Question Number	Scheme	Marks
5(a)	$(A=)8$	B1 **(1)**
(b)	$16=10+"8"\mathrm{e}^{-Bt}\Rightarrow \mathrm{e}^{-Bt}=...$	M1
	$\mathrm{e}^{-45B}="\frac{3}{4}"\Rightarrow -45B=\ln"\frac{3}{4}"\Rightarrow B=...$	**d**M1
	$B=$ awrt 0.00639	A1
		(3)
(c)	$\frac{\mathrm{d}T}{\mathrm{d}t}=-"8"\times\frac{1}{45}\ln\left(\frac{4}{3}\right)\times\mathrm{e}^{-\frac{1}{45}\ln\left(\frac{4}{3}\right)\times 2}=...$	M1
	$=-0.0505$	A1
		(2)
(d)	The temperature has a (lower) limit of $10\,°\mathrm{C}$ **or** $5=10+"8"\mathrm{e}^{-Bt}\Rightarrow \mathrm{e}^{-Bt}=-\frac{5}{"8"}$ e.g. which is not possible or cannot be solved or you cannot find the log of a negative number	B1 **(1)**
		(7 marks)

(a)

B1: $(A=)8$ or award for $(T=)10+8\mathrm{e}^{-Bt}$. Note that "$A=$" is not required, just look for 8.

(b)

M1: Sets $16=10+"8"\mathrm{e}^{-Bt}$ and rearranges to the form $\mathrm{e}^{-Bt}=...$ with or without $t = 45$

dM1: Uses $t = 45$, takes lns of both sides and proceeds to find a numerical expression for B

Depends on the previous method mark.

A1: Achieves awrt 0.00639 or 6.39×10^{-3} or e.g. $\frac{1}{45}\ln\left(\frac{4}{3}\right)$ or $-\frac{1}{45}\ln\left(\frac{3}{4}\right)$ or $\frac{-\ln(0.75)}{45}$ etc.

and apply isw once the correct value is seen. **Correct answer only scores <u>no</u> marks.**

(c)

M1: Differentiates using the chain rule to obtain $...\mathrm{e}^{-Bt}$ (not $...\mathrm{e}^{Bt}$) where … is a constant

and substitutes in $t=2$ to obtain a value for $\frac{\mathrm{d}T}{\mathrm{d}t}$.

Condone $\frac{\mathrm{d}T}{\mathrm{d}t}="8"\mathrm{e}^{-Bt}$ as long as it is clear they think they have found $\frac{\mathrm{d}T}{\mathrm{d}t}$.

If they lose the minus sign in $...\mathrm{e}^{-Bt}$ they obtain $\pm0.0518…$ and this scores M0

Note that if there is evidence that $\frac{\mathrm{d}T}{\mathrm{d}t}=...t\mathrm{e}^{-Bt}$ is being used, score M0

A1: -0.0505 cao. Accept 0.0505 **decreasing** or equivalent **<u>following correct work</u>**.

Ignore any units, correct or incorrect)

Correct answer only scores <u>no</u> marks.

(d)

B1: Either states that the (lower) limit of the model is $10\,°\text{C}$ or there is an asymptote at $T = 10$ or as t tends to ∞ T tends to 10. But do not allow incorrect statements e.g. the maximum temperature is 10. Also allow "the maximum the temperature can drop to is 10"

or

shows that the calculation cannot be carried out and makes a statement to that effect.

The working must be correct for their A and/or B where $A > 0$ and $B > 0$ and they must reach at least $e^{-Bt} = ...$

Allow comments such as: "which is not possible", "cannot be done", "you cannot find the log of a negative number" etc. but do not allow ambiguous/incorrect statements e.g. "logs cannot be negative", "you cannot have a negative time"

Also accept equivalent arguments e.g. "Ae^{-Bt} would need to be < 0 and this is not possible" (provided their $A > 0$)

If you are unsure if the reasoning is acceptable or not, use review.

Question Number	Scheme	Marks
6(a)	$\left(\frac{3\pi}{2}, 0\right)$	B1
		(1)
(b)	$f'(x) = \left(6\cos^2 x\right)e^{3\sin x} - \left(2\sin x\right)e^{3\sin x}$	M1A1
	$f'(x) = \left(6\cos^2 x\right)e^{3\sin x} - \left(2\sin x\right)e^{3\sin x}$ $\Rightarrow \left(6\left(1-\sin^2 x\right) - 2\sin x\right)\left(=0\right)$	**d**M1
	$\Rightarrow 3\sin^2 x + \sin x - 3 = 0$ oe	A1
		(4)
(c)	$\sin x = \frac{-1+\sqrt{37}}{6} \Rightarrow x = ...$	M1
	$x = 2.131$	A1
		(2)
		(7 marks)

(a)

B1: $\left(\frac{3\pi}{2}, 0\right)$ or accept the identification that $x = \frac{3\pi}{2}$ at *R* e.g. cos *x* = 0 so $x = \frac{3\pi}{2}$

Accept $\frac{3\pi}{2}$ written on the diagram at the point *R* or just $\frac{3\pi}{2}$ seen as the answer as long as there is no evidence that *y* is anything other than zero. Must be exact.

(b)

M1: Attempts the product rule. Award for the form $f'(x) = \pm\alpha\cos^2 x e^{3\sin x} \pm \beta \sin x e^{3\sin x}$

A1: Correct derivative in any form

dM1: Attempts to use the identity $\pm\sin^2 x \pm \cos^2 x = \pm 1$ to produce a 3 term quadratic expression in sin *x* which may be seen embedded but with the $e^{3\sin x}$ factored.

e.g. $e^{3\sin x}\left(6\left(1-\sin^2 x\right) - 2\sin x\right)$

Depends on the previous method mark.

A1: $3\sin^2 x + \sin x - 3 = 0$ or any integer multiple of this equation e.g. $6 - 6\sin^2 x - 2\sin x = 0$ and apply isw once a correct equation is seen.

Must be "extracted" but allow if seen, used or implied in part (c) and allow recovery from missing brackets if the quadratic expression is extracted correctly.

Beware:

$f'(x) = \left(-6\cos^2 x\right)e^{3\sin x} + \left(2\sin x\right)e^{3\sin x} = 0$ leading to $3\sin^2 x + \sin x - 3 = 0$ scores

M1A0dM1A0

But allow full recovery in (c)