Question Number	Scheme	Marks
7(a)	$T_A - T_B = m\ddot{x}$	M1
	$\frac{2mg}{l}\left(\frac{2l}{3} - x\right) - \frac{mg}{l}\left(\frac{4l}{3} + x\right) = m\ddot{x}$ or $\frac{mg}{l}\left(\frac{4l}{3} - x\right) - \frac{2mg}{l}\left(\frac{2l}{3} + x\right) = m\ddot{x}$.	dM1A1
	$-\frac{3g}{l}x = \ddot{x}$, so SHM	A1
	$T = \frac{2\pi}{\sqrt{\frac{3g}{l}}} = 2\pi\sqrt{\frac{l}{3g}}$ *	M1 A1*
		(6)
7(b)	$\frac{1}{2}l \times \sqrt{\frac{3g}{l}}$ or $\frac{1}{2}\sqrt{3gl}$ or $\sqrt{\frac{3gl}{4}}$ oe	B1
		(1)
7(c)	$\frac{3g}{2}$ or $1.5g$	B1
		(1)
7(d)	$x = a\cos\omega t \Rightarrow v = -a\omega\sin\omega t$	M1
	$-\frac{3}{4}\sqrt{gl} = -a\omega\sin\omega t$ to find t	M1A1
	Solve for t	M1
	$t = \frac{\pi}{3}\sqrt{\frac{l}{3g}}$ oe	A1
		(5)
		(13)

Notes	
(a)	
M1	Equation of motion in a *general* position, allow *a* for acceleration, correct no. of terms, condone sign errors.
dM1	Use Hooke's Law to sub for the two tensions, allow *a* for acceleration. Extensions must be different and of the form $(d \pm x)$ where *d* is a multiple of *l*.
A1	Correct unsimplified equation, allow *a* for acceleration.
A1	Correct equation using $\ddot{x}$ for acceleration.
M1	Use of $\frac{2\pi}{\omega}$ Their ω from their equation of motion, which must be in terms of *x*.
A1*cso	Given answer correctly obtained – this includes proof of SHM **with conclusion** and correct expression for the period.
(b)	
B1	Cao Speed at *O* so must be positive. Unsimplified, ignore errors from subsequent 'simplifying' of surds.
(c)	
B1	Cao Max acceleration so must be positive.

(d)	
Main	
M1	Use of $x = a\cos\omega t$ to obtain $v = -a\omega\sin\omega t$ Substitution for a and ω is not required.
M1	Use $v = -a\omega\sin\omega t$ with $a = \frac{l}{2}$ and $\omega = \sqrt{\frac{3g}{l}}$ to obtain equation in t only, $-\frac{3}{4}\sqrt{gl} = -a\omega\sin\omega t$
A1	Correct equation in t only
M1	Solve to find the required time, t
A1	Cao for required time.
ALT 1	
M1	Use of $x = a\sin\omega t$ to obtain $v = a\omega\cos\omega t$ Substitution for a and ω is not required.
M1	Use $v = a\omega\cos\omega t$ with $a = \frac{l}{2}$ and $\omega = \sqrt{\frac{3g}{l}}$ to obtain equation in t only, $\frac{3}{4}\sqrt{gl} = a\omega\cos\omega t$
A1	Correct equation in t only
M1	Solve to find t and then subtract from $\frac{1}{4}$ period to find the required time. Eg $t = \frac{\pi}{6}\sqrt{\frac{l}{3g}} \Rightarrow$ required time = $\frac{1}{4}\left(2\pi\sqrt{\frac{l}{3g}}\right) - \frac{\pi}{6}\sqrt{\frac{l}{3g}} = \frac{\pi}{3}\sqrt{\frac{l}{3g}}$
A1	Cao for required time, $t = \frac{\pi}{3}\sqrt{\frac{l}{3g}}$ oe
ALT2	
M1	Use of $x = a\cos\omega t$ or use of $x = a\sin\omega t$. Substitution for a and ω is not required.
M1	Using $v^2 = \omega^2(a^2 - x^2)$ with $a = \frac{l}{2}$ and $\omega = \sqrt{\frac{3g}{l}}$ to obtain equation in x only. $\left(-\frac{3}{4}\sqrt{gl}\right)^2 = \omega^2(a^2 - x^2)$
A1	Correct equation in x only. (Solution leads onto the first M mark in (d))
M1	Solves for t and then completes the method to find the required time. e.g. $\frac{l}{4} = \frac{l}{2}\cos\left(\sqrt{\frac{3g}{l}}t\right)$ or quarter period with sin method.
A1	Cao for required time, $t = \frac{\pi}{3}\sqrt{\frac{l}{3g}}$ oe
SPECIAL CASE where a = ½ is clearly stated as amplitude and consistently used in (b) (c) & (d)	
(b)	B1 $\frac{1}{2}\sqrt{\frac{3g}{l}}$
(c)	B1 $\frac{3g}{2l}$
(d)	Maximum M1 M1 A0 M0 A0

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