Question Number	Scheme	Marks
3(a)	$m = \dfrac{2.25-2}{5}$ $\log_{10} V = 0.05t + 2$	M1 A1
		(2)
(b)	$\log_{10} V = 0.05t + 2 \Rightarrow V = 10^{0.05t+2}$ $a = 100$ or $b = 1.12$ $V = 100\times(1.12)^t$	M1 A1 A1
		(3)
(c)	$\dfrac{\mathrm{d}V}{\mathrm{d}t} = 100\times\ln 1.12\times(1.12)^t \quad \left(=11.33(1.12)^t\right)$ $100\times\ln 1.12\times(1.12)^T = 50 \Rightarrow (1.12)^T = \dfrac{50}{100\ln 1.12}$ $(T=)\ \log_{1.12}\left(\dfrac{50}{100\ln 1.12}\right) = \ldots$ $(T=)13$	B1ft M1 dM1 A1
		(4)
		(9 marks)

(a)

M1: Attempts to find the gradient of the line, must be change in "*y*"/change in "*x*". May be found via simultaneous equations – look for an attempt to solve the correct equations.

A1: $\log_{10} V = 0.05t + 2$ Accept log in place of $\log_{10}$ here and throughout but must be correct variables.

(b)

M1: Correct attempt to make *V* the subject, or alternatively takes log of $V = ab^t$ and finds an equation in just *a* or *b* ie either $2 = \log_{10} a$ or $\dfrac{1}{20} = \log_{10} b$. If there is no incorrect working allow for obtaining an expression for *a* or *b*, e.g. $a = 10^2$ or $b = 10^{0.05}$.

A1: $a = 100$ or $b = \text{awrt}\,1.12$ (may be stated or embedded in an equation of the correct form).

A1: $V = 100\times(\text{awrt } 1.12)^t$. The equation must be given not just values.
SC Award M1A1A0 for candidates who start with an incorrect step of $V = 10^{0.05t} + 10^2$ but recover to $V = 10^2\times 10^{0.05t} = 100(1.12)^t$ in subsequent work (and similar for variants).

(c)

B1ft: Differentiates to the form $"100"\ln"1.12"\times("1.12")^t$ follow through their values for *a* and *b* from part (b). Accept any unsimplified equivalents and values correct to 3sf.

M1: Sets their $\frac{\mathrm{d}V}{\mathrm{d}t}$ - which must be a changed function of the form $K("1.12")^t$ (*K* may be 1) equal to 50 and rearranges to the form $("1.12")^T = ...$

dM1: Correctly proceeds from and equation of form $("1.12")^T = ...$ to $T = ...$ (any valid means, you may need to check their value if no method is shown).

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.