••50 A standing wave pattern on a string is described by

$$y(x, t) = 0.040 (\sin 5\pi x)(\cos 40\pi t),$$

where x and y are in meters and t is in seconds. For $x \geq 0$, what is the location of the node with the (a) smallest, (b) second smallest, and (c) third smallest value of x? (d) What is the period of the oscillatory motion of any (nonnode) point? What are the (e) speed and (f) amplitude of the two traveling waves that interfere to produce this wave? For $t \geq 0$, what are the (g) first, (h) second, and (i) third time that all points on the string have zero transverse velocity?

For nodes

a) $x_n = n \frac{\lambda}{2}$ $\quad n = 0, 1, 2, \ldots$

$n = 0 \Rightarrow \boxed{x = 0}$

$\lambda = \frac{2\pi}{k} = \frac{2\pi}{5\pi} = 0.4\,m$

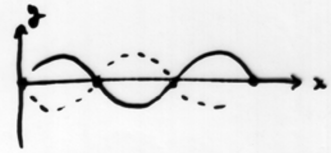
b) $n = 1 \Rightarrow x = \frac{\lambda}{2} = \boxed{0.2\,m}$

c) $n = 2 \Rightarrow x = \lambda = \boxed{0.4\,m}$

$f = \frac{\omega}{2\pi} = \frac{40\pi}{2\pi} = 20\,Hz$

d) $T = \frac{1}{f} = \frac{1}{20} = \boxed{0.05\,s}$

e) $v = \frac{\omega}{k} = \frac{40\pi}{5\pi} = \boxed{8\,m/s}$



f) $y_m = \boxed{0.02\,m}$

g) $u = -0.04 \times 40\pi \sin 5\pi x \sin 40\pi t = 0$

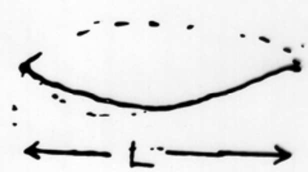
$\Rightarrow \sin 40\pi t = 0 \Rightarrow 40\pi t = 0, \pi, 2\pi, \ldots$

$\boxed{t = 0, \frac{1}{40}, \frac{2}{40}, \frac{3}{40}, \ldots \text{ sec.}}$

77 A 1.50 m wire has a mass of 8.70 g and is under a tension of 120 N. The wire is held rigidly at both ends and set into oscillation. (a) What is the speed of waves on the wire? What is the wavelength of the waves that produce (b) one-loop and (c) two-loop standing waves? What is the frequency of the waves that produce (d) one-loop and (e) two-loop standing waves?

a) $v = \sqrt{\frac{\tau}{\mu}} = \sqrt{\frac{120}{\frac{8.7\times10^{-3}}{1.5}}} = 144 \text{ m/s}$

b) $L = \frac{\lambda}{2} \Rightarrow \lambda = 2L = \boxed{3\text{ m}}$



c) $L = \lambda \Rightarrow \boxed{\lambda = 1.5\text{ m}}$

d) $f_1 = \frac{v}{2L} = \frac{144}{3} = \boxed{48\text{ HZ}}$

e) $f_2 = 2\frac{v}{2L} = 2\times\frac{144}{3} = \boxed{96\text{ HZ}}$