Question Number	Scheme		Marks
7(a)	*General* equation of motion for particle, measuring **up** from *E*. $T-\frac{3mg}{2}=\frac{3m\ddot{x}}{2}$	*General* equation of motion for particle, measuring **down** from *E*. $\frac{3mg}{2}-T=\frac{3m\ddot{x}}{2}$	M1
	Use HL in equation of motion with extension $\left(\frac{3L}{8}\pm x\right)$	Use HL in equation of motion with extension $\left(\frac{3L}{8}\pm x\right)$	DM1
	Correct equation $\frac{4mg}{L}\left(\frac{3L}{8}-x\right)-\frac{3mg}{2}=\frac{3m\ddot{x}}{2}$	Correct equation $\frac{3mg}{2}-\frac{4mg}{L}\left(\frac{3L}{8}+x\right)=\frac{3m\ddot{x}}{2}$	A1
	Complete conclusion $-\frac{8g}{3L}x=\ddot{x} \quad \therefore \quad SHM \ *$		A1*
	Identify ω from SHM method and use to find the Period		DM1
	$\omega^2=\frac{8g}{3L}$ or $\omega=\sqrt{\frac{8g}{3L}}$ Period $=\frac{2\pi}{\omega}=2\pi\sqrt{\frac{3L}{8g}}=\pi\sqrt{\frac{3L}{2g}}$ *		A1*
			(6)
7(b)	Correct amplitude, $a=\frac{1}{2}L$		B1
	Use of SHM displacement equation with amplitude substituted. No need to substitute for ω. [1] $x=-a\cos\omega t$ [2] $x=a\cos\omega t$ [3] $x=a\sin\omega t$ [4] $x=-a\sin\omega t$		M1
	Complete method to find an equation for a relevant time. No need to substitute for ω. **Either** Use $\ddot{x}=-\omega^2x$ with $-\frac{2g}{3}$ to find displacement. May start again with N2L, HL and $-\frac{2g}{3}$ to find displacement. **Must** then combine displacement of $\pm\frac{L}{4}$ with one of [1], [2], [3] or [4] above to form an equation in t (and ω).		M1

Question Number	Scheme	Marks
	Or Substitute $-\frac{2g}{3}$ and their a in the corresponding acceleration equation to form an equation in t (and ω) [1] $\ddot{x} = a\omega^2 \cos(\omega t)$ [2] $\ddot{x} = -a\omega^2 \cos(\omega t)$ [3] $\ddot{x} = -a\omega^2 \sin(\omega t)$ [4] $\ddot{x} = a\omega^2 \sin(\omega t)$	
	Dependent on both previous M marks. Complete method to find the required time. Where appropriate, must use the correct proportion of the given period to find an expression for the required time. Must use the correct ω. [1] $t = \frac{1}{\omega} \times \cos^{-1}\left(-\frac{1}{2}\right)$ [2] $t = \frac{1}{\omega}\cos^{-1}\left(\frac{1}{2}\right) - \frac{\text{period}}{2} = \frac{5\pi}{3\omega} - \frac{\text{period}}{2}$ [3] $t = \frac{1}{\omega}\sin^{-1}\left(\frac{1}{2}\right) + \frac{\text{period}}{4} = \frac{\text{period}}{4} + \frac{\pi}{6\omega}$ [4] $t = \frac{1}{\omega}\sin^{-1}\left(-\frac{1}{2}\right) - \frac{\text{period}}{4} = \frac{7\pi}{6\omega} - \frac{\text{period}}{4}$	DM1
	$t = \frac{2\pi}{3}\sqrt{\frac{3L}{8g}}$ o.e.	A1
		(5)
		(11)
	Notes for question 7	
7(a)		
M1	Equation of motion in a *general* position ie T does not take a particular value. Allow a for acceleration here. Required terms present with no extras. Condone sign errors but must have a difference between T and weight. Condone missing $\frac{3}{2}$ in 'ma' term only for this mark.	
DM1	Dependent on previous M. Use of Hooke's Law in a *general* equation of motion with general position measured from E. Extension in HL must be of the appropriate form: $\left(\frac{3L}{8} - x\right)$ or $\left(\frac{3L}{8} + x\right)$. Allow a for acceleration, condone sign errors. Must use the correct mass, $\frac{3m}{2}$ in 'ma' term.	
A1	For a fully correct unsimplified equation. Must use $\ddot{x}$ for acceleration.	

Question Number	Scheme	Marks
A1*	Correct SHM equation and conclusion. Equation must have required form, $\ddot{x} = -\omega^2 x$ with $\ddot{x}$ for acceleration. Conclusion must include 'SHM'	
DM1	Dependent on both previous M's. Use of $\frac{2\pi}{\omega}$ where ω has come from an attempt at using N2L at a general point.	
A1*	Obtain the given answer for the period. Must follow from complete and correct working. At least one line of working must be seen between $\ddot{x} = -\frac{8g}{3L}x$ and reaching the given Period. Eg • period = $\frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\frac{8g}{3L}}} = \pi\sqrt{\frac{3L}{2g}}$ • $\omega = \sqrt{\frac{8g}{3L}}$, period = $\frac{2\pi}{\omega} = \pi\sqrt{\frac{3L}{2g}}$ Note The score of M1 DM1 A1 A0* DM1 A1* is possible if there is no conclusion of 'SHM' The score of M1 DM1 A0 A0* DM1 A1* is possible if $\ddot{x}$ is not used for acceleration.	
7(b)		
B1	Correct amplitude, $\frac{L}{2}$.	
M1	Use of suitable SHM equation with their amplitude substituted. May be implied if starting with a corresponding velocity or acceleration equation. No need to replace ω.	
M1	All necessary steps completed to find an equation for a relevant time. No need to replace ω.	
DM1	Complete method to find an expression for the **required** time. Must use the correct ω.	
A1	Correct value for required time in **exact** form, in terms of L and g e.g. $\frac{2\pi}{3}\sqrt{\frac{3L}{8g}}$, $\frac{\pi}{3}\sqrt{\frac{3L}{2g}}$, $\pi\sqrt{\frac{L}{6g}}$, $\frac{\pi}{6}\sqrt{\frac{6L}{g}}$	

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