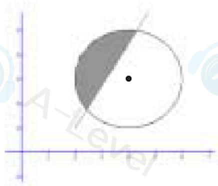
Question	Answer	Marks	Guidance
6(a)	Show a circle centre (4, 3) Allow dashes for coordinates on axes	**B1**	Note full circle is not required but must show centre and include relevant arc.
	Show a circle with radius 2. Can be implied by at least two of the points (2, 3), (6, 3), (4, 1) and (4, 5) being correct	**B1FT**	FT centre not at the origin.
	Point representing (2, 1)	**B1**	Half-line or 'correct' full line extending into the third quadrant implies point (2, 1).
	Show a half-line at their (2, 1) at an angle of $\frac{1}{3}\pi$, cutting top of circle between $x = 3$ and $x = 5$	**B1FT**	FT the point (±2, ±1) or (±1, ±2).
	Shade the correct region Needs correct half-line or "correct" full line extending into the third quadrant **AND** correct circle	**B1**	
		5	

Question	Answer	Marks	Guidance
6(b)	Carry out a correct method for finding the greatest value of arg z in the correct region in (a)	**M1**	E.g. $\sin^{-1}(2/\sqrt{(25)}) + \tan^{-1}(3/4)$ or $\sin^{-1}(2/\sqrt{(25)}) + \sin^{-1}(3/5)$. Or, e.g., substitute $y = kx$ in circle equation, solve when discriminant = 0, to get $\tan^{-1}\left(\frac{6+\sqrt{21}}{6}\right)$.
	Obtain answer 1.06, or 1.05 or 1.055 or 1.056 or 60.4° or 60.5°	**A1**	The marks in **(b)** are available even if errors in **(a)**. No working seen scores 0/2 marks.
		2	

5(i)	$\cos 6x = 1 - 2\sin^2 3x \Rightarrow \sin^2 3x = \frac{1}{2} - \frac{1}{2}\cos 6x$ $\int \sin^2 3x\,dx = \int\left(\frac{1}{2} - \frac{1}{2}\cos 6x\right)dx$	M1
	$= \frac{1}{2}x - \frac{1}{12}\sin 6x(+c)$	A1
		(2)
(ii)	$\int x\left(x^2+4\right)^{\frac{3}{2}}dx = \frac{1}{5}\left(x^2+4\right)^{\frac{5}{2}}(+c)$	M1A1
		(2)
		Total 4

Question	Answer	Marks	Guidance
5(b)	Obtain one correct gradient	**B1**	E.g. $\frac{1}{2}$ at $(0, 2)$.
	Obtain second correct gradient	**B1**	E.g. $\frac{-3}{2}$ at $(0, -2)$.
		2	

4(a)	$A = 93$	B1
		(1)
(b)	$100 = 125 - "93"\text{e}^{-0.109T} \Rightarrow A\text{e}^{-0.109T} = \ldots$	M1
	$A\text{e}^{kT} = B \Rightarrow T = \dfrac{\ln\left(\dfrac{B}{A}\right)}{k}$	dM1
	$T = 12.05$	A1
		(3)
(c)	$\dfrac{\text{d}N}{\text{d}t} = 0.109 \times "93"\text{e}^{-0.109\times 7}$	M1
	4 730 (total sales per month)	A1
		(2)
(d)	The limit is 125 000 / the model has a limit below 150 000	B1
		(1)
		(7 marks)

Question	Answer	Marks	Guidance
4	Obtain final answers $\frac{3}{5}+\frac{4}{5}\text{i}$ and $-\text{i}$ Accept $0.6 + 0.8\text{i}$ and $0 - \text{i}$	A1	**SC** Both correct final answers from $10w^2 - 2(3-\text{i})w + (3-\text{i})^2 = 0$ with no working then **SC B1** for both. Allow $x = \frac{3}{5}, y = \frac{4}{5}$ or $x = 0, y = -1$. A0 for $\frac{3+4\text{i}}{5}$.

7(a)	$y = \text{e}^{-x^2}\sin 3x \Rightarrow \dfrac{\text{d}y}{\text{d}x} = 3\text{e}^{-x^2}\cos 3x - 2x\text{e}^{-x^2}\sin 3x$	M1A1
	$3\text{e}^{-x^2}\cos 3x - 2x\text{e}^{-x^2}\sin 3x = 0 \Rightarrow 3\cos 3x - 2x\sin 3x = 0$ $\Rightarrow 3\cos 3x = 2x\sin 3x \Rightarrow \tan 3x = \dfrac{3}{2x}$	dM1
	$x = \dfrac{1}{3}\arctan\left(\dfrac{3}{2x}\right)$ *	A1*
		(4)
(b)(i)	$x_1 = 0.4 \Rightarrow x_2 = \dfrac{1}{3}\arctan\left(\dfrac{3}{2\times 0.4}\right)$	M1
	$(x_2 =)0.4367$	A1
(ii)	$(x_4 =)0.4307$	A1
		(3)

Question	Answer	Marks	Guidance
4(a)	Use correct product rule or quotient rule, and attempt at chain rule	M1	$k\text{e}^{-4x}\tan x + \text{e}^{-4x}\sec^2 x$ or $\dfrac{\text{e}^{4x}\sec^2 x - \tan x(k\text{e}^{4x})}{(\text{e}^{4x})^2}$ Need to see $\text{d}(\tan x)/\text{d}x = \sec^2 x$ (formula sheet) and attempt at $k\text{e}^{-4x}$, where $k \neq 1$.
	Obtain correct derivative in any form	A1	$-4\text{e}^{-4x}\tan x + \text{e}^{-4x}\sec^2 x$ or $\dfrac{\text{e}^{4x}\sec^2 x - \tan x(4\text{e}^{4x})}{(\text{e}^{4x})^2}$
	Use trigonometric formulae to express derivative in the form $k\text{e}^{-4x}\sin x\cos x\sec^2 x + a\text{e}^{-4x}\sec^2 x$ or $k\text{e}^{-4x}\dfrac{\sin x\cos x}{\cos x\cos x} + a\text{e}^{-4x}\sec^2 x$ or $\sec^2 x(k\text{e}^{-4x}\sin x\cos x + a\text{e}^{-4x})$ Allow $\dfrac{1}{\cos^2 x}$ instead of $\sec^2 x$	M1	Need to use $\dfrac{\tan x}{\sec^2 x} = \sin x\cos x$ or $\tan x = \dfrac{\sin x}{\cos x}\cdot\dfrac{\cos x}{\cos x}$ 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 $-4\text{e}^{-4x}\tan x + \text{e}^{-4x}\sec^2 x$ to given answer $\sec^2 x(1 - 2\sin 2x)\,\text{e}^{-4x}$ 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 $\frac{\pi - their\,2x}{2}$ 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 Number	Scheme	Marks
6(a)	$\theta = 75, t = 0 \Rightarrow 75 = 21 + A \Rightarrow A = \ldots$	M1
	$A = 54$	A1
		(2)
(b)	$\theta = 21 + 54e^{-kt} \Rightarrow 25 = 21 + 54e^{-5k}$	M1
	$54e^{-5k} = 4 \Rightarrow e^{-5k} = \frac{2}{27} \Rightarrow -5k = \ln\frac{2}{27} \Rightarrow k = \ldots$	M1
	$k = -\frac{1}{5}\ln\frac{2}{27} = 0.521$	A1
		(3)

Question	Answer	Marks
3(a)	Remove logarithms correctly and state $1 + e^{-x} = e^{-2x}$, or equivalent	B1
	Show equation is $u^2 + u - 1 = 0$, where $u = e^x$, or equivalent	B1
		2
3(b)	Solve a 3-term quadratic for u	M1
	Obtain root $\frac{1}{2}\left(-1+\sqrt{5}\right)$, or decimal in [0.61, 0.62]	A1
	Use correct method for finding x from a positive root	M1
	Obtain answer $x = -0.481$ only	A1
		4

10(a)	$\frac{1}{4}=\sin^2 4y \Rightarrow y=\frac{\pi}{24}$	M1A1
		(2)
(b)	$\frac{dx}{dy}=8\sin 4y\cos 4y$	M1A1
		(2)
(c)	$\frac{dx}{dy}=8\sin 4y\cos 4y \to \frac{dy}{dx}=\frac{1}{8\sin 4y\cos 4y}$	M1
	$\frac{dy}{dx}=\frac{1}{8\sqrt{x(1-x)}}$	M1
	$\frac{dy}{dx}=\frac{1}{\sqrt{16-64\left(x-\frac{1}{2}\right)^2}}$	A1
		(3)
(d)(i)	$x=\frac{1}{2}$	B1ft
(ii)	$\frac{dy}{dx}=\frac{1}{4}$	B1ft
		(2)
		(9 marks)

Question	Answer	Marks	Guidance
10(b)	Integrate by parts and reach $ax\sin 2x+b\int\sin 2x\,dx$	*M1	
	Obtain $\frac{1}{2}x\sin 2x-\frac{1}{2}\int\sin 2x\,dx$	A1	OE
	Complete integration and obtain $\frac{1}{2}x\sin 2x+\frac{1}{4}\cos 2x$	A1	OE
	Use limits of $x=0$ and $x=\frac{\pi}{4}$ in the correct order, having integrated twice to obtain $ax\sin 2x+c\cos 2x$	DM1	If correct, $\frac{1}{2}\left(\frac{\pi}{4}\right)\sin\frac{2\pi}{4}+\frac{1}{4}\cos\frac{2\pi}{4}-\frac{1}{4}\cos 0$ or $\frac{1}{2}\left(\frac{\pi}{4}\right)\sin\frac{2\pi}{4}-\frac{1}{4}\cos 0$. Max one substitution error.
	Obtain answer $\frac{\pi}{8}-\frac{1}{4}$ or exact simplified two term equivalent	A1	ISW Accept $\frac{\pi-2}{8}$. Accept $\frac{1}{2}x\sin 2x+\frac{1}{4}\cos 2x$ then final answer.
		5	