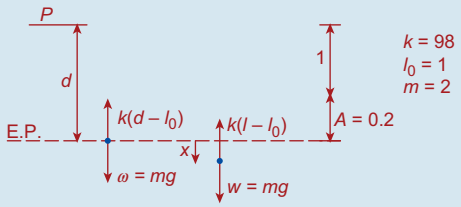
Exercise 13E

Q. 1.



(i) At Equilibrium Position (E.P.): ↑ = ↓

so $k[d - l_0] = 2g$

$\Rightarrow 98[d - 1] = 19.6$

$\Rightarrow d = 1.2$ m

(ii) NZL: $\Sigma F = ma$

$\downarrow mg - k[d + x - l_0] = ma$

$\Rightarrow 19.6 - 98[0.2 + x] = 2a$

$\Rightarrow a = -49x \Rightarrow$ SHM with $\omega = 7$

(iii) $\Rightarrow T = \frac{2\pi}{\omega} \Rightarrow T = \frac{2\pi}{7}$ s

(iv) $v_{MAX} = \omega A \Rightarrow v_{MAX} = 7(0.2)$

$\Rightarrow v_{MAX} = 1.4$ m

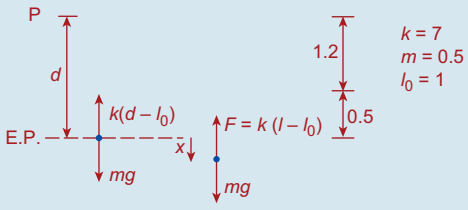
(v) Falls 0.15 metres $\Rightarrow x = 0.2 - 0.15$

$\Rightarrow x = 0.05$

We have $x = A\cos\omega t$, (Particle released from extrems position)

So $0.05 = 0.2\cos 7t \Rightarrow t = 0.188$ s

Q. 2.



At E.P. ↑ = ↓

$\Rightarrow mg = k(d - l_0)$ ... (1)

$\Rightarrow 4.9 = 7(d - 1)$

$\Rightarrow d = 1.7, A = 1.7 - 1.2 = 0.5$

NZL: $\Sigma F = ma$

$\downarrow mg - k[l - l_0] = ma$

$mg - k[d + x - l_0] = ma$

From (1) ~~$k(d - l_0)$~~ $-$ ~~$k(d - l_0)$~~ $- kx = ma$

(i) $\Rightarrow a = -\frac{7}{0.5}x$

$\Rightarrow a = -14x$

$\Rightarrow$ SHM

$\Rightarrow \omega = \sqrt{14}$

(ii) $a_{MAX} = \omega^2 A = 14(0.5)$

$\Rightarrow a_{MAX} = 7$ m/s^2

$F_{MAX} = ma_{MAX} = 0.5(7)$

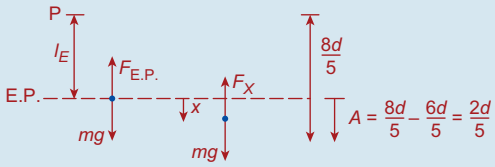
$\Rightarrow F_{MAX} = 3.5$ N

(iii) When 2 metres below P, $x = -0.3$ with $x = A\cos\omega t$

so $-0.3 = 0.5\cos\sqrt{14}t$

$\Rightarrow t = 0.59$ s

Q. 3.



(i) At E.P., $F_{E.P.} = mg$

$\Rightarrow k[l_E - l_0] = mg$ ... (1)

$\Rightarrow \frac{\cancel{49}^{5}}{d}[l_E - d] = \cancel{mg}$

$\Rightarrow l_E = \frac{6d}{5}$

At x, NZL: $\Sigma F = ma$

$\downarrow mg - Fx = ma$

$\Rightarrow mg - k[l_E + x - l_0] = ma$

$\Rightarrow mg - mg - kx = ma$ From (1)

$\Rightarrow a = -\frac{k}{m}x$

$\Rightarrow a = -\frac{49}{d}x$

$\Rightarrow$ SHM

$\omega = \frac{7}{\sqrt{d}}$

(ii) String becomes slack: $x = -\frac{d}{5}$

We have $x = A\cos\omega t$

$\Rightarrow -\frac{d}{5} = \frac{2d}{5}\cos\frac{7}{\sqrt{d}}t$

$\Rightarrow \cos\frac{7t}{\sqrt{d}} = -\frac{1}{2}$

$\Rightarrow \frac{7t}{\sqrt{d}} = \frac{2\pi}{3}$

$\Rightarrow t = \frac{2\pi\sqrt{d}}{21}$

Note: Hooke's Law: $F = kx$, x = extension.