Definition → Notes.

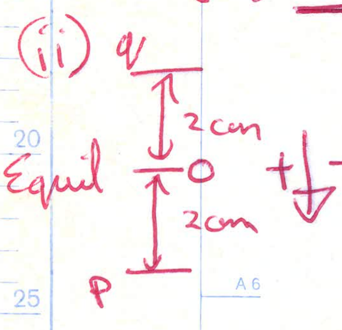
(i) From info in question: "Released from rest 0·1 m below equilibrium position"

$\boxed{A = \cdot 1}$. Also $T = 2$ secs $\Rightarrow \frac{2\pi}{\omega} = 2$ secs $\Rightarrow \boxed{\omega = \pi \text{ secs.}}$

In general $v^2 = \omega^2(A^2 - x^2)$. At Equil position $x = 0 \Rightarrow v^2 = \omega^2 A^2$
$\Rightarrow v = \omega A$

$\therefore \; \underline{v = \pi(\cdot 1) = (\cdot 1)\pi \, ms^{-1}}$.

(ii)



Obviously Time oq = Time op, by symmetry

Time op: got from $x = A \sin \omega t$. with $x = \cdot 02$

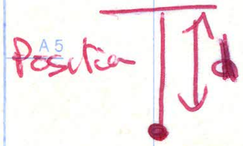
$\therefore \; \cdot 02 = \cdot 1 \sin \pi t$

$\Rightarrow \sin \pi t = \cdot 2 \Rightarrow t = \frac{1}{\pi} \sin^{-1}(\cdot 2)$

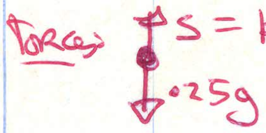
$\Rightarrow t = \frac{1}{\pi}(\cdot 201)$

$\therefore$ Total time [pq] $= 2t = \frac{2}{\pi}(\cdot 201) = \underline{0{\cdot}128 \text{ secs.}}$

(iii) Find Elastic Constant (A) Consider forces on string at ~~Equil~~ Equilibrium position.
distance d below ceiling, where particle in equil.

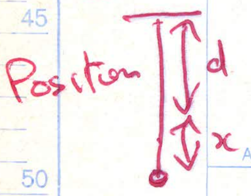


NII $\Rightarrow \; -S + \cdot 25g = 0 \Rightarrow \boxed{k(d - l) = \cdot 25g}$



$S = k(d - l)$ where l = Natural length

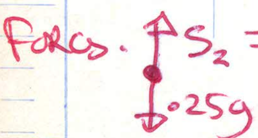
(B) Consider forces on string at typical position $d + x$ below ceiling
(i.e. x below equilibrium)



NII $\Rightarrow -S_2 + \cdot 25g = \cdot 25a$.

$\Rightarrow -k(x + d - l) + \cdot 25g = \cdot 25a$

$\Rightarrow -kx \underbrace{- k(d - l) + \cdot 25g}_{\text{CANCEL}} = \cdot 25a$.



$S_2 = k(x + d - l)$

$\Rightarrow \boxed{-kx = \cdot 25a} \Rightarrow a = \frac{-k}{\cdot 25} x$

But because of SHM, $+\frac{k}{\cdot 25} = \omega^2 = \pi^2 \Rightarrow \boxed{k = \cdot 25\pi^2}$

(iv) By Equil forces Eqn. $k(d - l) = \cdot 25g$

$\Rightarrow d - l = \frac{\cdot 25g}{\cdot 25\pi^2} = \frac{g}{\pi^2} \Rightarrow$ String slackens by $\boxed{\frac{g}{\pi^2}}$