Question	Scheme	Marks
8	$y = 2x + x^3 + \cos x$	
	Assume (there is a stationary point so) $\frac{dy}{dx} = 0$ for some value of x	**B1**
	So for this x $\frac{dy}{dx} = 2 + 3x^2 - \sin x$	**M1**
	$\frac{dy}{dx} = 0 \Rightarrow \sin x = 3x^2 + 2 \ldots 2$	**dM1**
	This is a contradiction as $\lvert \sin x \rvert$,, 1 for all x, hence the assumption is false and so the function has no stationary points.	**A1cso**
		(4)
		(4 marks)

Notes:

B1: For a clear, suitable assumption with reference to $\frac{dy}{dx} = 0$ or implication that it means $\frac{dy}{dx} = 0$ at some point in their proof. Need not mention "for some x", but stating "for all x" is B0. Accept just "Assume $\frac{dy}{dx} = 0$"

M1: Attempts the derivative achieving $2 + 3x^2 \pm \sin x$

dM1: Makes progress with a correct method leading to a contradiction. E.g. set their derivative equal to 0, makes sin x the subject and deduces greater than or equal to 2. Other methods are possible, e.g. states $x^2 \geq 0$ and $\sin x \leq 1$ and deduces $2 + 3x^2 - \sin x \geq 1$ (hence cannot be zero). It must be clear what the contradiction will be but allow if there are some inaccuracies in details e.g. condone if a strict inequality is used for this mark. There must be reference to both $(3)x^2 \ldots 0$ and the range of $\sin x$ in some way.

Do not accept "this equation has no solutions" without proof as to why there can be no solutions.

Note: A sketch is not a proof. An algebraic approach is required, but accept verbal arguments (e.g. stating "the minimum of $2+3x^2$ is 2" and "sin x cannot exceed one" etc), which may accompany a sketch.

A1cso: Fully correct proof, with derivative correct and contradiction made clear and conclusion drawn referring back to no stationary points. All necessary details must have been given. Condone cases where strict inequalities have been given instead of unstrict ones.

Question	Scheme	Marks
9(a)	$\frac{\mathrm{d}x}{\mathrm{d}t}=\sec t\tan t$ and $\frac{\mathrm{d}y}{\mathrm{d}t}=\sqrt{3}\sec^2\left(t+\frac{\pi}{3}\right)$	**B1**
	$\left(\frac{\mathrm{d}y}{\mathrm{d}x}=\right)\frac{\mathrm{d}y}{\mathrm{d}t}\div\frac{\mathrm{d}x}{\mathrm{d}t}=\frac{\sqrt{3}\sec^2\left(t+\frac{\pi}{3}\right)}{\sec t\tan t}$ oe	**M1 A1**
		(3)
(a) Alt	$x=\sec t \qquad y=\sqrt{3}\frac{\tan t+\sqrt{3}}{1-\sqrt{3}\tan t}$	
	$\frac{\mathrm{d}x}{\mathrm{d}t}=\sec t\tan t$ and $\frac{\mathrm{d}y}{\mathrm{d}t}=\sqrt{3}\frac{\left(1-\sqrt{3}\tan t\right)\sec^2 t-\left(\tan t+\sqrt{3}\right)\left(-\sqrt{3}\sec^2 t\right)}{\left(1-\sqrt{3}\tan t\right)^2}$ (oe)	**B1**
	$\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{\mathrm{d}y}{\mathrm{d}t}\div\frac{\mathrm{d}x}{\mathrm{d}t}=\sqrt{3}\frac{\left(1-\sqrt{3}\tan t\right)\sec^2 t-\left(\tan t+\sqrt{3}\right)\left(-\sqrt{3}\sec^2 t\right)}{\sec t\tan t\left(1-\sqrt{3}\tan t\right)^2}$ oe	**M1 A1**
(b)	$t=\frac{\pi}{3}\Rightarrow x=2, y=-3$	**B1**
	$t=\frac{\pi}{3}\Rightarrow\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{\sqrt{3}\sec^2\frac{2\pi}{3}}{\sec\frac{\pi}{3}\tan\frac{\pi}{3}}=\ldots\left(=2\right)$	**M1**
	Tangent is $y+3=2\left(x-2\right)\Rightarrow y=2x-7$ 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**
	$=\sqrt{3}\frac{\sqrt{x^2-1}+\sqrt{3}}{1-\sqrt{3}\sqrt{x^2-1}}\times\frac{1+\sqrt{3}\sqrt{x^2-1}}{1+\sqrt{3}\sqrt{x^2-1}}=..$	
	$=\sqrt{3}\frac{\sqrt{x^2-1}+\sqrt{3}\left(x^2-1\right)+\sqrt{3}+3\sqrt{x^2-1}}{1-\left(3x^2-3\right)}=\frac{..\sqrt{x^2-1}+..x^2}{4-3x^2}$	**M1**
	$=\frac{3x^2+4\sqrt{3x^2-3}}{4-3x^2}$	**A1**
		(5)

(12 marks)

Notes:

(a)

B1: Both derivatives given correctly. See Alt for an alternative form for y

M1: Divides their $\frac{\mathrm{d}y}{\mathrm{d}t}$ by their $\frac{\mathrm{d}x}{\mathrm{d}t}$

A1: Correct expression and isw after a correct answer, accept any equivalent – e.g. see the Alt form in scheme.

(b)

B1: Correct values for x and y stated or implied.

M1: Some evidence of substituting in $t = \frac{\pi}{3}$ to their gradient expression to find the gradient of the tangent. Must be evaluated. You may need to check their value matches their $\frac{\mathrm{d}y}{\mathrm{d}x}$ if no substitution or other evidence is shown.

M1: Correct method for the equation of the tangent, using their evaluated gradient. Must use their $\frac{\mathrm{d}y}{\mathrm{d}x}$ for the gradient but allow a slip in sign on one side for the coordinates in the formula. If they use $y = mx + c$ they need to proceed as far as finding c.

A1cso: Correct equation in the form stated. Must have come from a correct $\frac{\mathrm{d}y}{\mathrm{d}x}$.

(c)

M1: Attempts the compound angle formula on y, accept with sign errors. Allow if the $\sqrt{3}$ is missing. Must be seen or used in part (c).

M1: Uses $\sec^2 t = 1 + \tan^2 t$ to find tan t or $\tan^2 t$ in terms of x and substitutes to produce an equation linking y and x. Allow if there are errors rearranging after a correct formula.

A1: Any correct Cartesian formula, with trig terms evaluated.

M1: Full method to reach an answer in the required form, so multiplies through numerator and denominator by appropriate factor for their denominator and expands the numerator. The denominator work may be implied.

A1: Achieves the correct answer.