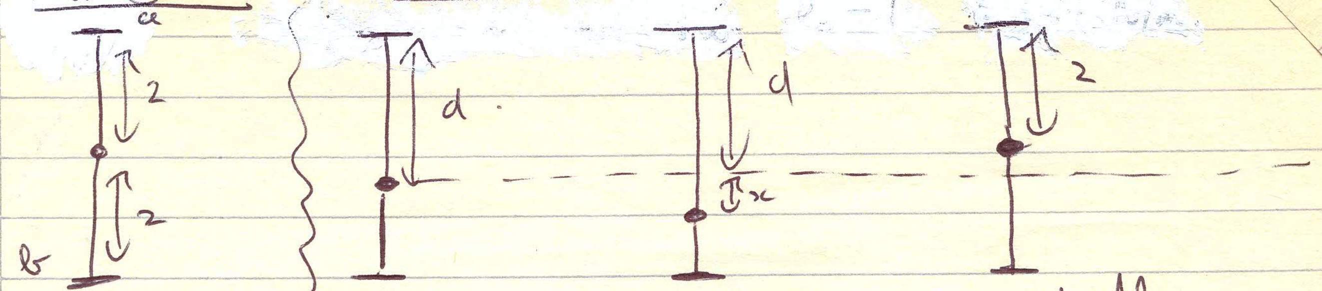
SHM
H76 Q3

SHM (definition):

Spring Alone: POSITIONS

Sign conv: + ↓



$l_0 = 1$, $k = 49$ N/m. Equil. Typical Initially.

FORCES

accel = 0. accel = a.

① Find position of Equilibrium.

$N\,II \Rightarrow \quad S_2 + w - S_1 = 0.$

$\Rightarrow \quad 49((4-d)-1) + 2g - 49(d-1) = 0.$

$\Rightarrow \quad 196 - 49d - 49 + 19{\cdot}6 - 49d + 49 = 0.$

$\Rightarrow \quad -98d + 215{\cdot}6 = 0.$

$\Rightarrow \quad d = \frac{215{\cdot}6}{98}$

$d = 2{\cdot}2$ m. Equil position is 2.2m below a.

N.B. Distances above Equil are − Distances below are +

② Show SHM: Typical Position.

$N\,II \Rightarrow \quad S_2' + w - S_1' = 2a.$

$\Rightarrow \quad 49([4-(d+x)]-1) + 2g - 49((d+x)-1) = 2a.$

$\Rightarrow \quad 49([4-(2{\cdot}2+x)]-1) + 2(9{\cdot}8) - 49((2{\cdot}2+x)-1) = 2a$

$\Rightarrow \quad 49(0{\cdot}8 - x) + 19{\cdot}6 - 49(1{\cdot}2 + x) = 2a.$

$\Rightarrow \quad 39{\cdot}2 - 49x + 19{\cdot}6 - 58{\cdot}8 - 49x = 2a.$

$\Rightarrow \quad -98x = 2a$

$\Rightarrow \quad -49x = a$

So accel $= -49x \Rightarrow$ SHM with $\omega = 7$.

To finish question Need A:

Initially: distance from roof = 2m, and $v = 0$ here

$\Rightarrow$ distance from equil position $= 2 - 2{\cdot}2 = -{\cdot}2$

$\Rightarrow v^2 = \omega^2(A^2 - x^2) \Rightarrow 0 = A^2 - (\cdot 2)^2 \Rightarrow$ $A = \pm{\cdot}2$

Time to reach point 2.3 m below a.

This point is $2{\cdot}3 - 2{\cdot}2 = {\cdot}1$m below Equil.

Starting from extreme, where $A = -{\cdot}2$, $x = A\cos\omega t$.

$+({\cdot}1) = (-{\cdot}2)\cos 7t \Rightarrow -\frac{1}{2} = \cos 7t \Rightarrow 7t = 2{\cdot}094$

$\Rightarrow t = {\cdot}3$ secs

See book for alternative

Equil $-{\cdot}2$ / ${\cdot}1$

Speed here $v^2 = \omega^2(A^2 - x^2) \Rightarrow v = 1{\cdot}21\ ms^{-1}$