Question Number	Scheme	Marks	AOs
8 (i)	$\tan\theta = \dfrac{\sin\theta}{\cos\theta}$	B1	1.1a
	e.g. $2\dfrac{\sin\theta}{\cos\theta} - 5\sin\theta\cos\theta = 0 \Rightarrow \sin\theta\left(2 - 5\cos^2\theta\right) = 0$ **or** $2\dfrac{\sin\theta}{\cos\theta} - 5\sin\theta\cos\theta = 0 \Rightarrow \sin\theta\left(2 - 5 + 5\sin^2\theta\right) = 0$	M1	3.1a
	$\cos\theta = (\pm)\sqrt{\dfrac{2}{5}} \Rightarrow \theta = ...$ **or** $\sin\theta = (\pm)\sqrt{\dfrac{3}{5}} \Rightarrow \theta = ...$	dM1	1.1b
	Two of $\theta = 50.8°, 129.2°, 180°, 230.8°$ All $\theta = 50.8°, 129.2°, 180°, 230.8°$ with no extras	A1 A1	1.1b 2.1
		(5)	
(ii)	$H = 40\sin(0.3t + 2)°$		
(a)	$t = 0 \Rightarrow H = 40\sin 2°$	M1	3.4
	awrt 1.40 metres	A1	3.2a
		(2)	
(b)	$25 = 40\sin(0.3T + 2)° \Rightarrow \sin(0.3T + 2)° = \dfrac{25}{40}$	M1	3.1b
	$\Rightarrow 0.3T + 2 =$ either 38.7 or 141.3	A1	1.1b
	$\Rightarrow 0.3T + 2 =$ "141.3" $\Rightarrow T = ...$	dM1	3.2a
	$\Rightarrow T =$ awrt 464	A1	1.1b
		(4)	
			(11 marks)

Notes:

(i) **Do not be concerned about their argument throughout part (i), so they may be using e.g. *x* With the exception of the B1, condone their argument going "missing".**

B1: States or uses a **correct** $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$ which may be seen in the body of their work or as side working. There must be an argument for this mark, e.g. $\tan x = \dfrac{\sin x}{\cos x}$ but not just $\tan = \dfrac{\sin}{\cos}$

M1: Uses $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$, multiplies by $\cos\theta$, takes out a factor of $\sin\theta$ **or** cancels $\sin\theta$ to form an equation in $\cos\theta$ only. Condone $2\tan\theta \rightarrow \dfrac{2\sin\theta}{2\cos\theta}$ for the method marks only.

Alternatively, takes out a factor of $\sin\theta$ **or** cancels $\sin\theta$ **and** replaces $\pm\cos^2\theta$ with $\pm 1 \pm \sin^2\theta$ (in either order) to form an equation in $\sin\theta$ only (not just $5\sin^3\theta - 3\sin\theta = 0$).

Note that this mark may be implied by e.g. $5\sin^3\theta - 3\sin\theta = 0 \Rightarrow \sin\theta = \{\pm\}\dfrac{\sqrt{15}}{5}$

If they expand $5\sin\theta\left(\pm 1 \pm \sin^2\theta\right)$ incorrectly to $\pm 5\sin\theta \pm 5\sin^2\theta$ i.e. not $\sin^3\theta$ then they do not score this mark as they have materially altered the question.

Condone squaring in the wrong place e.g. $\cos\theta^2$ only if it is recovered by later work.

If they replace $\sin\theta$ with e.g. X in $5\sin^3\theta-3\sin\theta=0$ to get $5X^3-3X=0$ then score for any of e.g. $X\left(5X^2-3\right)=0$, $5X^2-3=0$ or $X=\{\pm\}\dfrac{\sqrt{15}}{5}$ even if they do not replace X with $\sin\theta$

dM1: Dependent on the previous method mark.

Solves an equation of the form $\cos^2\theta=k\Rightarrow\theta=...$ or $\sin^2\theta=k\Rightarrow\theta=...$ with $0<k<1$ using the correct order of operations. Allow similarly e.g. $p\sin^2\theta-q=0\Rightarrow\theta=...$ with $0<\dfrac{q}{p}<1$

You may need to check that their θ follows from their $\sin\theta=\{\pm\}\sqrt{k}$

Proceeding directly from a cubic such as $5\sin^3\theta-3\sin\theta=0$ to $\sin\theta=\{\pm\}\dfrac{\sqrt{15}}{5}\Rightarrow\theta=...$ is also acceptable.

Note the correct equations are $\cos\theta=\pm\dfrac{\sqrt{10}}{5}\left\{=\pm\dfrac{\sqrt{2}}{\sqrt{5}}=\text{awrt}\pm0.63\right\}$ and

$\sin\theta=\pm\dfrac{\sqrt{15}}{5}\left\{=\pm\dfrac{\sqrt{3}}{\sqrt{5}}=\text{awrt}\pm0.77\right\}$

Condone squaring in the wrong place e.g. $\cos\theta^2$ only if it is recovered by later work.

A1: **Two** of $\theta=50.8°, 129.2°, 180°, 230.8°$ with or without the degrees symbol.

For both A marks allow awrt for any of $\theta=50.8°, 129.2°, 230.8°$

A1: Full and rigorous solution to find all **four** answers $\theta=50.8°, 129.2°, 180°, 230.8°$ with or without the degrees symbol. Note that the $180°$ may appear separate from their final line. Ignore any answers outside the domain $0<\theta\leqslant270°$

(ii)(a)

M1: Uses the model by substituting $t=0\Rightarrow H=40\sin\left(0.3(0)+2\right)$ o.e.

May be implied by awrt 1.4 (using degrees) or awrt 36.4 (using radians).

A1: cao including units. Sight of awrt 1.40m or 140cm only scores both marks but condone 1.4m

(ii)(b) **Note: Use of *t* in place of *T* is acceptable throughout this part of the question.**

M1: Uses the model by substituting $H=25$ and proceeds to $\sin\left(0.3T+2\right)=k$

A1: A "correct" value for $0.3T+2$, i.e., either awrt 38.7 or awrt 141 (or truncated 38.6) but do not be concerned with the LHS. Cannot be implied by just awrt 122 or awrt 464 unless there is sight of e.g. $0.3T+2=\sin^{-1}\left(\dfrac{25}{40}\right)$ or e.g. $T=\dfrac{\sin^{-1}\left(\dfrac{25}{40}\right)-2}{0.3}$ as both awrt 122 and awrt 464 can be found directly from their calculator.

dM1: Full method to find the **second** smallest time $0.3T+2=180-\sin^{-1}\left(\dfrac{25}{40}\right)\Rightarrow T=...$

Dependent on the previous method mark.

Condone slips in the order of operations for solving $0.3T+2=180-\sin^{-1}\left(\dfrac{25}{40}\right)$

If using radians, they must convert back to degrees before solving $0.3T+2=...$

If they find the second smallest time but then reject it, they still score the dM1.

A1: $\{t/T=\}$ awrt 464 following award of the 3 previous marks. If there is more than one answer given, then awrt 464 must be clearly selected or the others rejected.