Question Number	Scheme	Marks
1(a)	$\left(\frac{\mathrm{d}y}{\mathrm{d}x}=\right)2x\cos\left(\frac{1}{2}x\right)-\frac{1}{2}x^2\sin\left(\frac{1}{2}x\right)$	M1 A1
	Sets $\frac{\mathrm{d}y}{\mathrm{d}x}=0\Rightarrow\tan\left(\frac{1}{2}x\right)=\frac{4}{x}\Rightarrow x=2\arctan\left(\frac{4}{x}\right)$*	**d**M1 A1*
		(4)
(b)	$x_2=2\arctan\left(\frac{4}{2}\right)$	M1
	$x_2=$ awrt 2.214 $\qquad$ $x_6=2.155$ cao	A1, A1
		(3)
		(7 marks)

(a)

M1: Differentiates using the product rule to obtain an expression of the form $Ax\cos\left(\frac{1}{2}x\right)+Bx^2\sin\left(\frac{1}{2}x\right)$

If the product rule is quoted it must be correct.

A1: For a correct simplified or unsimplified derivative.

dM1: Sets their $\frac{\mathrm{d}y}{\mathrm{d}x}=0$ and proceeds to an equation involving $\tan\left(\frac{1}{2}x\right)$. This may be implied by their working.

The M1 must have been scored.

A1*: Correctly achieves the given answer of $x=2\arctan\left(\frac{4}{x}\right)$

An intermediate line of $\tan\left(\frac{1}{2}x\right)=\frac{4}{x}$ or $\frac{\sin\left(\frac{1}{2}x\right)}{\cos\left(\frac{1}{2}x\right)}=\frac{2x}{\frac{1}{2}x^2}$ must be seen

Note that some may work backwards having differentiated e.g.

$$x=2\arctan\left(\frac{4}{x}\right)\Rightarrow\frac{x}{2}=\arctan\left(\frac{4}{x}\right)\Rightarrow\tan\left(\frac{x}{2}\right)=\frac{4}{x}\Rightarrow\frac{x\sin\left(\frac{x}{2}\right)}{\cos\left(\frac{x}{2}\right)}=4\Rightarrow4\cos\left(\frac{x}{2}\right)=x\sin\left(\frac{x}{2}\right)$$

$$\Rightarrow2x\cos\left(\frac{x}{2}\right)=\frac{1}{2}x^2\sin\left(\frac{x}{2}\right)\Rightarrow2x\cos\left(\frac{x}{2}\right)-\frac{1}{2}x^2\sin\left(\frac{x}{2}\right)=0$$

Score M1 for a complete method to reach $\frac{\mathrm{d}y}{\mathrm{d}x}=0$ and A1 if correct with (minimal) conclusion.

(b)

M1: Attempts to use the given iteration formula. Award for $x_2=2\arctan\left(\frac{4}{2}\right)$ or awrt 2.21

Note that this mark may also be implied by awrt 127 if they are using degrees and no working is shown.

A1: x_2 = awrt 2.214

A1: x_6 = 2.155 (Note that this is not awrt)

Question Number	Scheme	Marks
2(a)	States or uses $\sin 2x = 2\sin x\cos x$	B1
	$\dfrac{1-\cos 2x}{2\sin 2x} = \dfrac{1-\left(1-2\sin^2 x\right)}{4\sin x\cos x} = \dfrac{2\sin^2 x}{4\sin x\cos x} = \dfrac{1}{2}\tan x$	M1 A1
		(3)
(b)	$\dfrac{9\left(1-\cos 2\theta\right)}{2\sin 2\theta} = 2\sec^2\theta \Rightarrow 9\times"\dfrac{1}{2}"\tan\theta = 2\sec^2\theta$	M1
	Attempts $1+\tan^2\theta = \sec^2\theta \Rightarrow 4\tan^2\theta - 9\tan\theta + 4 = 0$	**d**M1 A1
	$\Rightarrow \tan\theta = \dfrac{9\pm\sqrt{17}}{8}\left(1.64038..., 0.60961...\right)$	M1
	$\Rightarrow \theta =$ awrt $31.4°, 58.6°$	A1 A1
		(6)
(b) Way 2	$\dfrac{9\left(1-\cos 2\theta\right)}{2\sin 2\theta} = 2\sec^2\theta \Rightarrow 9\times"\dfrac{1}{2}"\tan\theta = 2\sec^2\theta$	M1
	$\dfrac{9}{2}\tan\theta = 2\sec^2\theta \Rightarrow \dfrac{9\sin\theta}{\cos\theta} = \dfrac{4}{\cos^2\theta} \Rightarrow 9\sin\theta\cos\theta = 4 \Rightarrow \sin 2\theta = \dfrac{8}{9}$	**d**M1A1
	$\sin 2\theta = \dfrac{8}{9} \Rightarrow 2\theta = 62.7333..., 117.266... \Rightarrow \theta = ...$	M1
	$\Rightarrow \theta =$ awrt $31.4°, 58.6°$	A1 A1
		(9 marks)

(a)

B1: States or uses $\sin 2x = 2\sin x\cos x$

M1: Attempts to use $1 - \cos 2x = \pm 2\sin^2 x$ and $2\sin 2x = A\sin x\cos x$ and to proceeds to $k\tan x$

A1: Fully correct solution with correct bracketing if seen

(b)

M1: Uses part (a) to form an equation of the form $A\tan\theta = B\sec^2\theta$

dM1: Replaces $\sec^2\theta$ by $\pm 1 \pm \tan^2\theta$ and proceeds to form a 3TQ equation in just $\tan\theta$

A1: Correct 3TQ. E.g. $9\tan\theta = 4 + 4\tan^2\theta$

M1: Correct attempt to find at least one value for $\tan\theta$ for their 3TQ in $\tan\theta$

Allow solutions from calculators and condone decimals as long as accuracy is to at least 2sf.

A1: One of either awrt 31.4° **or** awrt 58.6°

A1: Both awrt 31.4° **and** awrt 58.6°. Withhold this mark if there are extra solutions in range.

……

(b) Way 2

M1: Uses part (a) to form an equation of the form equation $A\tan\theta = B\sec^2\theta$

dM1: Uses $\sec^2\theta = \dfrac{1}{\cos^2\theta}$, $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$ and $\sin 2\theta = ...\sin\theta\cos\theta$ to produce an equation of the form $\sin 2\theta = C$

A1: $\sin 2\theta = \dfrac{8}{9}$

M1: Full method to find at least one value of θ from $\sin 2\theta = C$ where $-1 < C < 1$.

E.g. $2\theta = \sin^{-1}C$, $\theta = \frac{1}{2}\sin^{-1}C$. (NB radians gives 0.547…, 1.02… and implies the M mark)

A1, A1: As above