Question	Scheme	Marks	AOs
10(a)	$\frac{dH}{dt} = \frac{H\cos 0.25t}{40} \Rightarrow \int \frac{1}{H} dH = \int \frac{\cos 0.25t}{40} dt$	M1	3.1a
	$\ln H = \frac{1}{10}\sin 0.25t\,(+c)$	M1 A1	1.1b 1.1b
	Substitutes $t = 0, H = 5 \Rightarrow c = \ln(5)$	dM1	3.4
	$\ln\left(\frac{H}{5}\right) = \frac{1}{10}\sin 0.25t \Rightarrow H = 5e^{0.1\sin 0.25t}$ *	A1*	2.1
		(5)	
(b)	Max height = $5e^{0.1} = 5.53\,m$ (Condone lack of units)	B1	3.4
		(1)	
(c)	Sets $0.25t = \frac{5\pi}{2}$	M1	3.1b
	31.4	A1	1.1b
		(2)	
			(8 marks)

(a)

M1: Separates the variables to reach $\int \frac{1}{H} dH = \int \frac{\cos 0.25t}{40} dt$ or equivalent.

The integral signs need to be present on both sides and the dH AND dt need to be in the correct positions.

M1: Integrates both sides to reach $\ln H = A\sin 0.25t$ or equivalent with or without the + *c*

A1: $\ln H = \frac{1}{10}\sin 0.25t + c$ or equivalent with or without the + *c*. Allow two constants, one either side

If the 40 was on the lhs look for $40\ln H = 4\sin 0.25t + c$ or equivalent.

dM1: Substitutes $t = 0, H = 5 \Rightarrow c = ..$ There needs to have been a single " + *c* " to find.

It is dependent upon the previous M mark. You may allow even if you don't explicitly see "$t = 0, H = 5$" as it may be implied from their previous line

If the candidate has attempted to change the subject and made an error/ slip then condone it for this M but not the final A. Eg. $40\ln H = 4\sin 0.25t + c \Rightarrow\Rightarrow H^{40} = e^{4\sin 0.25t} + e^{c} \Rightarrow 5^{40} = 1 + e^{c} \Rightarrow c = ...$

Also many students will be attempting to get to the given answer so condone the method of finding c =... These students will lose the A1* mark

A1*: Proceeds via $\ln H = \frac{1}{10}\sin 0.25t + \ln 5$ or equivalent to the given answer $H = 5e^{0.1\sin 0.25t}$ with at least one correct intermediate line and no incorrect work.

DO NOT condone *c*'s going to *c*'s when they should be e^{c} or *A*

Accept as a minimum $\ln H = \frac{1}{10}\sin 0.25t + \ln 5 \Rightarrow H = \mathrm{e}^{\frac{1}{10}\sin 0.25t + \ln 5}$ or $H = \mathrm{e}^{\frac{1}{10}\sin 0.25t} \times \mathrm{e}^{+\ln 5}$ before sight of the given answer

If the only error was to omit the integration signs on line 1, thus losing the first M1, allow the candidate to have access to this mark following a correct intermediate line (see above).

If they attempt to change the subject first then the constant of integration must have been adapted if the A1* is to be awarded. $\ln H = \frac{1}{10}\sin 0.25t + c \Rightarrow H = \mathrm{e}^{\frac{1}{10}\sin 0.25t + c} \Rightarrow H = A\mathrm{e}^{\frac{1}{10}\sin 0.25t}$

The dM1 and A1* under this method are awarded at virtually the same time.

Also, for the final two marks, you may see a proof from $\int_0^H \frac{40}{H}\,dH = \int_5^t \cos 0.25t\,dt$

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There is an alternative via the use of an integrating factor.

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(b)

B1: States that the maximum height is 5.53 m Accept $5\mathrm{e}^{0.1}$ Condone a lack of units here, but penalise if incorrect units are used.

(c)

M1: For identifying that it would reach the maximum height for the 2nd time when $0.25t = \frac{5\pi}{2}$ or 450

A1: Accept awrt 31.4 or 10π Allow if units are seen