Question	Scheme	Marks	AOs
1	$(x-3)^2+y^2=\left(\frac{t^2+5}{t^2+1}-3\right)^2+\left(\frac{4t}{t^2+1}\right)^2$	M1	3.1a
	$=\frac{(2-2t^2)^2+16t^2}{(t^2+1)^2}=\frac{4+8t^2+4t^4}{(t^2+1)^2}$	dM1	1.1b
	$\frac{4(t^4+2t^2+1)}{(t^2+1)^2}=\frac{4(t^2+1)^2}{(t^2+1)^2}=4*$	A1*	2.1
		(3)	

M1: Attempts to substitute the given parametric forms into the Cartesian equation or the lhs of the Cartesian equation. There may have been an (incorrect) attempt to multiply out the $(x-3)^2$ term.
dM1: Attempts to combine (at least the lhs) using correct processing into a single fraction, multiplies out and collects terms on the numerator.
A1*: Fully correct proof showing all key steps

Question	Scheme	Marks	AOs
Alt	$x=\frac{t^2+5}{t^2+1}\Rightarrow xt^2+x=t^2+5\Rightarrow t^2=\frac{5-x}{x-1}$ $y=\frac{4t}{t^2+1}\Rightarrow y^2=\frac{16t^2}{(t^2+1)^2}=\frac{16\left(\frac{5-x}{x-1}\right)}{\left(\frac{5-x}{x-1}+1\right)^2}$	M1	3.1a
	$y^2=\frac{16\left(\frac{5-x}{x-1}\right)}{\left(\frac{5-x}{x-1}+1\right)^2}=16\left(\frac{5-x}{x-1}\right)\times\left(\frac{(x-1)}{5-x+x-1}\right)^2\Rightarrow y^2=(5-x)(x-1)$	dM1	1.1b
	$y^2=(5-x)(x-1)\Rightarrow y^2=6x-x^2-5$ $\Rightarrow y^2=4-(x-3)^2$ or other intermediate step $\Rightarrow(x-3)^2+y^2=4*$	A1*	2.1
		(3)	
		(3 marks)	

Notes

M1: Adopts a correct strategy for eliminating t to obtain an equation in terms of x and y only. See scheme.
Other methods exist which also lead to an appropriate equation. E.g using $t=\frac{y}{x-1}$
dM1: Uses correct processing to eliminate the fractions and start to simplify
A1*: Fully correct proof showing all key steps

Question	Scheme	Marks	AOs
2(a) Way 1	$x=(t+3)^2-25$	**M1**	1.1b
	$\Rightarrow x+25=(t+3)^2 \Rightarrow (x+25)^{\frac{1}{2}}=(t+3) \Rightarrow y=...$	**M1**	2.1
	$y=6\ln(x+25)^{\frac{1}{2}} \Rightarrow y=3\ln(x+25)$	**A1cso**	1.1b
		(3)	
	(a) Way 2		
	$y=6\ln(t+3)=3\ln(t+3)^2$	**M1**	1.1b
	$y=3\ln(t+3)^2=3\ln(t^2+6t+9)=3\ln(x+16+9)$	**M1**	2.1
	$y=3\ln(x+25)$	**A1cso**	1.1b
	(a) Way 3		
	$y=6\ln(t+3) \Rightarrow \frac{y}{6}=\ln(t+3) \Rightarrow t+3=e^{\frac{y}{6}} \Rightarrow t=e^{\frac{y}{6}}-3$	**M1**	1.1b
	$x=\left(e^{\frac{y}{6}}-3\right)^2+6\left(e^{\frac{y}{6}}-3\right)-16 \Rightarrow y=...$ or $x=\left(e^{\frac{y}{6}}-3+8\right)\left(e^{\frac{y}{6}}-3-2\right) \Rightarrow y=...$	**M1**	2.1
	$y=3\ln(x+25)$	**A1cso**	1.1b
	(a) Way 4		
	$x=(t+3)^2-25$	**M1**	1.1b
	$\frac{dy}{dx}=\frac{\frac{dy}{dt}}{\frac{dx}{dt}}=\frac{\left(\frac{6}{t+3}\right)}{2t+6} \Rightarrow \frac{3}{(t+3)^2}=\frac{3}{x+25} \Rightarrow y=3\ln(x+25)(+c)$	**M1**	2.1
	e.g. $t=0 \Rightarrow x=-16, y=6\ln3 \Rightarrow 6\ln3=3\ln(9) \Rightarrow c=0$ $y=3\ln(x+25)$	**A1cso**	1.1b
(b)	$x=0,\ y=3\ln25$ oe e.g. $6\ln5$	**B1ft**	2.2a
	$\frac{dy}{dx}=\frac{3}{x+"25"} \Rightarrow \frac{dy}{dx}=\frac{3}{0+"25"} \quad \left(=\frac{3}{25}\right)$ **or** $\frac{\frac{dy}{dt}}{\frac{dx}{dt}}=\frac{\left(\frac{6}{t+3}\right)}{2t+6} \Rightarrow \frac{\frac{6}{2+3}}{2\times2+6} \quad \left(=\frac{6}{50}=\frac{3}{25}\right)$	**M1**	2.1
	$y-"3\ln25"="\frac{3}{25}"(x\{-0\})$	**dM1**	3.1a
	$25y-3x=150\ln5$	**A1**	2.2a
		(4)	
			(7 marks)

Notes

Choose the mark scheme that best matches their chosen method.

(a) **Way 1**

M1: Attempts to complete the square. Award for sight of $x=(t+3)^2 \pm \dots$ where $\dots \neq 0$

M1: Rearranges their $x=(t+3)^2-25$ to either $(t+3)=\dots$ or $(t+3)^2=\dots$ and then substitutes correctly their expression into the parametric equation for y. So e.g., $t=\sqrt{x+25}-3 \rightarrow y=6\ln\left(\sqrt{x+25}-3\right)$ is M0.

A1cso: $y=3\ln(x+25)$ including brackets with all stages of working shown. The "$y=$" must appear at some point.

Way 2

M1: Attempts to use the power rule for logarithms $y=6\ln(t+3)=\dots\ln(t+3)^2$ where $\dots \neq 6$

M1: Writes $y=6\ln(t+3)$ as $3\ln(t+3)^2$ and then multiplies out and substitutes correctly in for t to obtain a Cartesian equation for C

A1cso: $y=3\ln(x+25)$ including brackets with all stages of working shown. The "$y=$" must appear at some point.

Way 3

M1: Attempts to make t the subject for $y=6\ln(t+3)$ to obtain $t=e^{\frac{y}{6}} \pm \dots$ where $\dots \neq 0$

M1: Substitutes $t=e^{f(y)} \pm \dots$ correctly into $x=t^2+6t-16$ and rearranges to make y the subject.

A1cso: $y=3\ln(x+25)$ including brackets with all stages of working shown. The "$y=$" must appear at some point.

Way 4

M1: Attempts to complete the square. Award for sight of $x=(t+3)^2 \pm \dots$ where $\dots \neq 0$

M1: Attempts to find $\frac{dy}{dx}$ where $\frac{dy}{dx}=\frac{\left(\frac{\dots}{t+3}\right)}{at+b}$, $a,b \neq 0$ and uses the completed square form to find $\frac{dy}{dx}$ in terms of x and then integrates to obtain a Cartesian equation for C

A1cso: A complete method using any correct point on the curve to show that $c=0$ and obtain $y=3\ln(x+25)$ with all stages of working shown. The "$y=$" must appear at some point.

Note that a common incorrect approach in (a) is:

$$x=t^2+6t-16=(t-2)(t+8) \Rightarrow x=t-2 \Rightarrow t=x+2 \Rightarrow y=6\ln(x+5)$$

which scores no marks.

(b)

B1ft: Deduces $y = 3\ln 25$ oe e.g $y = 6\ln 5$ but allow follow through on their Cartesian equation with $x = 0$ and apply isw after a correct value or ft value for y

M1: Attempts to find $\frac{dy}{dx}$ when $x = 0$ so score for obtaining $\frac{dy}{dx} = \frac{\ldots}{x + "25"}$ and substituting in $x = 0$

Allow this mark if they use the letters A and B e.g. $\frac{dy}{dx} = \frac{\ldots}{x+B} = \frac{\ldots}{0+B}$ or allow a "made up" A and B.

or

Attempts to find $\frac{dy}{dx}$ when $t = 2$ by finding $\frac{\frac{dy}{dt}}{\frac{dx}{dt}} = \frac{\left(\frac{6}{t+3}\right)}{2t+6} \Rightarrow \frac{\frac{6}{5}}{2\times 2+6} \quad \left(= \frac{6}{50} = \frac{3}{25}\right)$

For the derivative look for $\frac{dy}{dx} = \frac{\left(\frac{\ldots}{t+3}\right)}{at+b}$ oe e.g. $\left(\frac{\ldots}{t+3}\right) \times \frac{1}{at+b}$ $a, b \neq 0$

NOTE if candidates find $\frac{\frac{dy}{dt}}{\frac{dx}{dt}} = \frac{\left(\frac{6}{t+3}\right)}{2t+6} = \frac{6(2t+6)}{t+3} = 12$ we will give BOD that $t = 2$ has been used unless there is clear evidence that $t = 2$ has not been used.

dM1: Attempts to find the equation of the tangent. Score for sight of $y - "3\ln 25" = "\frac{3}{25}"(x\{-0\})$ or if they use $y = mx + c$ they must proceed as far as $c = \ldots$ **It is dependent on the previous method mark.** Must have numeric A and B now.

A1: $25y - 3x = 150\ln 5$ or any integer multiple of this equation in the form $ax + by = c\ln 5$