Question Number	Scheme	Marks
4 (a)	$\log_{10} N = 2 \Rightarrow N = 100$	B1
		(1)
(b)	$\log_{10} N = 0.35t + 2 \Rightarrow N = 10^{0.35t+2}$	M1
	$\Rightarrow N = 10^{0.35t} \times 10^{2}$	dM1
	$\Rightarrow N = 100 \times 2.24^{t}$	A1
		(3)
(c)	Rate of growth at 5 hours is $\frac{dN}{dt} = 100 \times \ln 2.24 \times 2.24^{5}$	M1
	Allow an answer in the range 4530 to 4550 (bacteria per hour)	A1
		(2)
		Total 6

(a)

B1: For 100 Do not accept just 10^2 and cannot be awarded from 100 in part (b)

(b) **The demand of the question is 'show that', not just find values of *a* and *b***

Method 1: starting with $\log_{10} N = 0.35t + 2$

M1: Undoes the log. E.g. $\log_{10} N = 0.35t + 2 \Rightarrow N = 10^{0.35t+2}$

Give BOD for those who go from $\log_{10} N = 0.35t + 2$ straight to $N = 10^{0.35t} \times 10^{2}$

dM1: And follows with a correct application of the index law.

Look for $\log_{10} N = 0.35t + 2 \Rightarrow N = 10^{0.35t+2} = 10^{0.35t} \times 10^{2}$ o.e such as $10^{0.35t} \times 100$

But BOD for $\log_{10} N = 0.35t + 2 \Rightarrow N = 10^{0.35t} \times 10^{2}$ o.e. such as $10^{0.35t} \times 100$

And BOD for $\log_{10} N = 0.35t + 2 \Rightarrow N = 10^{0.35t+2} \Rightarrow N = 100 \times 2.24^{t}$

A1: CSO $N = 100 \times 2.24^{t}$ with no errors following M1, dM1. Allow awrt 2.24

Condone $a = 100, b = 2.24$ following the award of M1 dM1

You should expect to see at least one correct line of working and no errors

Method 2: starting with $N = ab^{t}$

M1: Takes logs of both sides and applies one correct rule. E.g $N = ab^{t} \Rightarrow \log N = \log a + \log b^{t}$

Give BOD for those who write $N = ab^{t}$ followed by $\log N = \log a + t \log b$

dM1: And follows with $\log N = \log a + t \log b$ before setting

$\log a = 2$ and $\log b = 0.35$ and proceeding to values for *a* and *b*

A1: Fully shows and produces correct values following M1, dM1

CSO $N = 100 \times 2.24^{t}$ with no errors. Allow awrt 2.24

Condone $a = 100, b = 2.24$ following the award of M1 dM1

You should expect to see at least one correct line of working and no errors

Method 3: A simultaneous approach that finds values but does not show the result
M1: Sets up two simultaneous equations in *a* and *b*

E.g. Uses $t = 0, N = 100 \Rightarrow a = 100$ and $t = 1, N = 10^{2.35} \Rightarrow ab^1 = 223.9$

dM1: Solves to find values for *a* and *b*.
A0: Has not **shown** the result so cannot be awarded

Common error: Special Case

$\log_{10} N = 0.35t + 2 \Rightarrow N = 10^{0.35t} + 10^2$ so $a = 100$ and $b = 2.24$

Or even

$\log_{10} N = 0.35t + 2 \Rightarrow N = 10^{0.35t} + 10^2 \Rightarrow N = 100 \times 2.24^t$ so $a = 100$ and $b = 2.24$

Such work resulting in the **correct** values for *a* and *b* scores SC 100

(c) Full marks in part (c) can be scored following the SC

M1: Attempts $\frac{dN}{dt} = K \times "2.24"^5$ following through on their 2.24.

This cannot be scored from substituting *t* = 5 into their ab^t

A1: Calculates $\frac{dN}{dt} = 100 \times \ln 2.24 \times 2.24^5$ and achieves an answer in the range 4530 to 4550 (bacteria per hour)

Question Number	Scheme	Marks
5(a)	$\sin 3x = \sin(2x+x) = \sin 2x\cos x + \cos 2x \sin x$	M1
	$= (2\sin x\cos x)\cos x + (1-2\sin^2 x)\sin x$	dM1
	$= 2\sin x\cos^2 x + \sin x - 2\sin^3 x$	A1
	$= 2\sin x(1-\sin^2 x) + \sin x - 2\sin^3 x = 3\sin x - 4\sin^3 x$	A1
		(4)
(b)	$2\sin 3\theta = 5\sin 2\theta \Rightarrow 2(3\sin\theta - 4\sin^3\theta) = 10\sin\theta\cos\theta$	M1
	Divides or takes out $\sin\theta$ as a factor and uses $\sin^2\theta = 1-\cos^2\theta$ to set up and solve a 3TQ in $\cos\theta$ E.g. $\Rightarrow 6\sin\theta - 8\sin^3\theta = 10\sin\theta\cos\theta \Rightarrow 6-8(1-\cos^2\theta) = 10\cos\theta$ $\Rightarrow 4\cos^2\theta - 5\cos\theta - 1 = 0$ $\Rightarrow \cos\theta = \dfrac{5-\sqrt{41}}{8} = (-0.175...)$	dM1
	Any two of the following four answers $\sin\theta = 0 \Rightarrow \theta = 180°, 360°$ $\cos\theta = \dfrac{5-\sqrt{41}}{8} \Rightarrow \theta =$ awrt 100° or awrt 260°	A1
	All of 180°, 360°, awrt 100.1°, awrt 259.9°	A1
		(4)
		Total 8

(a)

M1: Attempts $\sin 3x = \sin(2x+x)$ and achieves $\pm\sin 2x\cos x \pm \cos 2x\sin x$. The $= \sin(2x+x)$ may be implied

dM1: Dependent upon the previous mark. It is for using $\sin 2x = 2\sin x\cos x$ and $\cos 2x = \pm 1 \pm 2\sin^2 x$, $\pm 1 \pm 2\cos^2 x$ or $\pm(\cos^2 x - \sin^2 x)$ to form an expression in just sin$x$ and cos$x$.

A1: Fully correct AND expanded expression in just sin$x$ and cos$x$

Examples of correct expanded expressions are;

$2\sin x\cos^2 x + \sin x - 2\sin^3 x$

$2\sin x\cos^2 x + 2\sin x\cos^2 x - \sin x$

$2\sin x\cos^2 x + \sin x\cos^2 x - \sin^3 x$

or $4\sin x\cos^2 x - \sin x$

Condone a missing x on a sin x, for example. Condone a slip in notation, e.g. writing $\sin x^3$ instead of $\sin^3 x$ as long as it is subsequently corrected.

A1: Proceeds correctly to $3\sin x - 4\sin^3 x$ using $\cos^2 x = 1-\sin^2 x$

Penalise notational and bracketing errors on this mark only

E.g. Writing $\cos x^2$ for $\cos^2 x$, mixing variables, missing x on a sin x etc