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

Question Number	Scheme	Marks
6(a)	$\dfrac{dy}{dx}=6\cos t\times\dfrac{1}{-8\sin t}=k\dfrac{\cos t}{\sin t}$	M1
	$\dfrac{dy}{dx}=-\dfrac{3}{4}\cot\left(\dfrac{\pi}{3}\right)=-\dfrac{\sqrt{3}}{4}$	**d**M1A1
		(3)
Mark (a) and (b) together.		

(b)	$\left(6,\,3\sqrt{3}-3\right)$	B1B1
	$-\dfrac{\sqrt{3}}{4}\rightarrow\dfrac{4}{\sqrt{3}}$	B1ft
	$y-3\sqrt{3}+3=\dfrac{4}{\sqrt{3}}(x-6)$ or $y=\dfrac{4}{\sqrt{3}}x+c\Rightarrow-3\sqrt{3}+3=\dfrac{4}{\sqrt{3}}\times6+c\Rightarrow c=\left(-3-5\sqrt{3}\right)$	M1
	When $y=0\ \ -3\sqrt{3}+3=\dfrac{4}{\sqrt{3}}(x-6)\Rightarrow x=\ldots$	**d**M1
	$\left(\dfrac{15+3\sqrt{3}}{4},\,0\right)$	A1
		(6)
(b)		

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

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	M1
	Substitutes $t=2, x=2\times4-6\times2=-4$ Hence $A=(-4,0)$	A1
	When $t=-2, x=2\times4-6\times-2=20, (y=0)$ Hence $B=(20,0)$ *	B1*
		(3)
(b)	$\dfrac{dy}{dx}=\dfrac{dy/dt}{dx/dt}=\dfrac{3t^2-4}{4t-6}$	M1A1
	Sub $t=-2$ into $\dfrac{dy}{dx}=\dfrac{3t^2-4}{4t-6} \Rightarrow$ gradient $=\left(-\dfrac{4}{7}\right)$	M1
	Uses their $\left(-\dfrac{4}{7}\right)$ and $(20,0)$ to produce eqn of tangent $\Rightarrow 7y+4x-80=0$ *	M1 A1*
		(5)
(c)	Substitutes $x=2t^2-6t$, $y=t^3-4t$, into $7y+4x-80=0$	
	$\Rightarrow 7\left(t^3-4t\right)+4\left(2t^2-6t\right)-80=0$	M1
	$\Rightarrow 7t^3+8t^2-52t-80=0$	A1
	$\Rightarrow (t+2)^2(7t-20)=0$	
	$t=\text{"}\dfrac{20}{7}\text{"} \Rightarrow x=....$	dM1
	$x=-\dfrac{40}{49}$	A1
		(4)
		(12 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
	$A=\int_{(x=0)}^{(x=3)} y\frac{dx}{dt}(dt)=\int_{\left(t=\frac{9}{4}\right)}^{(t=0)}\frac{t^3}{\sqrt{9+4t}}\times "\frac{-2}{\sqrt{9-4t}}"(dt)$	M1
	$=-2\int_{\left(\frac{9}{4}\right)}^{(0)}\frac{t^3}{\sqrt{81-16t^2}}(dt)$ or e.g. $-2\int_{\left(\frac{9}{4}\right)}^{(0)}\frac{t^3}{\sqrt{(9-4t)(9+4t)}}(dt)$ **Depends on both previous M marks.**	ddM1
	$=2\int_0^{\frac{9}{4}}\frac{t^3}{\sqrt{81-16t^2}}dt$	A1
		(4)
(b)	$\frac{du}{dt}=-32t$ or $du=-32t\,dt$ 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
	$A=2\int_0^{\frac{9}{4}}\frac{t^2}{\sqrt{81-16t^2}}tdt=2\int_{(81)}^{(0)}\frac{(81-u)}{16\sqrt{u}}\frac{du}{-32}$ or $A=2\int_0^{\frac{9}{4}}\frac{t^2}{\sqrt{81-16t^2}}tdt=2\int_{(81)}^{(0)}\frac{\left(\frac{1}{4}(81-u)^{\frac{1}{2}}\right)^3}{\sqrt{u}}\times-\frac{1}{8}(81-u)^{-\frac{1}{2}}du$	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
	$=-\frac{1}{256}\left(0-\left(162\sqrt{81}-\frac{2}{3}\sqrt{81}^3\right)\right)=\ldots$ **Depends on all previous M marks.**	ddM1
	$=\frac{243}{64}$	A1
		(6)
		(10 marks)

Question	Scheme	Marks
5(a)	$y=\dfrac{2}{t(3-t)}=1\Rightarrow 2=3t-t^2\Rightarrow t=\ldots$	M1
	$\left(t^2-3t+2=\left(t-1\right)\left(t-2\right)=0\Rightarrow\right)a=1,b=2$	A1
		(2)
(b)	Area under curve $=\displaystyle\int_{t="1"}^{t="2"} y\,\mathrm{d}x=\int_1^2 y\frac{\mathrm{d}x}{\mathrm{d}t}\mathrm{d}t=\int_1^2\frac{2}{t(3-t)}\times(2t+2)\,\mathrm{d}t$	M1 A1
	$t=1\Rightarrow x=3,\quad t=2\Rightarrow x=8$	B1
	So area of $R=1\times\left(8-3\right)-\displaystyle\int_1^2\frac{2}{t(3-t)}\times(2t+2)\,\mathrm{d}t$	M1
	$=5-4\displaystyle\int_1^2\frac{t+1}{t(3-t)}\mathrm{d}t$	A1
		(5)
(c)(i)	$\dfrac{t+1}{t(3-t)}=\dfrac{A}{t}+\dfrac{B}{3-t}$	M1
	$\Rightarrow t+1=A(3-t)+Bt$ E.g. $t=0\Rightarrow 1=3A\Rightarrow A=\dfrac{1}{3}$; $t=3\Rightarrow 4=3B\Rightarrow B=\dfrac{4}{3}$	M1
	$\dfrac{t+1}{t(3-t)}=\dfrac{1}{3t}+\dfrac{4}{3(3-t)}$	A1
(ii)	$\displaystyle\int\frac{t+1}{t(3-t)}\mathrm{d}t=\int\frac{1}{3t}+\frac{4}{3(3-t)}\mathrm{d}t=\frac{1}{3}\ln t-\frac{4}{3}\ln\left(3-t\right)$	M1
	$\text{Area}=5-4\left[\dfrac{1}{3}\ln t-\dfrac{4}{3}\ln\left(3-t\right)\right]_1^2=5-4\left(\dfrac{1}{3}\ln 2-\dfrac{4}{3}\ln 1-\dfrac{1}{3}\ln 1+\dfrac{4}{3}\ln 2\right)$ $=5-4\left(\dfrac{1}{3}\ln 2+\dfrac{4}{3}\ln 2\right)$	dM1
	$=5-\dfrac{20}{3}\ln 2$	A1
		(6)
		(13 marks)

Question Number	Scheme	Marks
8(a)	A and B are where $y = 0$ so $t^3 - 9t = 0 \Rightarrow t(t^2 - 9) = 0 \Rightarrow t = 3 \quad (0 \text{ and } -3)$ 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)	$\dfrac{dy}{dx} = \dfrac{dy/dt}{dx/dt} = \dfrac{3t^2 - 9}{2t + 2}$ Substitutes $t = 3$ into $\dfrac{dy}{dx} = \dfrac{3t^2 - 9}{2t + 2} \Rightarrow \dfrac{dy}{dx} = \dfrac{9}{4}$ Uses their $\dfrac{9}{4}$ 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 $9x - 4y - 135 = 0$ $\Rightarrow 9(t^2 + 2t) - 4(t^3 - 9t) - 135 = 0$ $\Rightarrow 4t^3 - 9t^2 - 54t + 135 = 0$ $\Rightarrow (t^2 - 6t + 9)(4t + 15) = 0$ $t = -\dfrac{15}{4}$ Coordinates of X are $\left(\dfrac{105}{16}, -\dfrac{1215}{64}\right)$	M1 dM1 A1 dM1A1 **(5)** **(12 marks)**