(ii) t_1, from Q to E.P. $= \frac{T}{4} = \frac{2\pi}{4\omega} = \frac{\pi}{2}$ s

t_2, from E.P. to P, $t_2 = \frac{\text{distance}}{\text{speed}}$

where $V = \omega A$ at E.P.

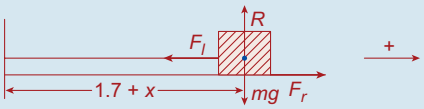
$\Rightarrow t_2 = \frac{a}{\omega A} = \frac{a}{1(a)} = 1$ s

$\therefore$ Total time $= t_1 + t_2$

$= \frac{\pi}{2} + 1$

$= 2.57$ s

Q. 9. (i)



(ii) 1. $R = mg = (1)(9.8) = 9.8$

2. $F_r = \mu R = \frac{1}{2}(9.8) = 4.9$

3. $F_l = k(l - l_0)$

$= 7(1.7 + x - 1)$

$= 4.9 + 7x$

$F = F_r - F_l$

$= 4.9 - 4.9 - 7x$

$= -7x$

$F = ma$

$\Rightarrow -7x = la$

$\Rightarrow a = -7x$

It will perform SHM with $w = \sqrt{7}$.

Periodic time $= \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{7}}$

(iii) The centre of oscillation, where $x = 0$, is 1.7 m from p. It was released where $x = 2$. Therefore $A = 2$.

It starts from an extreme point

$\therefore x = A\cos\omega t \Rightarrow x = 2\cos\sqrt{7}t$

To find t when $x = 0.3$ (i.e. $2 - 1.7$)

$0.3 = 2\cos\sqrt{7}t$

$\Rightarrow \cos\sqrt{7}t = 0.15$

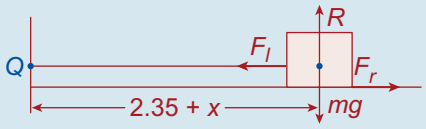
$\Rightarrow \sqrt{7}t = \cos^{-1}(0.15)$

$= 1.4202$

$\Rightarrow t = \frac{1.4201}{\sqrt{7}}$

$= 0.54$ s

Q. 10. (i)



1. $R = mg = 5(9.8) = 49$

2. $F_r = R = (1)(49) = 49$

3. $F_l = k(l - l_0)$

$= 140(2.35 + x - 2)$

$= 49 + 140x$

$F = F_r - F_l$

$= 49 - 49 - 140x$

$= -140x$

$F = ma$

$\Rightarrow -140x = 5a$

$\Rightarrow a = -28x$

This is SHM with $\omega = \sqrt{28} = 2\sqrt{7}$.

(ii) $|QO| = 2.35$

(iii) It starts when $|qp| = 3$

$\therefore 2.35 + x = 3$

$\Rightarrow x = 0.65$

The ampitude is, therefore, 0.65

(iv) $T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{7}}$

(v)

The journey from A to B can be divided into two parts: A to O and O to B.

A to O: $\frac{1}{4}$ of a full cycle $t = \frac{1}{4}\left(\frac{\pi}{\sqrt{7}}\right)$

$= 0.2968$

O to B: $x = A\sin\omega t$ (starts at centre)

$0.35 = 0.65\sin 2\sqrt{7}t$

$\Rightarrow \sin 2\sqrt{7}t = \frac{35}{65} = \frac{7}{13} = 0.5385$

$\Rightarrow 2\sqrt{7}t = \sin^{-1}(0.5385) = 0.5687$

$\Rightarrow t = 0.1075$

Total time $= 0.2968 + 0.1075$

$= 0.4043$

$= 0.404$ s