Question Number	Scheme	Marks
6 (a)	$5e^{x-1}+3=18 \Rightarrow e^{x-1}=3$	M1
	$\Rightarrow x=\ln 3+1$ or $e^{x}=3e$	A1
	$\Rightarrow x=\ln 3e$	A1
		(3)
(b)	Sets $5e^{x-1}+3=10-x^{2}$ and proceeds to find and use a suitable function. Eg $(f(x)=)7-x^{2}-5e^{x-1}$	B1
	Attempts $f(1.1335)=0.001$ and $f(1.1345)=-0.007$	M1
	Correct values with reason(change of sign and continuous) and conclusion, hence α is 1.134 to 3dp	A1
		(3)
(c)	$x_2=-\sqrt{7-5e^{-3-1}}=-2.628388$	M1 A1
	$\beta=-2.620330$	A1
		(3)
		(9 marks)

(a)

M1 For attempting to proceed from $5e^{x-1}+3=18$ to $e^{x-1}=...$ or $e^{x}=...$

A1 $x=\ln 3+1$ or for $e^{x}=3e$

A1 $x=\ln 3e$ Accept $x=\ln 3e^{1}$

(b)

B1 Sets the equations equal to each other and finds a suitable function which is then used.

Suitable functions are $f(x)=\pm\left(7-x^{2}-5e^{x-1}\right)$, $g(x)=\pm\left(x-\sqrt{7-5e^{x-1}}\right)$ or $h(x)=\pm\left(x-1-\ln\left(\frac{7-x^{2}}{5}\right)\right)$

M1 Substitutes $x=1.1335$ and $x=1.1345$, or suitable values for a tighter interval (either side of 1.133634..), into a suitable function and obtains one correct value to 1sf rounded or truncated.

FYI for the + options above

$f(1.1335)=0.001$ and $f(1.1345)=-0.007$

$g(1.1335)=-0.0005$ and $g(1.1345)=0.003$

$h(1.1335)=-0.0002$ and $g(1.1345)=0.001$

A1 Requires both values to be correct (1sf rounded or truncated), a reason (change of sign and continuous) and a minimal conclusion

(c)

M1 For an attempt at substituting -3 into the iterative equation.

This is implied by the sight of the expression or awrt -2.63

A1 awrt -2.628388

A1 $\beta=$ awrt -2.620330 condone -2.62033

.....

It is possible in part (b) to score B0 M1 A1 by comparing y values for $y=5e^{x-1}+3$ and $y=10-x^{2}$ at $x=1.1335$ and $x=1.1345$ For the A1 apply the similar criteria as for the main scheme with values to 3d.p..

At $x=1.1335$, $y|_{1.1335}=5e^{x-1}+3=8.714$ and $y|_{1.1335}==10-x^{2}=8.715$

At $x=1.1345$, $y|_{1.1345}=5e^{x-1}+3=8.720$ and $y|_{1.1345}=10-x^{2}=8.713$

Question Number	Scheme	Marks
7.(a)	$R=\sqrt{17}$	B1
	$\tan\alpha=4\Rightarrow\alpha=$ awrt 1.326	M1A1
		(3)
(b)	Minimum height $=\dfrac{24}{3+"R"}=3.37$ (metres)	M1 A1
		(2)
(c)	Uses part (a) $10=\dfrac{24}{3+\sqrt{17}\cos\left(\frac{1}{2}t-1.326\right)}\Rightarrow\cos\left(\frac{1}{2}t-1.326\right)=\dfrac{-0.6}{\sqrt{17}}$	M1 A1
	$t=$ awrt 6.09	M1 A1
		(4)
		(9 marks)

(a)

B1 $R=\sqrt{17}$

Condone $R=\pm\sqrt{17}$ (Do not allow decimals for this mark Eg 4.12 but remember to isw after $\sqrt{17}$)

M1 $\tan\alpha=\pm4,\ \tan\alpha=\pm\dfrac{1}{4}\Rightarrow\alpha=...$

If R is used to find α accept $\sin\alpha=\pm\dfrac{4}{R}$ or $\cos\alpha=\pm\dfrac{1}{R}\Rightarrow\alpha=...$

A1 $\alpha=$ awrt 1.326 Note that the degree equivalent $\alpha=$ awrt $75.96°$ is A0

(b)

M1 Attempts minimum height by stating or finding $\dfrac{24}{3+"R"}$

Attempts via differentiation must be complete methods with correct work up to slips in coefficients. They are unlikely to succeed.

FYI $\dfrac{\mathrm{d}H}{\mathrm{d}t}=-\dfrac{24\left(2\cos\left(\frac{t}{2}\right)-\frac{1}{2}\sin\left(\frac{t}{2}\right)\right)}{\left(4\sin\left(\frac{t}{2}\right)+\cos\left(\frac{t}{2}\right)+3\right)^2}=0\Rightarrow\tan\left(\frac{t}{2}\right)=4\Rightarrow H=\dfrac{24}{3+\cos(1.326)+4\sin(1.326)}$

A1 3.37 (metres) Assume metres unless otherwise stated, but 3.37 cm is A0. Accept 337 cm as long as the units are stated, but do not accept $\dfrac{24}{3+\sqrt{17}}$ and do not isw if incorrect units are given following 3.37.

(c)

M1 Attempts to use their answer to part (a) (including their R and their α) AND proceeds to

$\cos\left(\beta t\pm"1.326"\right)=k,\quad -1<k<1$ and $\beta=1$ or $\dfrac{1}{2}$

A1 $\cos\left(\beta t\pm"1.326"\right)=\dfrac{-0.6}{\sqrt{17}}$ or awrt -0.146 where $\beta=1$ or $\dfrac{1}{2}$

M1 Full method to make t the subject from an equation of the form $\cos\left(\frac{1}{2}t\pm"1.326"\right)=k,\quad -1<k<1$

Look for $2\times\left(\text{their }\arccos\left(k\right)\pm\text{their }\alpha\right)$

A1 awrt $t=6.09$ (Ignore any extra solutions outside the domain, but A0 if extras inside are given.)