Question Number	Scheme	Marks
4(a)	$10=\log_a 8-\log_a 4\Rightarrow \log_a 2=10$	M1
	$a^{10}=2$	M1
	$a=2^{1/10}=1.07177...$ *	A1*
		(3)
(b)	$w=\log_{1.072}(t+5)-\log_{1.072}4\Rightarrow w=\log_{1.072}\left(\frac{t+5}{4}\right)$	M1
	$w=\log_{1.072}\left(\frac{t+5}{4}\right)\Rightarrow \frac{t+5}{4}=1.072^w\Rightarrow t=...$	M1
	$t=4\times 1.072^w-5$	A1
		(3)
(b) ALT	$w=\log_{1.072}(t+5)-\log_{1.072}4\Rightarrow w+\log_{1.072}4=\log_{1.072}(t+5)$	M1
	$\Rightarrow t+5=1.072^{w+\log_{1.072}4}$	M1
	$\Rightarrow t=1.072^{w+\log_{1.072}4}-5$	A1
(c)	$t=4\times 1.072^{15}-5=...$	M1
	awrt 6.35	A1
		(2)
		(8 marks)

(a)

M1: Substitutes $t=3$ and $w=10$ into the equation and achieves $\log_a 2=10$ or e.g. $\log_a \frac{8}{4}=10$ correctly

M1: Correctly removes the log to obtain $a^{10}="2"$

A1*: Fully correct proof showing $a=2^{1/10}$ or $a=\sqrt[10]{2}$ or $a=\sqrt[10]{\frac{8}{4}}$ and obtains awrt 1.072

Note that this may be implied by the accuracy of their *a* e.g. 1.071773463… so allow for 1.0718 (rounded) or 1.0717 (truncated).

May also see logarithm approach e.g. $a^{10}=2\Rightarrow \log a^{10}=\log 2\Rightarrow \log a=\frac{\log 2}{10}\Rightarrow a=10^{\frac{\log 2}{10}}=...$

or $a^{10}=2\Rightarrow \ln a^{10}=\ln 2\Rightarrow \ln a=\frac{\ln 2}{10}\Rightarrow a=e^{\frac{\ln 2}{10}}=...$

<u>False solutions in (a):</u>

$$10=\log_a 8-\log_a 4\Rightarrow \frac{\log_a 8}{\log_a 4}=10\Rightarrow \log_a 2=10\Rightarrow a^{10}=2\Rightarrow a=\sqrt[10]{2}=1.072$$

Scores **M0M1A0**

$$10=\log_a 8-\log_a 4\Rightarrow \frac{8\log a}{4\log a}=10\Rightarrow 2\log a=10\Rightarrow \log a^2=10\Rightarrow a^{10}=2\Rightarrow a=\sqrt[10]{2}=1.072$$

Scores no marks

(b)

M1: Applies the subtraction law for logs to write the equation as $w = \log_{1.072}\left(\frac{t+5}{4}\right)$

M1: Writes the equation as $1.072^w = \mathrm{f}(t)$ and proceeds to make *t* the subject.

A1: $t = 4\times 1.072^w - 5$

Alternative:

M1: Rearranges to make $\log_{1.072}(t+5)$ the subject correctly

M1: Removes the logs on lhs to obtain $\mathrm{f}(t) = 1.072^{\mathrm{g}(w)}$

A1: Correct equation. $t = 1.072^{w+\log_{1.072} 4} - 5$

In both cases allow the use of "*a*" or a more accurate value for "*a*" rather than 1.072 for both method marks.

(c)

M1: Substitutes $w = 15$ into their equation from (b) or possibly the given equation $w = \log_{1.072}(t+5) - \log_{1.072} 4$ and proceeds to find a value for *t*

A1: awrt 6.35 (months) (NB If full accuracy used for *a* answer is 6.3137… and scores A0)
Ignore any units if given.

Question Number	Scheme	Marks
5(a)	$\cos\theta(3\cos\theta-\tan\theta)=2\Rightarrow\cos\theta(3\cos\theta-\frac{\sin\theta}{\cos\theta})=2$ or e.g. $\cos\theta(3\cos\theta-\tan\theta)=2\Rightarrow 3\cos^2\theta-\sin\theta=2$ or e.g. $\cos\theta(3\cos\theta-\tan\theta)=2\Rightarrow 3\cos^2\theta-\frac{\sin\theta}{\cos\theta}\cos\theta=2$	M1
	$3(1-\sin^2\theta)-\sin\theta=2$	M1
	$3\sin^2\theta+\sin\theta-1=0$ *	A1*
		(3)
(b)	$(\sin 2x=)\frac{-1\pm\sqrt{13}}{6}$ (or awrt 0.43 and awrt –0.77 (or truncated –0.76))	M1A1
	$2x=\sin^{-1}(0.434...)$ or $2x=\sin^{-1}(-0.77...)\Rightarrow x=...$	M1
	$-1.13,\ -0.438,\ 0.225,\ 1.35$	A1A1
		(5)
		(8 marks)

(a)

M1: Uses $\tan\theta=\frac{\sin\theta}{\cos\theta}$ to write the equation in terms of sine and cosine only.

M1: Uses $\sin^2\theta+\cos^2\theta=1$ to obtain a quadratic equation in sine only.

A1*: Achieves $3\sin^2\theta+\sin\theta-1=0$ * with no errors.

Condone one notational slip e.g. $3\sin\theta^2$ instead of $3\sin^2\theta$ or e.g. 3 sin for $3\sin\theta$ in the working but the printed answer must be correct but allow e.g. $0=\sin\theta+3\sin^2\theta-1$

(b)

M1: Attempts to solve the quadratic $3\sin^2\theta+\sin\theta-1=0$ which may be in any variable. Usual rules apply for solving a quadratic (via a calculator is also acceptable and may imply this mark). If no working is shown then the roots must be correct.

A1: $\frac{-1\pm\sqrt{13}}{6}$ or a minimum of $\frac{-1\pm\sqrt{13}}{2\times 3}$ (or as decimals awrt 0.43 and awrt –0.77).

Whether subsequently rejected or not. Ignore any labelling just look for these values.

M1: Attempts to find one angle within the range by finding the inverse sine of one of their roots and dividing by 2. May be implied by their values and allow if working in degrees.

A1: Any two of awrt $-1.13,\ -0.438,\ 0.225,\ 1.35$

A1: All four of awrt $-1.13,\ -0.438,\ 0.225,\ 1.35$ and no others in the range.

Special case - answers in degrees: –64.9, –25.1, 12.9, 77.1

Score A1 for awrt any 2 of these and then A0 so a maximum of 7/8 for the question.

NB allow answers to be found in degrees which are subsequently converted to radians but then left in terms of π e.g. $\frac{-64.9\pi}{180}$ etc. provided the answers round to the $-1.13,\ -0.438,\ 0.225,\ 1.35$

Some candidates are obtaining a different quadratic equation in (a) e.g. $3\sin^2\theta-\sin\theta-1=0$. In such cases allow both M marks in (b) if they persist with their incorrect quadratic provided there are sign errors only e.g. $\pm 3\sin^2\theta\pm\sin\theta\pm 1=0$