| Question Number | Scheme | Marks |
|---|---|---|
| **6(a)** | $\frac{20(0.2-x)}{0.4}-\frac{20(0.2+x)}{0.4}=0.4\ddot{x}$ | M1A1 |
| | $-100x=0.4\ddot{x}$ | |
| | $\ddot{x}=-250x \quad \therefore \text{SHM}$ | dM1A1cso (4) |
| **(b)** | Period $=\frac{2\pi}{\sqrt{250}}$ oe | B1ft (1) |
| **(c)** | $v_{\max}=\frac{2}{0.4}=5\,\text{m s}^{-1}$ | B1 |
| | $a\omega=5 \quad a=\frac{5}{\sqrt{250}}=\frac{1}{\sqrt{10}}\ (=0.3162...)\,\text{m}$ | M1A1ft (3) |
| **(d)** | $x=a\cos\omega t \quad 0.1=\frac{1}{\sqrt{10}}\cos\sqrt{250}t$ or $x=a\sin\omega t \quad 0.1=\frac{1}{\sqrt{10}}\sin\sqrt{250}t$ | M1A1ft |
| | $t=\frac{1}{\sqrt{250}}\cos^{-1}\left(0.1\times\sqrt{10}\right)$ or $t=\frac{1}{\sqrt{250}}\sin^{-1}\left(0.1\times\sqrt{10}\right)$ | A1 |
| | Time for which $AP > 0.5$ | |
| | $=\frac{2\pi}{\sqrt{250}}-2\frac{1}{\sqrt{250}}\cos^{-1}\left(0.1\times\sqrt{10}\right)$ or $=\frac{\pi}{\sqrt{250}}+2\frac{1}{\sqrt{250}}\sin^{-1}\left(0.1\times\sqrt{10}\right)$ | dM1 |
| | $=0.2393...\text{s}$ | A1cso (5) [13] |

**(a)**

**M1** Attempt an equation of motion using a difference of 2 tensions obtained from Hooke's law and having different variable extensions. $\ddot{x}$ or $a$ allowed. Can be in algebraic form.

**A1** Correct equation. $\ddot{x}$ or $a$ allowed but if $a$ used the signs must indicate it is in the same direction as $\ddot{x}$ Can be in algebraic form.

**dM1** Rearrange their equation to the required form $\ddot{x}=-\omega^2 x$. Must be $\ddot{x}$. They cannot just lose terms to get to the required form.

**A1ft** Correct equation, can be numerical as shown or algebraic $\left(e.g. \quad \ddot{x}=-\frac{4\lambda}{ml}x\right)$, **and** state conclusion. If algebraic this must include stating that their "$\omega^2$" is positive.

**(b)**

**B1ft** Correct period (numerical) as shown or equivalent. Follow through their $\omega$ from $\ddot{x}$ or $a=\pm\omega^2 x$ (0.40 or better)

**(c)B1** Correct max speed, seen explicitly or used

**M1** Using $v_{\max}=a\omega$ to obtain a value for $a$

**A1ft** Correct value, exact or decimal (0.32 or better)

**(d)**

**M1** Use $x=a\cos\omega t$ or $x=a\sin\omega t$ with $x=\pm 0.1$, their $\omega, a$.

**A1ft** Correct equation, follow through their $\omega, a$

**A1** Correct expression for time from their choice of equation (if only decimal seen, award for 2sf or better 0.078997.. for cos,0.020349… for sin) Must have come from fully correct work in (a)

**dM1** Complete correct method to obtain the required time. Dependent on previous M mark.

**A1cso** Correct final answer. 2s.f. or better. Must have come from fully correct work in (a) and (d), although they might not have used $\ddot{x}$