Question Number	Scheme	Marks
3(a)	$\int \frac{9x}{3x^2+k}\,\mathrm{d}x = \frac{3}{2}\ln\left(3x^2+k\right)+C$	M1A1
		(2)
(b)	$\frac{3}{2}\ln(75+k)-\frac{3}{2}\ln(12+k)=\ln 8$	M1
	$\frac{3}{2}\ln\left(\frac{75+k}{12+k}\right)=\ln 8$ oe	dM1
	$\frac{75+k}{12+k}=4\Rightarrow k=...$	ddM1
	$(k=)\ 9$	A1
		(4)
		(6 marks)

(a)

M1 Integrates to $A\ln(3x^2+k)$ with or without the + *C*. Allow *A* = 1 for this mark. Condone invisible brackets.

A1 $\frac{3}{2}\ln\left(3x^2+k\right)+C$ or $\frac{3}{2}\ln B\left(3x^2+k\right)$ oe Must include the constant of integration that is different from *k*. Must have brackets around $3x^2+k$

Also allow eg $\ln\left[B\left(3x^2+k\right)\right]^{\frac{3}{2}}$

(b) *Be aware they can solve equations on the calculator which is not acceptable*

M1 Attempts to substitute in 5 and 2 into their changed expression which must include *x* and *k*, subtracting either way round and sets equal to $\ln 8$. The values embedded in an equation is sufficient to score this mark. Condone slips if they attempted to evaluate when substituting in. Ignore the + *C* .

dM1 Attempts to apply the subtraction (or addition) law of logarithms once to an equation of the form $\pm A\ln(B+k)\pm A\ln(C+k)=\ln D$ or equivalent (allow *A* = 1) **.**

Typically look for $A\ln(B+k)-A\ln(C+k)=\ln D \Rightarrow A\ln\left(\frac{B+k}{C+k}\right)=\ln D$ or equivalent

Do not be concerned with arithmetical errors and condone slips dealing with their *A*

Condone invisible brackets.

ddM1 Solves their equation of the form $\ln\left(\frac{B+k}{C+k}\right)=\ln D^{\frac{1}{A}}$ or $\ln\left(\frac{B+k}{C+k}\right)^{A}=\ln D$

where $A\neq 1$, and the *A* is correctly dealt with by

- removing lns correctly
- rearranging to form a linear equation in *k*
- proceeding to find a value for *k*.

eg $\text{"}\ln\left(\frac{\text{"75"}+k}{\text{"12"}+k}\right)=\ln 8^{\text{"}\frac{2}{3}\text{"}} \Rightarrow \text{"75"}+k=\text{"48"}+\text{"}4k\text{"} \Rightarrow k=...$

It is dependent on both of the previous method marks.

Condone arithmetical slips in their rearrangement and condone invisible brackets as long as the intention is clear. Also condone this mark to be scored if *k* is negative.

A1 9 cao (with intermediate working seen)

They cannot proceed from $\frac{3}{2}\ln(75+k)-\frac{3}{2}\ln(12+k)=\ln 8$ to $(k=)\ 9$ without some intermediate working seen (eg an equation with the lns removed)

Note an answer of $\ln\left(3x^2+k\right)\ (+C)$ in (a) will score a maximum of M1dM1ddM0A0 in (b)

Question Number	Scheme	Marks
4(a)	Gradient $= \dfrac{3.85-3.08}{5-0}$ (=0.154 or $\dfrac{77}{500}$) $\log_{10} N = 3.08 + 0.154t$ oe	M1 A1
		(2)
(b)	$a = 10^{3.08} =$ awrt 1200 $\log_{10} b = "0.154"$ or $b = 10^{"0.154"}$ $b =$ awrt 1.43	B1 M1 A1
		(3)
(c)	$\log_{10} 500\,000 = 3.08 + 0.154T \Rightarrow T = ...$ or $T = \log_{"1.43"}\left(\dfrac{500\,000}{"1200"}\right) = ...$ $(T =)$ awrt 17	M1 A1
		(2)
		(7 marks)

Mark (a) and (b) together
(a)

M1 A correct attempt to find the gradient between the given coordinates. This may be implied by $10^{0.154}$ or awrt 1.43 or $\dfrac{77}{500}$. The values embedded in the expression $\dfrac{3.85-3.08}{5-0}$ or $\dfrac{3.08-3.85}{-5}$ is sufficient. Check Figure 1 and may be seen in (b)

A1 $\log_{10} N = 3.08 + 0.154t$ Must be in terms of $\log_{10} N$ and t (may be seen in (b))
Condone log N or lg N for $\log_{10} N$ but do not accept ln N
Accept equivalent equations such as $\log_{10} N = \dfrac{77}{25} + \dfrac{77}{500}t$ or $500\log_{10} N = 1540 + 77t$ or $t = \dfrac{500}{77}\log_{10} N - \dfrac{1540}{77}$
Do not accept $N = 1200 \times 1.43^t$