When $x = -\frac{3}{5}$, what is v?

$v^2 = \omega^2(A^2 - x^2)$

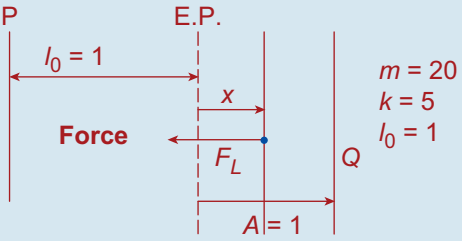
$\Rightarrow v^2 = 144\left(1 - \frac{9}{25}\right)$

$\Rightarrow v^2 = 144\left(\frac{16}{25}\right)$

$\Rightarrow v = 12\left(\frac{4}{5}\right)$

$= \frac{48}{5} = 9.6$ m/s

Q. 6.



(i) **Hooke's Law:** $F = k\,[l - l_0]$

where, k = spring constant

l = current length

l_0 = original length.

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

$\overset{+}{\rightarrow} F_L = ma$

$\Rightarrow -k(l_0 + x - l_0) = ma$

$\Rightarrow -5(x) = 20\,a$

$\Rightarrow a = -\frac{x}{4}$

$\Rightarrow$ SHM with $\omega = \frac{1}{2}$

(ii) $\Rightarrow T = \frac{2\pi}{\omega} = 4\pi$

Note: Particle travels from Q to E.P. with SHM. It then travels to P with uniform velocity. (String has gone slack)

t_1; from Q to E.P., is $\frac{T}{4} = \left(\frac{1}{4}\text{ of cycle}\right) = \pi$

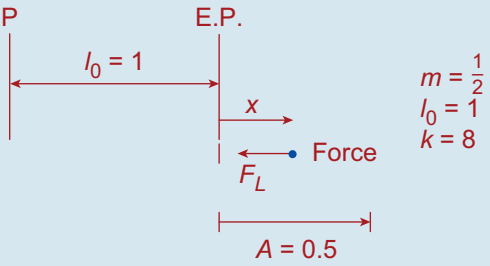
t_2; from E.P. to P, $t = \frac{\text{distance}}{\text{speed}}$

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

$\Rightarrow t_2 = \frac{l_0}{\left(\frac{1}{2}\right)(1)} = 2$

so Total Time Taken $= t_1 + t_2 = \pi + 2$, **QED**

Q. 7.



$F = k[l - l_0]$

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

$\overset{+}{\rightarrow} -F_L = ma$

$\Rightarrow -k(l - l_0) = ma$

$\Rightarrow -8[1 + x - 1] = \frac{1}{2}a$

(i) $\Rightarrow a = -16x$

$\Rightarrow$ SHM, $\omega = 4$

$\omega = 4, \quad A = 0.5, \quad T = \frac{2\pi}{\omega} = \frac{\pi}{2}$

(ii) Max $v = \omega A$

$\Rightarrow v_{MAX} = 4\left(\frac{1}{2}\right)$

$= 2$ m/s

(iii) $x = A\cos \omega t$ (Starting at Extreme Point)

Note, when particle has travelled 0.2 m, $x = 0.3$.

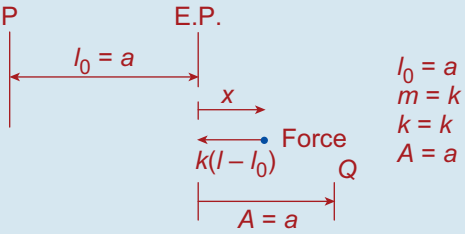
$\Rightarrow 0.3 = 0.5 \cos 4t$

$\Rightarrow \cos 4t = \frac{3}{5}$

$\Rightarrow 4t = \cos^{-1}\left(\frac{3}{5}\right)$

$\Rightarrow t = 0.23$ s

Q. 8.



(i) At x, NZL: $\Sigma F = ma$

$\overset{+}{\rightarrow} -k(l - l_0) = m\ddot{x}$

Note: We use $\ddot{x}$, instead of the more usual a, for acceleration, to avoid confusion. Here A is amplitude, a is original length.

So $-k\,(x + x - a) = k\ddot{x}$

$\Rightarrow \ddot{x} = -x$

$\Rightarrow$ SHM with $\omega = 1$ rad/s