A1: FYI Quadratic is $32x^2-12x-3915$ which has critical values of $-\frac{87}{8}$ and $\frac{45}{4}$ which may be found via a calculator

dM1: Selects outside region. It is dependent upon a correct $\frac{1}{4}(2x+7)^2...\left(\frac{1}{3}x+11\right)^2$ o.e.

A1: $x\leqslant -\frac{87}{8}, x\geqslant \frac{45}{4}$ Allow other forms such as $x\in\left(-\infty,-\frac{87}{8}\right]\cup\left[\frac{45}{4},\infty\right)$

Question Number	Scheme	Marks
8 (a)	$\log_{10} x = 2.74-0.079t$	
	$\log_{10} x = 2.74-0.079t$ | $x = p\,q^{-t}$	
	$x = 10^{2.74}\times 10^{-0.079t}$ | $\log_{10} x = \log_{10} pq^{-t}$	
	$x = 10^{2.74}\times\left(10^{0.079}\right)^{-t}$ | $\log_{10} x = \log_{10} p - t\log_{10} q$	
	A correct equation for p or q. E.g. either $\log_{10} p = 2.74$ or $\log_{10} q = 0.079$	M1
	A correct value for either p or q. Either $p =$ awrt 550 or $q =$ awrt 1.2	A1
	A correct equation for both p and q. E.g both $p = 10^{2.74}$ and $q = 10^{0.079}$	dM1
	Both $p =$ awrt 550 and $q =$ awrt 1.2 **with** proof*	A1*
		(4)
(b)	"p" is the amount of antibiotic (in mg) in the patient's bloodstream at the start	B1
		(1)
(c)	$x = 400\times 1.4^{-t} \Rightarrow \frac{dx}{dt} = -400\ln 1.4\times 1.4^{-t}$	B1
	Substitutes $t=5$ into $\frac{dx}{dt} =$ awrt -25	M1 A1
		(3)
		(8 marks)

(a)

M1:A correct equation in either p or q

For p look for $\log_{10} p = 2.74$ or $p = 10^{2.74}$ For q look for $\log_{10} q = 0.079$ or $q = 10^{0.079}$

This is implied by a correct value for either p or q (See below), $x = 550\times q^{-t}$, or $x = p\times 1.2^{-t}$

A1:Either $p =$ awrt 550, $q =$ awrt 1.2, $x = 550\times q^{\pm t}$, or $x = p\times 1.2^{-t}$

dM1:A correct equation for both p and q. E.g. sight of both $p = 10^{2.74}$ and $q = 10^{0.079}$

This may be implied by $x = 550\times 1.2^{-t}$

A1*: Both $p =$ awrt 550 and $q =$ awrt 1.2 **with** proof* as it is a "show that" question.

There must be no incorrect working. Correct values of p and q are implied by $x = 550\times 1.2^{-t}$

This "proof" part can be shown with a minimum of working

Starting with $x = p\,q^{-t}$ a minimum of $\log_{10} x = \log_{10} p - t\log_{10} q$ followed by correct equations and values is sufficient

Starting with $\log_{10} x = 2.74-0.079t$ a minimum of $x = 10^{2.74}\times 10^{-0.079t}$ followed by correct equations and/or values is sufficient

(b)

B1 Award for a statement that refers or alludes to the amount of antibiotic in the bloodstream when $t = 0$

E.g. "p" is the amount of antibiotic (in mg) (in the patient's bloodstream) at the start

Condone that "p" is the dose of antibiotic (in mg) given to the patient

Condone " just / immediately after" but not "before" the dose is given

Don't allow students to give a correct and an incorrect answer. This would be B0

(c)

B1: $x = 400 \times 1.4^{-t} \Rightarrow \dfrac{\mathrm{d}x}{\mathrm{d}t} = \pm 400 \ln 1.4 \times 1.4^{-t}$

M1: Substitutes $t = 5$ into a changed function of the form $\left(\dfrac{\mathrm{d}x}{\mathrm{d}t}\right) = k \times 1.4^{-t}$ where $k \neq 400$

The left hand side may be incorrect. E.g. $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ or similar

A1: $\dfrac{\mathrm{d}x}{\mathrm{d}t} = \text{awrt} - 25$

Note that candidates who lose the negative sign when differentiating to get $\dfrac{\mathrm{d}x}{\mathrm{d}t} = \text{awrt } 25$ score B1 M1 A0

Alt seen;

B1: $x = 400 \times 1.4^{-t} \Rightarrow \ln x = \ln 400 - t \ln 1.4 \Rightarrow \dfrac{1}{x}\dfrac{\mathrm{d}x}{\mathrm{d}t} = \pm \ln 1.4$

M1 A1: As before

Question Number	Scheme	Marks
9 (i)	$2\sec^2 x - 3\tan x = 2$	
	$2\left(1+\tan^2 x\right) - 3\tan x = 2$	M1
	$2\tan^2 x = 3\tan x \Rightarrow \tan x = \frac{3}{2}, \left(\tan x = 0\right)$	dM1
	$x =$ awrt $0.983, \pi$	A1, B1
		(4)
(ii)	$\frac{\sin 3\theta}{\sin\theta} - \frac{\cos 3\theta}{\cos\theta} \equiv \frac{\sin 3\theta\cos\theta - \cos 3\theta\sin\theta}{\sin\theta\cos\theta} \equiv \frac{\sin\left(3\theta-\theta\right)}{\sin\theta\cos\theta}$	M1
	$\equiv \frac{\sin\left(3\theta-\theta\right)}{\frac{1}{2}\sin 2\theta}$	dM1, A1
	$\equiv \frac{\cancel{\sin 2\theta}}{\frac{1}{2}\cancel{\sin 2\theta}} \equiv 2$ *	A1*
		(4)
		(8 marks)

(i)

M1: Attempts to use $\sec^2 x = \pm 1 \pm \tan^2 x$ within the given equation, condoning slips

There are alternatives using for example $\sec^2 x = \frac{1}{\cos^2 x}$, $\tan x = \frac{\sin x}{\cos x}$ and $\cos^2 x = 1 - \sin^2 x$

FYI the correct equation using this method would be $2\sin^2 x - 3\sin x\cos x = 0$

dM1: Valid method of solving a quadratic equation in $\tan x$. Condone division by $\tan x$

In the alternative the method of solving is similar $\sin x\left(2\sin x - 3\cos x\right) = 0 \Rightarrow \tan x = \frac{3}{2}$

A1: $x =$ awrt 0.983 as the only solution to $\tan x = \frac{3}{2}$ in the region $\left(0, \pi\right]$

B1: $x = \pi$ or awrt 3.14 (as the only solution in the range for $\tan x = 0$ or $\sin x = 0$ in the region $\left(0, \pi\right]$).

Condone the inclusion of 0 as that is outside the range

Condone 180° if both angles have been given in degrees. Ignore any solution outside the range

(ii)

M1: Attempts to form a single fraction and uses

- either the compound angle formula on the numerator. Allow $\sin\left(3\theta \pm \theta\right)$
- or the double angle on the denominator. Allow $\sin\theta\cos\theta = k\sin 2\theta$

dM1: Attempts to form a single fraction and uses both

- the compound angle formula on the numerator. Must be $\sin\left(3\theta - \theta\right)$
- and the double angle on the numerator or denominator. Allow $\sin\theta\cos\theta = k\sin 2\theta$

A1: For reaching the form $\frac{\sin\left(3\theta-\theta\right)}{\frac{1}{2}\sin 2\theta}$ **or** $\frac{2\sin\theta\cos\theta}{\sin\theta\cos\theta}$

A1*: Fully complete proof.

Alt soln

M1: Attempts compound angle formulae for both $\sin 3\theta$ and $\cos 3\theta$. Condone **only** sign slips