Question	Answer	Marks	Guidance
10(a)	Use correct product or quotient rule	*M1	$\frac{dy}{dx}=\left(-\frac{1}{2}\right)(2-x)e^{-\frac{1}{2}x}-e^{-\frac{1}{2}x}$ M1 requires at least one of derivatives correct
	Obtain correct derivative in any form	A1	
	Equate derivative to zero and solve for x	DM1	
	Obtain $x = 4$	A1	ISW
	Obtain $y = -2e^{-2}$, or exact equivalent	A1	
		5	

Question	Answer	Marks	Guidance
10(b)	Commence integration and reach $a(2-x)e^{-\frac{1}{2}x}+b\int e^{-\frac{1}{2}x}dx$	*M1	Condone omission of dx $-2(2-x)e^{-\frac{1}{2}x}+4e^{-\frac{1}{2}x}$ or $2xe^{-\frac{1}{2}x}$
	Obtain $-2(2-x)e^{-\frac{1}{2}x}-2\int e^{-\frac{1}{2}x}dx$	A1	OE
	Complete integration and obtain $2xe^{-\frac{1}{2}x}$	A1	OE
	Use correct limits, $x = 0$ and $x = 2$, correctly, having integrated twice	DM1	Ignore omission of zeros and allow max of 1 error
	Obtain answer $4e^{-1}$, or exact equivalent	A1	ISW

Question	Answer	Marks	Guidance
4	State or imply $\frac{dx}{dt}=2-\sec^2 t$ or $\frac{dy}{dt}=2\frac{\cos 2t}{\sin 2t}$	B1	
	Use $\frac{dy}{dx}=\frac{dy}{dt}\div\frac{dx}{dt}$	M1	
	Obtain correct answer in any form	A1	
	Use double angle formula to express derivative in terms of cos x and sin x	M1	
	Obtain the given answer correctly	A1	AG
		5	

Question	Answer	Marks	Guidance
4(a)	Use correct product rule or quotient rule, and attempt at chain rule	M1	$ke^{-4x}\tan x+e^{-4x}\sec^2 x$ or $\frac{e^{4x}\sec^2 x-\tan x(ke^{4x})}{(e^{4x})^2}$ Need to see $d(\tan x)/dx = \sec^2 x$ (formula sheet) and attempt at ke^{-4x}, where $k \neq 1$.
	Obtain correct derivative in any form	A1	$-4e^{-4x}\tan x+e^{-4x}\sec^2 x$ or $\frac{e^{4x}\sec^2 x-\tan x(4e^{4x})}{(e^{4x})^2}$
	Use trigonometric formulae to express derivative in the form $ke^{-4x}\sin x\cos x\sec^2 x+ae^{-4x}\sec^2 x$ or $ke^{-4x}\frac{\sin x\cos x}{\cos x\cos x}+ae^{-4x}\sec^2 x$ or $\sec^2 x(ke^{-4x}\sin x\cos x+ae^{-4x})$ Allow $\frac{1}{\cos^2 x}$ instead of $\sec^2 x$	M1	Need to use $\frac{\tan x}{\sec^2 x}=\sin x\cos x$ or $\tan x=\frac{\sin x}{\cos x}.\frac{\cos x}{\cos x}$ OE. M1 is independent of previous M1, but expression must be of appropriate form.
	Obtain correct answer with $a = 1$ and $b = -2$	A1	At least one line of trigonometric working is required from $-4e^{-4x}\tan x+e^{-4x}\sec^2 x$ to given answer $\sec^2 x(1-2\sin 2x)e^{-4x}$ with elements in any order. If only error: $4\sin x\cos x = 4\sin 2x$ M1 A1 M1 A0.

Question	Answer	Marks	Guidance
4(b)	Equate derivative to zero and use correct method to solve for x	**M1**	$\sin 2x = \frac{1}{2}$, hence $x = \frac{1}{2}\sin^{-1}\frac{1}{2}$ or $x = \tan^{-1}(2 \pm \sqrt{3})$ Allow M1 for correct method for non-exact value.
	Obtain answer, e.g. $x = \frac{1}{12}\pi$	**A1**	[0.262 M1 A0]
	Obtain second answer, e.g. $\frac{5}{12}\pi$ and no other in the given interval	**A1 FT**	FT $\frac{\pi - \textit{their}\, 2x}{2}$ if exact values; x must be $< \frac{\pi}{2}$. Ignore answers outside the given interval. Treat answers in degrees as a misread. 15°, 75°. **SC** No values found for a and b in **4(a)** but chooses values in **4(b)**: max **M1** for x.
		3	

Question	Answer	Marks	Guidance
11(a)	Use the correct product rule to differentiate	***M1**	Could be working in terms of a. Obtain the form $\frac{p}{\sqrt{x}}\sin 2x + q\sqrt{x}\cos 2x$.
	Obtain $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{1}{2\sqrt{x}}\sin 2x + 2\sqrt{x}\cos 2x$	**A1**	
	Equate the derivative to zero and form an equation without surds	**DM1**	E.g. $\sin 2a + 4a\cos 2a = 0$. Could be working in terms of x.
	Obtain $\tan 2a = -4a$ from correct work	**A1**	AG
		4	
11(b)	Calculate the values of a relevant expression or pair of expressions at $x = 0.9$ and $x = 0.95$	**M1**	Allow smaller interval, provided it contains the root. Must be working in radians.
	Complete the argument correctly with correct calculated values	**A1**	E.g. $\begin{cases}\tan 1.8 + 3.6 = -0.686... < 0 \\ \tan 1.9 + 3.8 = 0.873... > 0\end{cases}$
		2	
11(c)	State $a = \frac{1}{2}(\pi - \tan^{-1} 4a)$ and rearrange to $\pi - 2a = \tan^{-1} 4a$	**B1**	Or work from right to left. Allow working in x or a.
	State $\tan(\pi - 2a) = 4a$ and rearrange to $\tan 2a = -4a$	**B1**	Allow working in x or a.
		2	

Question	Answer	Marks	Guidance
11(d)	Use the iterative process correctly at least once	**M1**	M0 if working in degrees.
	Obtain final answer 0.9183	**A1**	
	Show sufficient iterations to at least 6 d.p. to justify 0.9183 to 4 d.p. or show there is a sign change in the interval $(0.91825, 0.91835)$	**A1**	E.g. $0.9, 0.920872, 0.917944, 0.918347, 0.918292...$
		3	

Question	Answer	Marks	Guidance
4	State $\frac{dy}{d\theta} = 1 - 2\sin\theta$	**B1**	Ignore left side throughout dx/dt, dy/dt, dx, dy but must see $\frac{dy}{dx}$ for final A1.
	Use correct quotient rule, or product rule if rewrite x as $\cos\theta(2-\sin\theta)^{-1}$	**M1**	Incorrect formula seen M0 A0 otherwise BOD.
	Obtain $\frac{dx}{d\theta} = \frac{-(2-\sin\theta)\sin\theta + \cos^2\theta}{(2-\sin\theta)^2}$ o.e.	**A1**	$-\sin\theta(2-\sin\theta)^{-1} - \cos\theta(2-\sin\theta)^{-2}(-\cos\theta)$ or equivalent.
	Use $\frac{dy}{dx} = \frac{dy}{d\theta} \div \frac{dx}{d\theta}$	**M1**	$\left(\frac{dy}{dx} = (1-2\sin\theta) \div \frac{1-2\sin\theta}{(2-\sin\theta)^2}\right)$. Allow M1 even if errors in both derivatives.
	Obtain $\frac{dy}{dx} = (2-\sin\theta)^2$.	**A1**	AG – must see working in above cell to gain final A1. Allow $\cos^2\theta + \sin^2\theta = 1$ to be implied. x instead of θ or missing θ more than twice on right side then A0 final mark.
		5	

Question	Answer	Marks	Guidance
5(a)	Use correct product rule	**M1**	$\frac{d}{dx}(x^2)\cos(3x) + x^2\frac{d}{dx}(\cos 3x)$.
	Obtain correct derivative in any form	**A1**	e.g. $2x\cos 3x - 3x^2\sin 3x$.
	Equate derivative to zero and obtain $a = \frac{1}{3}\tan^{-1}\left(\frac{2}{3a}\right)$.	**A1**	AG Condone $a = \frac{1}{3}\tan^{-1}\frac{2}{3a}$. Must at least reach expression $2x = 3x^2\tan(3x)$ or better before final answer to gain A1. Final answer must be in terms of a. Can work with x and switch to a at very end. Look for $\frac{2}{3}a$ or $\frac{2}{3}x$ in working not immediately corrected or as penultimate line A0.
		3	
5(b)	Use the iterative process $a_{n+1} = \frac{1}{3}\tan^{-1}\left(\frac{2}{3a_n}\right)$ correctly at least twice during successive iterations in the numerous iterations	**M1**	Degrees 0/3.
	Obtain final answer 0.36	**A1**	Must be 2d.p.
	Show sufficient iterations to 4 or more d.p. to justify 0.36 to 2 d.p. or show there is a sign change in the interval $(0.355, 0.365)$	**A1**	Allow small errors in 4th d.p. Allow errors at start if self corrects later.
	0.5 0.4 0.3 0.2 0.1 π/6 π/12 0.3091 0.3435 0.3826 0.4264 0.4740 0.3017 0.3989 0.3789 0.3650 0.3499 0.3339 0.3176 0.3820 0.3439 0.3513 0.3566 0.3625 0.3688 0.3754 0.3502 0.3649 0.3619 0.3599 0.3576 0.3552 0.3526 0.3624 0.3567 0.3578 0.3604 0.3614 0.3576 0.3580	**3**	

Question	Answer	Marks	Guidance
7(a)	Use chain rule to differentiate LHS	*M1	
	Obtain $\frac{1}{x+y}\left(1+\frac{dy}{dx}\right)$	A1	
	Equate derivative of LHS to $1 - 2\frac{dy}{dx}$ and solve for $\frac{dy}{dx}$	DM1	
	Obtain the given answer correctly	A1	
		4	
7(b)	State $x + y = 1$	B1	
	Obtain or imply $x - 2y = 0$	B1	
	Obtain coordinates $x = \frac{2}{3}$ and $y = \frac{1}{3}$	B1	
		3	