Question Number	Scheme	Marks
6(a)	$\theta = 75,\ t = 0 \Rightarrow 75 = 21 + A \Rightarrow A = ...$	M1
	$A = 54$	A1
		(2)
(b)	$\theta = 21 + 54\mathrm{e}^{-kt} \Rightarrow 25 = 21 + 54\mathrm{e}^{-5k}$	M1
	$54\mathrm{e}^{-5k} = 4 \Rightarrow \mathrm{e}^{-5k} = \frac{2}{27} \Rightarrow -5k = \ln\frac{2}{27} \Rightarrow k = ...$	M1
	$k = -\frac{1}{5}\ln\frac{2}{27} = 0.521$	A1
		(3)

Notes:

(a)

M1: Substitutes $\theta = 75$ and $t = 0$ into the given equation, uses $\mathrm{e}^0 = 1$ and proceeds to find a value for A.
Look for $75 = 21 + A \times 1 \Rightarrow A = ...$

A1: For $A = 54$
Sight of 54 with no incorrect working scores both marks.

(b)

M1: Uses $\theta = 25$ and $t = 5$ with their A in $\theta = 21 + A\mathrm{e}^{\pm kt}$ so e.g. $25 = 21 + 54\mathrm{e}^{\pm 5k}$ is all that is required.

M1: Proceeds from an equation of the form $\mathrm{e}^{\pm 5k} = \alpha$ where $\alpha > 0$ to $\pm 5k = \ln\alpha \Rightarrow k = ...$ to obtain a value for k. Condone slips but the log work must be correct. Must be using ln and not e.g. $\log_{10}$ which for reference gives $k = 0.226$
May be implied by the correct exact value for k following through their A.

A1: For awrt 0.521 from correct and sufficient work.
Allow the exact value e.g. $-\frac{1}{5}\ln\frac{2}{27}$ and apply isw if subsequently rounded incorrectly.
May be seen embedded e.g. $\theta = 21 + 54\mathrm{e}^{-0.521t}$
Minimum for full marks in (b) is: $25 = 21 + 54\mathrm{e}^{-5k} \Rightarrow k = -\frac{1}{5}\ln\frac{4}{54}$
$25 = 21 + 54\mathrm{e}^{-5k} \Rightarrow \mathrm{e}^{-5k} = \frac{4}{54} \Rightarrow k = 0.521$ scores M1dM0A0
$25 = 21 + 54\mathrm{e}^{-5k} \Rightarrow k = 0.521$ scores M1dM0A0

Note that some candidates are using $\theta = 50$ and $t = 5$ leading to $k = 0.124$ and this scores a maximum of **M0M1A0** in (b)

(c)	$\theta = 21 + 54\text{e}^{-0.521t} \Rightarrow \dfrac{\text{d}\theta}{\text{d}t} = -28.1...\text{e}^{-0.521t}$	M1
	$-28.1...\text{e}^{-0.521T} = -9 \Rightarrow \text{e}^{-0.521T} = \dfrac{9}{28.1...} \Rightarrow -0.521T = \ln\left(\dfrac{9}{28.1...}\right)$ $\Rightarrow T = \ln\left(\dfrac{9}{28.1...}\right) \div -0.521$	dM1
	$= 2.19$	A1
		(3)

(c)

M1: Differentiates to obtain $\dfrac{\text{d}\theta}{\text{d}t} = \alpha\text{e}^{-kt}$ where $\alpha \neq A$

dM1: **Depends on the previous mark.**

Sets their $\dfrac{\text{d}\theta}{\text{d}t}$ = – 9 or sets $-\left(\text{their}\dfrac{\text{d}\theta}{\text{d}t}\right) = 9$ and proceeds to obtain a value for *t* (or *T*).

You do not need to be concerned about the processing as long as they reach a value.

For this mark they must have obtained $\dfrac{\text{d}\theta}{\text{d}t} = \alpha\text{e}^{-kt}$ with $\alpha < 0$ and $k > 0$

Do **not** condone work where candidates ignore/cross out signs to make their equation solvable.

A1: For awrt 2.19

Just look for this value so ignore any units, correct or incorrect, and apply isw once awrt 2.19 is seen.

Must follow M1dM1 previously.

Note candidates who used $\theta = 50$ and $t = 5$ leading to $k = 0.124$ in (b) who proceed correctly in (c) will obtain $T = -2.38$ and can score a maximum of **M1dM1A0** in (c)

Note correct answer with no working scores no marks in (c).

Question Number	Scheme	Marks
7(a)	$y = \mathrm{e}^{-x^2}\sin 3x \Rightarrow \dfrac{\mathrm{d}y}{\mathrm{d}x} = 3\mathrm{e}^{-x^2}\cos 3x - 2x\mathrm{e}^{-x^2}\sin 3x$	M1A1
	$3\mathrm{e}^{-x^2}\cos 3x - 2x\mathrm{e}^{-x^2}\sin 3x = 0 \Rightarrow 3\cos 3x - 2x\sin 3x = 0$ $\Rightarrow 3\cos 3x = 2x\sin 3x \Rightarrow \tan 3x = \dfrac{3}{2x}$	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
	$\left(x_2 =\right) 0.4367$	A1
(ii)	$\left(x_4 =\right) 0.4307$	A1
		(3)

Notes:

(a)

M1: Differentiates using the product rule to obtain $\alpha\mathrm{e}^{-x^2}\cos 3x + \beta x\mathrm{e}^{-x^2}\sin 3x$, $\alpha, \beta \neq 0$

A1: Correct derivative in any form

dM1: **Depends on the first method mark.**

Sets their $\dfrac{\mathrm{d}y}{\mathrm{d}x} = 0$ (which may be implied), cancels e^{-x^2} and rearranges to $\pm\tan 3x = ...$

A1*: Correct proof with no errors seen.

Allow e.g. $\tan^{-1}$ or e.g. artan for arctan and allow e.g. $x = \dfrac{1}{3}\arctan\dfrac{3}{2x}$

Ignore any reference or attempts to solve $\mathrm{e}^{-x^2} = 0$

(b)

M1: Attempts to substitute $x = 0.4$ into the formula.

Allow if seen embedded in the formula or may be implied by $x_2 =$ awrt 0.44

A1: Awrt 0.4367

A1: 0.4307 cao **not** awrt 0.4307

Both values correct as defined with no working scores M1A1A1