$\sin 2\theta = \frac{1}{5} \Rightarrow (\theta =)\ 0.101, 1.47$

$\text{cosec}\ 2\theta = 5 \Rightarrow (\theta =)\ 0.101, 1.47$

Question Number	Scheme	Marks
8(a)	$\frac{dv}{dt} = -e^{t-10} + 9e^{-0.75t} = 0 \Rightarrow 9 = e^{1.75t-10}$ or $9e^{-0.75t} = e^{t-10}$	M1A1
	$9 = e^{1.75t-10} \Rightarrow t = \frac{10+\ln 9}{1.75}$ or $\ln 9 - 0.75t = t - 10 \Rightarrow t = \frac{10+\ln 9}{1.75}$	M1
	$t = \text{awrt } 6.97$	A1
	awrt $11.9\ (\text{ms}^{-1})$	A1
		(5)
(b)	$\int 12 - 12e^{-0.75t} - e^{(t-10)}\,dt = 12t - e^{(t-10)} + 16e^{-0.75t}\ (+C)$	M1A1
	$\left[12t - e^{(t-10)} + 16e^{-0.75t}\right]_0^T = 100 \Rightarrow 12T = \ldots$	M1
	$T = \frac{1}{12}\left(116 - 16e^{-0.75T} + e^{T-10} - e^{-10}\right)$ *	A1*
		(4)
(c) **(i)**	$T_2 = \frac{1}{12}\left(116 - 16e^{-0.75\times 10} + e^{10-10} - e^{-10}\right)$	M1
	$T_2 = \text{awrt } 9.7493$	A1
(ii)	9.7293 (seconds)	A1
		(3)
		(12 marks)

(a) *** Be aware this can be solved directly on a calculator. Calculus must be seen***

M1 Differentiates to $\pm Ae^{t-10} \pm Be^{-0.75t}$ and **sets equal to 0** Must be seen in (a) Do not accept differentiating to eg $\ldots te^{t-10}$. Condone an expression of $12 \pm Ae^{t-10} \pm Be^{-0.75t}$ only

A1 $9 = e^{1.75t-10}$ or equivalent eg $9e^{-0.75t} - e^{t-10} = 0$

M1 Proceeds from their equation of the form $Ae^{Ct\pm D} - Be^{Et\pm F} = 0$ or equivalent leading to a value or an expression (which may be unsimplified) for *t*. If log work is seen it must be correct.

Eg $\frac{40+4\ln 9}{7}$ or $\frac{10+\ln 9}{1.75}$ will score this mark

$9e^{-0.75t} - e^{t-10} = 0 \Rightarrow$ awrt 6.97 can also score this mark

This cannot be scored from an unsolvable equation.

A1 awrt 6.97 or awrt 6.96 including exact unsimplified expressions such as $\frac{40+4\ln 9}{7}$ or $\frac{10+\ln 9}{1.75}$.

A1 awrt 11.9 (ms^{-1}) with all previous marks scored. Condone lack of units

Note: awrt 6.97 and awrt 11.9 with no calculus scores 0 marks

(b)

M1 Attempts to integrate the expression for *v*. Award for $12t \pm Ae^{(t-10)} \pm Be^{-0.75t}$.

Do not accept eg $12t \pm Ae^{(t-10)+1} \pm Be^{-0.75t+1}$

Allow if their attempt to integrate appears in part (a) as long as it is a clear attempt at integration. Limits may have been substituted in.

A1 $12t - e^{(t-10)} + 16e^{-0.75t}$ (with or without $+C$) and allow unsimplified eg $12t - e^{(t-10)} - \frac{12}{-0.75}e^{-0.75t}$

Do not withhold this mark if they write $12x$ but subsequently replace it with T later on.

M1 Substitutes T and 0 into their changed expression with three different terms in t, sets equal to 100 and attempts to make $12T$ or T the subject.

Eg $\left(12T - e^{T-10} + 16e^{-0.75T}\right) - \left(-e^{-10} + 16\right) = 100 \Rightarrow 12T = ...$

Condone arithmetical slips in their rearrangement.

A1* $T = \frac{1}{12}\left(116 - 16e^{-0.75T} + e^{T-10} - e^{-10}\right)$ with no errors including bracket errors/omissions.

Must have $T =$ …

(c)

(i)

M1 Substitutes 10 into the iterative formula. The expression with 10 embedded is sufficient to score this mark.

May be implied by awrt 9.7492 or awrt 9.7493. May also be implied by 9.7306

A1 awrt 9.7493

(ii) ***Be aware that this can be found directly on a calculator which is not acceptable***

A1 9.7293 (seconds) (cannot be awarded without the method mark)

SC If they over round in (i) and (ii) and achieve 9.749 and 9.729 then award M1A0A1

Question Number	Scheme	Marks
9(a)	$\frac{dy}{dx} = \frac{(1+\sin x)(-2\sin x)-(1+2\cos x)\cos x}{(1+\sin x)^2}$	M1A1
	$(1+\sin x)(-2\sin x)-(1+2\cos x)\cos x = 0$ $\Rightarrow -2\sin x - \cos x - 2 = 0$	dM1
	$2\sin x + \cos x = -2$ *	A1*
		(4)
(b)		
	Possible solutions from $R\sin(x+\alpha)$ or $R\cos(x-\alpha)$: $2\sin x + \cos x = -2 \Rightarrow \sqrt{5}\sin(x+0.464) = -2$ or $\sqrt{5}\cos(x-1.107) = -2$ or eg solutions from squaring	M1M1A1
	$(2\sin x + \cos x)^2 = 4 \Rightarrow \cos x(3\cos x - 4\sin x) = 0$ --- $\sqrt{5}\sin(x+0.464) = -2$ or $\sqrt{5}\cos(x-1.107) = -2 \Rightarrow x = ...$ or $\tan x = \frac{3}{4} \Rightarrow x = ...$	dM1
	$x =$ awrt 3.79	A1
		(5)
		(9 marks)

(a)

M1 Attempts to differentiate by the product rule or quotient rule and proceeds to:

Quotient rule: $\frac{\pm A(1+\sin x)(\sin x) \pm (1+2\cos x)\cos x}{....}$ (Scored for the numerator only)

Product rule: $\pm\cos x(1+2\cos x)(1+\sin x)^{-2} \pm A\sin x(1+\sin x)^{-1}$

Alternatively, they express $\frac{1+2\cos x}{1+\sin x} = \frac{1}{1+\sin x} + \frac{2\cos x}{1+\sin x}$ and proceed to either

Quotient rule: $\pm\frac{\cos x}{(1+\sin x)^2} \pm \frac{A\sin x(1+\sin x) \pm \cos x(2\cos x)}{(1+\sin x)^2}$

Product rule: $\pm\cos x(1+\sin x)^{-2} \pm A\cos^2 x(1+\sin x)^{-2} \pm B\sin x(1+\sin x)^{-1}$

Condone arithmetical slips and invisible brackets.

A1 $\left(\frac{dy}{dx} =\right) \frac{(1+\sin x)(-2\sin x)-(1+2\cos x)\cos x}{(1+\sin x)^2}$ or equivalent (which may be unsimplified)