Question Number	Scheme	Marks
4(a)	$R = \sqrt{12}$ or $2\sqrt{3}$	B1
	$\alpha = \tan^{-1}\left(\frac{3}{\sqrt{3}}\right) = ...$	M1
	$\left(f(x) =\right)\sqrt{12}\sin\left(2x - \frac{\pi}{3}\right)$	A1
		(3)
(b)(i)	Minimum value $= \frac{18}{\sqrt{12}+4\sqrt{3}}\left(=\sqrt{3}\right)$	B1
(ii)	$\sin\left(6x - \frac{\pi}{3}\right) = 1 \Rightarrow x = \frac{5}{36}\pi$	M1A1
		(3)
		(6 marks)

A1: $\left(T =\right)13$

(a)

B1: $\sqrt{12}$ oee

M1: Attempts to find $\alpha = \tan^{-1}\left(\pm\frac{3}{\sqrt{3}}\right) = ...$ or $\alpha = \tan^{-1}\left(\pm\frac{\sqrt{3}}{3}\right) = ...$ or $\alpha = \cos^{-1}\left(\pm\frac{\sqrt{3}}{2\sqrt{3}}\right) = ...$ or $\alpha = \sin^{-1}\left(\pm\frac{3}{2\sqrt{3}}\right) = ...$

A1: $\left(f(x) =\right)\sqrt{12}\sin\left(2x - \frac{\pi}{3}\right)$ (or exact equivalent). Must give the expression but accept if given in (b), not just the values for R and α, but full marks can be scored in subsequent parts from the correct values if the expression is not explicitly stated.

(b)
(i)

B1: $\sqrt{3}$ or exact equivalent. No need to simplify. If multiple answers are given they must clearly identify this as the minimum value to score the mark.

(ii)

M1: Sets their $\sin\left(6x-\frac{\pi}{3}\right)=1$ and attempts to find a value for *x*. Follow through on f(3*x*) for their f(*x*).

A1: $\frac{5}{36}\pi$ only

Note: Answers only with no working shown is M0 (calculator method).

Question Number	Scheme	Marks
5(a)	$\left(\frac{4000\mathrm{e}^{0}}{19+\mathrm{e}^{0}}\right)=200$	B1
		(1)
(b)	$\frac{\mathrm{d}N}{\mathrm{d}t}=\frac{\left(19+\mathrm{e}^{0.2t}\right)\times 400\mathrm{e}^{0.1t}-4000\mathrm{e}^{0.1t}\times 0.2\mathrm{e}^{0.2t}}{\left(19+\mathrm{e}^{0.2t}\right)^{2}}$	M1A1
		(2)
(c)	$\left(19+\mathrm{e}^{0.2t}\right)\times 400\mathrm{e}^{0.1t}-4000\mathrm{e}^{0.1t}\times 0.2\mathrm{e}^{0.2t}=0\Rightarrow \mathrm{e}^{0.2T}=19$	M1A1
		(2)
(d)	$\mathrm{e}^{0.2T}=19\Rightarrow T=\frac{\ln 19}{0.2}\ (=14.7...)$ $N=\frac{4000\mathrm{e}^{0.1"14.7"}}{19+\mathrm{e}^{0.2"14.7"}}=458.8...\Rightarrow 459$ squirrels	M1 dM1A1
		(3)
		(8 marks)

(a)

B1: 200

(b)

M1: Attempts to differentiate via the quotient rule (or the product rule). Look for reaching $\frac{\left(19+\mathrm{e}^{0.2\mathrm{t}}\right)\times A\mathrm{e}^{0.1t}-B\mathrm{e}^{0.1t}\times\mathrm{e}^{0.2t}}{\left(19+\mathrm{e}^{0.2\mathrm{t}}\right)^{2}}$ or $A\mathrm{e}^{0.1t}\times\left(19+\mathrm{e}^{0.2\mathrm{t}}\right)^{-1}+B\mathrm{e}^{0.1t}\times-\left(19+\mathrm{e}^{0.2\mathrm{t}}\right)^{-2}\times\mathrm{e}^{0.2t}$ where $A, B > 0$

Condone missing brackets for the M mark.

A1: Correct unsimplified derivative and isw. Any missing brackets must have been recovered.

(c)

M1: Sets their numerator of the form $\pm P\mathrm{e}^{0.1T}\pm Q\mathrm{e}^{0.3T}$ (or unsimplified equivalent) equal to zero and rearranges to $\mathrm{e}^{0.2T}=A$

A1: $\mathrm{e}^{0.2T}=19$ and isw. Accept with t instead of T. Allow from answers to (b) with an incorrect denominator but correct numerator or negative of the numerator.

(d)

M1: Takes lns of both sides and proceeds to find a value for T (accept awrt 14.7 if method is not shown). There must be evidence of using logarithms. Alternatively score for stating or implying $\mathrm{e}^{0.1t}=\sqrt{19}$