 1} + \dots x^2}{4 - 3x^2}$	M1
	$= \frac{3x^2 + 4\sqrt{3x^2 - 3}}{4 - 3x^2}$	A1
		(5)

Question Number	Scheme	Marks
6 (a)(i)	Area $R = \int y \frac{dx}{dt} dt = \int 4 \sin t \times -4 \sin 2t dt$	M1 A1
	$= - \int 32 \sin^2 t \cos t dt$	dM1
	$x = 0 \Rightarrow t = \frac{\pi}{4}$ and $y = 0 \Rightarrow t = 0 \Rightarrow$ Area $= - \int_{\frac{\pi}{4}}^0 32 \sin^2 t \cos t dt = \int_0^{\frac{\pi}{4}} 32 \sin^2 t \cos t dt$ *	A1*
		(4)
(ii)	Area $= \left[\frac{32}{3} \sin^3 t \right]_0^{\frac{\pi}{4}} = \frac{32}{3} \times \frac{2\sqrt{2}}{8} = \frac{8\sqrt{2}}{3}$	M1 A1
		(2)
(b)	Attempts to use $\cos 2t = 1 - 2 \sin^2 t \Rightarrow \frac{x}{2} = 1 - 2 \left(\frac{y}{4} \right)^2$ $y = \sqrt{8 - 4x}$	M1A1 A1
		(3)
(c)	Range is $0 \leq f \leq 4$	B1
		(1)
		(10 marks)

Question Number	Scheme	Marks
5(a)	$\frac{dx}{dt} = \frac{2(1-t) - (-1)(3+2t)}{(1-t)^2} = \frac{5}{(1-t)^2} \quad \text{and} \quad \frac{dy}{dt} = -2t$ $\text{At } t=2 \Rightarrow \frac{dy}{dx} = \frac{(-1)^2}{5} \times (-2(2)) = -\frac{4}{5}$ $(-7, -3)$ $y+3 = \frac{5}{4}(x+7)$ $5x-4y+23=0$	M1A1 B1 M1 A1
		(5)
(b)	$x = \frac{3+2t}{1-t} \rightarrow t = \frac{x-3}{x+2}$ $y = 1 - \left(\frac{x-3}{x+2} \right)^2 = \frac{(x+2)^2 - (x-3)^2}{(x+2)^2} = \frac{10x-5}{(x+2)^2}$ $x \neq -2$	M1 dM1A1 B1
		(4)
		(9 marks)

Question Number	Scheme	Marks
8(a)	A and B are where $y = 0$ so $t^3 - 9t = 0 \Rightarrow t(t^2 - 9) = 0 \Rightarrow t = 3$ (0 and -3) Substitutes $t = 3$ in $x = 3^2 + 2 \times 3 = 15$ B(15, 0) $A = (3, 0)$	M1 A1* B1 (3)
8(a) ALT	Uses answer $x = 15$: $t^2 + 2t = 15 \Rightarrow t = 3$ (-5) Substitutes $t = 3$ in $y = t^3 - 9t = 27 - 27 = 0$ ✓ B(15, 0) $A = (3, 0)$	M1 A1* B1 (3)
(b)	$\frac{dy}{dx} = \frac{dy/dt}{dx/dt} = \frac{3t^2 - 9}{2t + 2}$ Substitutes $t = 3$ into $\frac{dy}{dx} = \frac{3t^2 - 9}{2t + 2} \Rightarrow \frac{dy}{dx} = \frac{9}{4}$ Uses their $\frac{9}{4}$ with (15, 0) to produce tangent equation $9x - 4y - 135 = 0$	M1 A1 dM1 A1 (4)
(c)	Substitutes $x = t^2 + 2t$, $y = t^3 - 9t$, into their $9x - 4y - 135 = 0$ $\Rightarrow 9(t^2 + 2t) - 4(t^3 - 9t) - 135 = 0$ $\Rightarrow 4t^3 - 9t^2 - 54t + 135 = 0$ $\Rightarrow (t^2 - 6t + 9)(4t + 15) = 0$ $t = -\frac{15}{4}$ Coordinates of X are $\left(\frac{105}{16}, -\frac{1215}{64}\right)$	M1 dM1 A1 dM1A1 (5) (12 marks)

Question Number	Scheme	Marks
6(a)	$\frac{dy}{dx} = 6 \cos t \times \frac{1}{-8 \sin t} = k \frac{\cos t}{\sin t}$	M1
	$\frac{dy}{dx} = -\frac{3}{4} \cot\left(\frac{\pi}{3}\right) = -\frac{\sqrt{3}}{4}$	dM1A1
		(3)
Mark (a) and (b) together.		

(b)	$(6, 3\sqrt{3}-3)$	B1B1
	$-\frac{\sqrt{3}}{4} \rightarrow \frac{4}{\sqrt{3}}$	B1ft
	$y-3\sqrt{3}+3 = \frac{4}{\sqrt{3}}(x-6)$ or $y = \frac{4}{\sqrt{3}}x + c \Rightarrow -3\sqrt{3}+3 = \frac{4}{\sqrt{3}} \times 6 + c \Rightarrow c = (-3-5\sqrt{3})$	M1
	When $y=0$ $-3\sqrt{3}+3 = \frac{4}{\sqrt{3}}(x-6) \Rightarrow x = \dots$	dM1
	$\left(\frac{15+3\sqrt{3}}{4}, 0\right)$	A1
(h)		(6)

(c)	$x = 8\cos t + 2 \Rightarrow \cos t = \frac{x-2}{8} \quad y = 6\sin t - 3 \Rightarrow \sin t = \frac{y+3}{6}$	M1
	$\frac{(x-2)^2}{64} + \frac{(y+3)^2}{36} = 1$	A1
		(2)
		(11 marks)

Question	Scheme	Marks
5(a)	$y = \frac{2}{t(3-t)} = 1 \Rightarrow 2 = 3t - t^2 \Rightarrow t = \dots$	M1
	$(t^2 - 3t + 2 = (t-1)(t-2) = 0 \Rightarrow) a=1, b=2$	A1
		(2)
(b)	Area under curve $= \int_{t=1}^{t=2} y \, dx = \int_1^2 y \frac{dx}{dt} dt = \int_1^2 \frac{2}{t(3-t)} \times (2t+2) dt$	M1 A1
	$t=1 \Rightarrow x=3, \quad t=2 \Rightarrow x=8$	B1
	So area of R $= 1 \times (8-3) - \int_1^2 \frac{2}{t(3-t)} \times (2t+2) dt$	M1
	$= 5 - 4 \int_1^2 \frac{t+1}{t(3-t)} dt$	A1
		(5)

(c)(i)	$\frac{t+1}{t(3-t)} = \frac{A}{t} + \frac{B}{3-t}$	M1
	$\Rightarrow t+1 = A(3-t) + Bt$	
	E.g. $t=0 \Rightarrow 1=3A \Rightarrow A=\frac{1}{3}$; $t=3 \Rightarrow 4=3B \Rightarrow B=\frac{4}{3}$	M1
(ii)	$\frac{t+1}{t(3-t)} = \frac{1}{3t} + \frac{4}{3(3-t)}$	A1
	$\int \frac{t+1}{t(3-t)} dt = \int \frac{1}{3t} + \frac{4}{3(3-t)} dt = \frac{1}{3} \ln t - \frac{4}{3} \ln(3-t)$	M1
	Area = $5 - 4 \left[\frac{1}{3} \ln t - \frac{4}{3} \ln(3-t) \right]_1^2 = 5 - 4 \left(\frac{1}{3} \ln 2 - \frac{4}{3} \ln 1 - \frac{1}{3} \ln 1 + \frac{4}{3} \ln 2 \right)$	dM1
	$= 5 - 4 \left(\frac{1}{3} \ln 2 + \frac{4}{3} \ln 2 \right)$	
	$= 5 - \frac{20}{3} \ln 2$	A1
		(6)
(13 marks)		

Question Number	Scheme	Marks
3 (a)	$x = \frac{t+15}{t+4} \Rightarrow t = \frac{15-4x}{x-1}$	M1
	$y = \frac{5}{t+2} \Rightarrow y = \frac{5}{\frac{15-4x}{x-1} + 2}$	M1
	$y = \frac{5(x-1)}{15-4x+2(x-1)}$	dM1
	$g(x) = \frac{5x-5}{13-2x} \quad 1 < x < \frac{15}{4}$	A1B1
		(5)
(b)	$0 < g(x) < \frac{5}{2}$	M1A1
		(2)
(7 marks)		

Question Number	Scheme	Marks
4(a)	A and B are where $t^3 - 4t = 0 \Rightarrow t(t^2 - 4) = 0 \Rightarrow t = 2$ or -2 Substitutes $t = 2, x = 2 \times 4 - 6 \times 2 = -4$ Hence $A = (-4, 0)$ When $t = -2, x = 2 \times 4 - 6 \times -2 = 20, (y = 0)$ Hence $B = (20, 0)$ *	M1 A1 B1* (3)
(b)	$\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}} = \frac{3t^2 - 4}{4t - 6}$ Sub $t = -2$ into $\frac{dy}{dx} = \frac{3t^2 - 4}{4t - 6} \Rightarrow \text{gradient} = \left(-\frac{4}{7}\right)$ Uses their $\left(-\frac{4}{7}\right)$ and $(20, 0)$ to produce eqn of tangent $\Rightarrow 7y + 4x - 80 = 0$ *	M1A1 M1 M1 A1* (5)
(c)	Substitutes $x = 2t^2 - 6t, y = t^3 - 4t$, into $7y + 4x - 80 = 0$ $\Rightarrow 7(t^3 - 4t) + 4(2t^2 - 6t) - 80 = 0$ $\Rightarrow 7t^3 + 8t^2 - 52t - 80 = 0$ $\Rightarrow (t + 2)^2 (7t - 20) = 0$ $t = -\frac{20}{7} \Rightarrow x = \dots$ $x = -\frac{40}{49}$	M1 A1 dM1 A1 (4) (12 marks)

Question Number	Scheme	Marks
9(a)	$\tan \theta = \sqrt{3} \Rightarrow k = \frac{\pi}{3} \text{ (or } 60^\circ \text{)} \text{ (Allow } x = \sqrt{3} \Rightarrow \theta = \frac{\pi}{3} \text{ (or } 60^\circ \text{))}$	B1
	$V = (\pi) \int y^2 dx = (\pi) \int (2 \sin 2\theta)^2 \sec^2 \theta d\theta \text{ oe}$	M1A1
	$4(\pi) \int \sin^2 2\theta \sec^2 \theta d\theta = 4(\pi) \int 4 \sin^2 \theta \cancel{\cos^2 \theta} \times \frac{1}{\cancel{\cos^2 \theta}} d\theta$	dM1
	$= 16(\pi) \int \sin^2 \theta d\theta \text{ oe e.g. } 16(\pi) \int (1 - \cos^2 \theta) d\theta$	A1
	$\sin^2 \theta = \frac{1 - \cos 2\theta}{2} \Rightarrow 16(\pi) \int \sin^2 \theta d\theta = 16(\pi) \int \frac{1 - \cos 2\theta}{2} d\theta$	dM1
	$\text{Volume} = \int_0^{\frac{\pi}{3}} 8\pi (1 - \cos 2\theta) d\theta$	A1 Cso
		(7)
(b)	$\int (1 - \cos 2\theta) d\theta \rightarrow \theta - \frac{\sin 2\theta}{2}$	B1
	$\text{Volume} = \int_0^{\frac{\pi}{3}} 8\pi (1 - \cos 2\theta) d\theta = [8\pi\theta - 4\pi \sin 2\theta]_0^{\frac{\pi}{3}} = \frac{8}{3}\pi^2 - 2\sqrt{3}\pi$	M1 A1
		(3)
		(10 marks)

Question Number	Scheme	Marks
5(a)	$\frac{dx}{dt} = \frac{2(1-t) - (-1)(3+2t)}{(1-t)^2} = \frac{5}{(1-t)^2} \text{ and } \frac{dy}{dt} = -2t$	M1A1 B1 M1 A1
	$\text{At } t=2 \Rightarrow \frac{dy}{dx} = \frac{(-1)^2}{5} \times (-2(2)) = -\frac{4}{5}$	
	$(-7, -3)$ $y+3 = \frac{5}{4}(x+7)$	
	$5x - 4y + 23 = 0$	
		(5)
(b)	$x = \frac{3+2t}{1-t} \rightarrow t = \frac{x-3}{x+2}$	M1
	$y = 1 - \left(\frac{x-3}{x+2}\right)^2 = \frac{(x+2)^2 - (x-3)^2}{(x+2)^2} = \frac{10x-5}{(x+2)^2}$	dM1A1
	$x \neq -2$	B1
		(4)
		(9 marks)

Question	Scheme	Marks
5(a)	$\frac{dx}{dt} = \frac{1}{2}(9-4t)^{-\frac{1}{2}} \times -4 = \left(\frac{-2}{\sqrt{9-4t}} \right)$	M1
	$A = \int_{(x=0)}^{(x=3)} y \frac{dx}{dt} (dt) = \int_{(t=\frac{9}{4})}^{(t=0)} \frac{t^3}{\sqrt{9+4t}} \times \frac{-2}{\sqrt{9-4t}} (dt)$	M1
	$= -2 \int_{(\frac{9}{4})}^{(0)} \frac{t^3}{\sqrt{81-16t^2}} (dt) \text{ or e.g. } -2 \int_{(\frac{9}{4})}^{(0)} \frac{t^3}{\sqrt{(9-4t)(9+4t)}} (dt)$ Depends on both previous M marks.	ddM1
	$= 2 \int_0^{\frac{9}{4}} \frac{t^3}{\sqrt{81-16t^2}} dt$	A1
		(4)
(b)	$\frac{du}{dt} = -32t \text{ or } du = -32t dt \text{ oe}$ or $u = 81 - 16t^2 \Rightarrow t^2 = \frac{1}{16}(81-u) \Rightarrow t = \frac{1}{4}(81-u)^{\frac{1}{2}} \Rightarrow \frac{dt}{du} = -\frac{1}{8}(81-u)^{-\frac{1}{2}}$	B1
	$A = 2 \int_0^{\frac{9}{4}} \frac{t^2}{\sqrt{81-16t^2}} t dt = 2 \int_{(81)}^{(0)} \frac{(81-u)}{16\sqrt{u}} \frac{du}{-32}$ or $A = 2 \int_0^{\frac{9}{4}} \frac{t^2}{\sqrt{81-16t^2}} t dt = 2 \int_{(81)}^{(0)} \frac{\left(\frac{1}{4}(81-u)^{\frac{1}{2}}\right)^3}{\sqrt{u}} \times -\frac{1}{8}(81-u)^{-\frac{1}{2}} du$	M1
	$= k \int_{(81)}^{(0)} 81u^{\frac{1}{2}} - u^{\frac{1}{2}} du$	A1ft
	$= K \left[\frac{81u^{\frac{1}{2}}}{\frac{1}{2}} - \frac{u^{\frac{3}{2}}}{\frac{3}{2}} \right]_{(81)}^{(0)}$	M1
	$= -\frac{1}{256} \left(0 - \left(162\sqrt{81} - \frac{2}{3}\sqrt{81^3} \right) \right) = \dots$ Depends on all previous M marks.	ddM1
	$= \frac{243}{64}$	A1
		(6)
(10 marks)		

Question	Scheme	Marks
3(a)	$x = 3 + 2 \sin t \quad y = \frac{6}{7 + \cos 2t} \quad -\frac{\pi}{2} \leq t \leq \frac{\pi}{2}$	
	$y = \frac{6}{7 + 1 - 2 \sin^2 t}$	M1
	$\sin t = \frac{x-3}{2} \Rightarrow y = \frac{6}{8 - 2\left(\frac{x-3}{2}\right)^2}$	M1A1
	$\Rightarrow y = \frac{12}{16 - (x-3)^2} = \frac{12}{(4-x+3)(4+x-3)} = \frac{12}{(7-x)(1+x)}^*$	M1A1*
	$\left(t = -\frac{\pi}{2} \Rightarrow x = 1, t = \frac{\pi}{2} \Rightarrow x = 5 \text{ so}\right) \quad p = 1 \text{ and } q = 5$	B1
		(6)
(a) Way 2	$y = \frac{6}{7 + 1 - 2 \sin^2 t}$	M1
	$y = \frac{12}{16 - 4 \sin^2 t} = \frac{12}{(4 + 2 \sin t)(4 - 2 \sin t)}$	M1A1
	$= \frac{12}{(4 + x - 3)(4 - (x - 3))} = \frac{12}{(7 - x)(1 + x)}^*$	M1A1*
	$\left(t = -\frac{\pi}{2} \Rightarrow x = 1, t = \frac{\pi}{2} \Rightarrow x = 5 \text{ so}\right) \quad p = 1 \text{ and } q = 5$	B1
(a) Way 3	$y = \frac{12}{(7 - x)(1 + x)} = \frac{12}{(4 - 2 \sin t)(4 + 2 \sin t)}$	M1
	$= \frac{12}{16 - 4 \sin^2 t}$	M1A1
	$= \frac{12}{16 - 4\left(\frac{1 - \cos 2t}{2}\right)}$	M1
	$= \frac{12}{16 - 2 + 2 \cos 2t} = \frac{12}{14 + 2 \cos 2t} = \frac{6}{7 + \cos 2t} = y^*$	A1*
	$\left(t = -\frac{\pi}{2} \Rightarrow x = 1, t = \frac{\pi}{2} \Rightarrow x = 5 \text{ so}\right) \quad p = 1 \text{ and } q = 5$	B1

(a) Way 4	$y = \frac{6}{7 + \cos 2t} \Rightarrow \cos 2t = \frac{6}{y} - 7 \Rightarrow 1 - 2\sin^2 t = \frac{6}{y} - 7$	M1
	$\sin t = \frac{x-3}{2} \Rightarrow \frac{6}{y} - 7 = 1 - 2\left(\frac{x-3}{2}\right)^2$	M1A1
	$\Rightarrow \frac{12}{y} = -x^2 + 6x + 7 \Rightarrow y = \frac{12}{-x^2 + 6x + 7} = \frac{12}{(7-x)(1+x)}^*$	M1A1*
	$\left(t = -\frac{\pi}{2} \Rightarrow x = 1, t = \frac{\pi}{2} \Rightarrow x = 5 \text{ so } \right) p = 1 \text{ and } q = 5$	B1
(b)	$\frac{12}{(7-x)(1+x)} = \frac{A}{7-x} + \frac{B}{1+x} \Rightarrow 12 = A(x+1) + B(7-x) \Rightarrow A = \dots, B = \dots$	M1
	So $(y) = \frac{3}{2(x+1)} - \frac{3}{2(x-7)}$ oe	A1A1
		(3)
(9 marks)		

Question Number	Scheme	Marks
10(a)	$\frac{dx}{dt} = 6t$ o.e.	B1
	$\text{Area} = \left(\int \sin t \sin 2t \times 6t \, dt = \right) \int \sin t \times 2 \sin t \cos t \times 6t \, dt$	M1
	$= 12 \int_0^{\frac{\pi}{2}} t \sin^2 t \cos t \, dt$	A1
		(3)
(b)	$= (12) \left[\frac{t}{3} \sin^3 t \right]_0^{\frac{\pi}{2}} - (12) \int_0^{\frac{\pi}{2}} \frac{1}{3} \sin^3 t \, dt$	M1
	$= (12) \left[\frac{t}{3} \sin^3 t \right]_0^{\frac{\pi}{2}} - \left(\frac{12}{3} \right) \int_0^{\frac{\pi}{2}} \sin t (1 - \cos^2 t) \, dt$	M1
	$= \left[4t \sin^3 t + 4 \cos t - \frac{4}{3} \cos^3 t \right]_0^{\frac{\pi}{2}}$	A1
	$= 2\pi - \left(4 - \frac{4}{3} \right)$	M1
	$= 2\pi - \frac{8}{3}$	A1
		(5)
		Total 8

Question Number	Scheme	Marks
3 (a)	$x = \frac{t+15}{t+4} \Rightarrow t = \frac{15-4x}{x-1}$ $y = \frac{5}{t+2} \Rightarrow y = \frac{5}{\frac{15-4x}{x-1} + 2}$ $y = \frac{5(x-1)}{15-4x+2(x-1)}$ $g(x) = \frac{5x-5}{13-2x} \quad 1 < x < \frac{15}{4}$	M1 M1 dM1 A1B1 (5)
(b)	$0 < g(x) < \frac{5}{2}$	M1A1 (2) (7 marks)

Question Number	Scheme	Marks
8 (a)	At $t = \frac{\pi}{4}$ $P = \left(\frac{1}{2}, 2\right)$	B1
	$\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}} = \frac{2\sec^2 t}{2\sin t \cos t} = 4$ when $t = \frac{\pi}{4}$	M1 A1
	Equation of l : $y-2 = -\frac{1}{4}\left(x-\frac{1}{2}\right) \Rightarrow 8y-16 = -2x+1 \Rightarrow 8y+2x=17^*$	dM1 A1 * cso
		(5)
(b)	$\int y \frac{dx}{dt} dt = \int 2 \tan t \times 2 \sin t \cos t dt$	M1
	$= \int 4 \sin^2 t dt$	A1
	$= \int 2 - 2 \cos 2t dt = 2t - \sin 2t$	dM1 A1
	Total area of $S = \left[2t - \sin 2t\right]_0^{\frac{\pi}{4}} + \frac{1}{2} \times 8 \times 2 = \frac{\pi}{2} - 1 + 8 = \frac{\pi}{2} + 7$	M1 A1
		(6)
		(11 marks)