6a	In equilibrium	M1	Need all three forces. Dimensionally correct
	$mg + 4mg\dfrac{l-e}{l} = 4mg\dfrac{e}{l}$	A1 A1	Unsimplified equation with at most one error Correct unsimplified equation
	$5l = 8e \Rightarrow e = \dfrac{5l}{8}$, $AE = l + \dfrac{5l}{8} = \dfrac{13l}{8}$ *	A1*	Obtain given answer from correct working. Must see AE =
ALT1	$mg + 4mg\dfrac{(2l-AE)}{l} = 4mg\dfrac{(AE-l)}{l}$	M1 A1 A1	Need all three forces. Dimensionally correct Unsimplified equation with at most one error Correct unsimplified equation
	$AE = \dfrac{13l}{8}$ *	A1*	Obtain given answer from correct working. Must see AE =
ALT2	$mg + 4mg\dfrac{\left(\frac{l}{2}-e\right)}{l} = 4mg\dfrac{\left(\frac{l}{2}+e\right)}{l}$	M1 A1 A1	Need all three forces. Dimensionally correct Unsimplified equation with at most one error Correct unsimplified equation
	$e = \dfrac{l}{8}$, $AE = l + \dfrac{l}{2} + \dfrac{l}{8} = \dfrac{13l}{8}$ *	A1*	Obtain given answer from correct working
		[4]	
6b	Equation of motion	M1	Need all terms. Dimensionally correct. Condone use of a for acceleration.
	$4mg\dfrac{\frac{5l}{8}+x}{l} - 4mg\dfrac{\frac{3l}{8}-x}{l} - mg = -m\ddot{x}$	A1 A1	Unsimplified equation with at most one error. Correct unsimplified equation Note: the question states x is measured vertically down.
	$\Rightarrow -m\ddot{x} = \dfrac{8mg}{l}x$, $\ddot{x} = -\dfrac{8g}{l}x$ *	A1*	Obtain given answer from correct working. Must use $\ddot{x}$
		[4]	
6c	Use of $v^2 = \omega^2\left(a^2 - x^2\right)$ with $a = \dfrac{3l}{8}$	M1	Or use of equivalent correct formula
	$= \dfrac{8g}{l}\left(\dfrac{9}{64}l^2 - \dfrac{1}{64}l^2\right)$	A1	Correct unsimplified expression for v or v^2
	$v = \sqrt{gl}$	A1	Correct only
		[3]	

6d	$x = \frac{3l}{8}\cos \omega t$	B1	Use of relevant formula with correct amplitude $x = \frac{3l}{8}\cos \omega t$ or $x = \frac{3l}{8}\sin \omega t$
	Use of $-\frac{l}{8} = \frac{3l}{8}\cos \omega t$ or $\frac{l}{8} = \frac{3l}{8}\sin \omega t$ and correct use of $\frac{1}{2} \times \frac{2\pi}{\omega}$ or $\frac{l}{8} = \frac{3l}{8}\cos \omega t$ and correct use of $\pi - \cos^{-1}\left(\frac{1}{3}\right)$	M1	Complete method to find t or required time $t = \frac{1}{\omega}\cos^{-1}\left(-\frac{1}{3}\right)$ or $t = \frac{1}{\omega}\sin^{-1}\left(\frac{1}{3}\right)$ with $\frac{1}{2}$period or $t = \frac{1}{\omega}\cos^{-1}\left(\frac{1}{3}\right)$ with π
	Required time $\frac{2}{\omega}\cos^{-1}\left(\frac{-1}{3}\right) = \sqrt{\frac{l}{2g}}\cos^{-1}\left(\frac{-1}{3}\right)$ or $\frac{\pi}{\omega} + \frac{2}{\omega}\sin^{-1}\left(\frac{1}{3}\right) = \sqrt{\frac{l}{8g}}\left(\pi + 2\sin^{-1}\left(\frac{1}{3}\right)\right)$ or $\frac{2}{\omega}\left[\pi - \cos^{-1}\left(\frac{1}{3}\right)\right] = \sqrt{\frac{l}{2g}}\left[\pi - \cos^{-1}\left(\frac{1}{3}\right)\right]$	A1	Or equivalent, accept $1.91\sqrt{\frac{l}{2g}}$, $1.35\sqrt{\frac{l}{g}}$, $0.43\sqrt{l}$ $3.82\sqrt{\frac{l}{8g}}$ $\cos^{-1}\left(\frac{-1}{3}\right) = 1.91...$
		[3]	
		(14)	