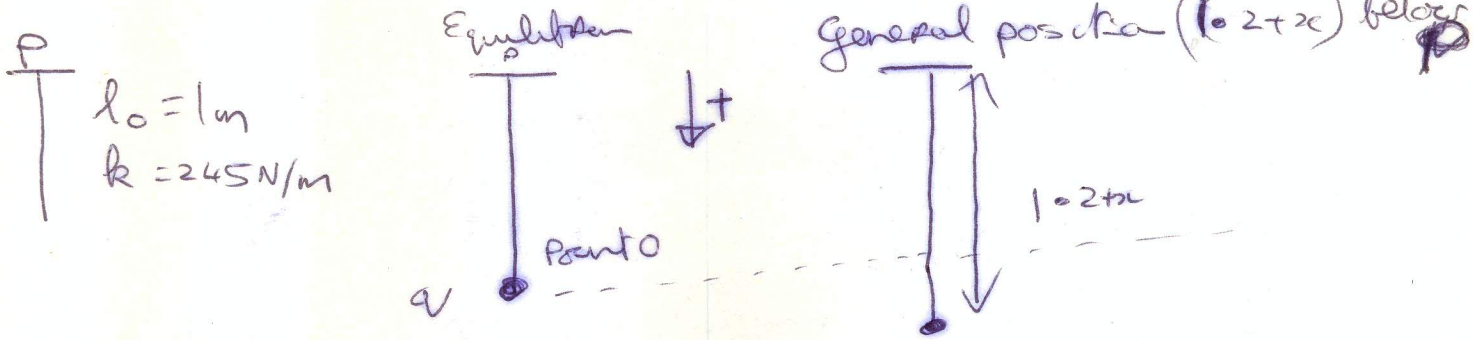
SHM 1974 Q4

SHM motion satisfying $-\omega^2 x = \text{accel}$.

$x = a\sin(\omega t + \alpha)$ satisfies eff $\frac{d^2}{dt^2} a\sin(\omega t + \alpha) = -\omega^2 x$

$\frac{d^2}{dt^2}(a\sin\omega t) = \frac{d}{dt} a\omega\cos\omega t = -a\omega^2 \sin\omega t$

$= -\omega^2 x$ qed



When in Equilibrium

$5g = T$

$\Rightarrow 5g = k(d-1)$

$\Rightarrow 49 = 245(d-1)$

$\Rightarrow \boxed{d = 1.2\ m}$ (surprise!)

Considering forces at point $1.2+x$ below P

$T+\Delta T$

$5g$

Net force is ΔT (because $T = 5g$)

where $\Delta T = -k(\text{ext pt } 1.2) = -k(x)$

$\therefore$ NII $\Rightarrow -kx = 5\,\text{accel}$

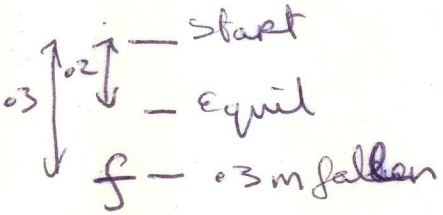
$\Rightarrow -245x = 5\,\text{accel}$

$\Rightarrow -49x = \text{accel}$.

$\therefore$ This is SHM with $\omega = 7$; Also when $x = 0$ accel $= 0$

Time to fall distance 0.3m = Time to go Start to Equil + Time to go Equil to f

$= \frac{1}{4}$ Periodic Time + Time [Equil to f]



Now: Amp $= .2$ as the particle is released a dist .2 from Equil. $\omega = 7$

$\therefore$ Time to go Equil to f: $x = A\sin\omega t \Rightarrow .1 = .2\sin 7t$

$\Rightarrow \frac{1}{2} = \sin 7t$

$\Rightarrow t = \frac{1}{7}\left(\frac{\pi}{6}\right)$

$\therefore$ Total time $= \frac{1}{4}\frac{2\pi}{7} + \frac{\pi}{42} = \frac{\pi}{14} + \frac{\pi}{42} = \frac{4\pi}{42} = \frac{2\pi}{21}$ secs

OR: $x = A\cos\omega t \Rightarrow -.3 = -.2\cos 7t$ etc.