11.28

First, find the speed of the wave in the rope from Eq. (11.4), with $F_T = 360\,\mathrm{N}$ and $\mu = 0.06\,\mathrm{kg/m}$ (linear mass-density):

$$v = \sqrt{\frac{F_T}{\mu}} = \sqrt{\frac{360\,\mathrm{N}}{0.06\,\mathrm{kg/m}}} = 77.5\,\mathrm{m/s}.$$

So the time t it takes for the wavepulse to make a round-trip in the rope of length L is $t = 2L/v = 2(30\,\mathrm{m})/(77.5\,\mathrm{m/s}) = 0.8\,\mathrm{s}$.

11.35

If the amplitude of a harmonic wave is A and its frequency is f, then each particle in the medium carrying the wave is in a simple harmonic motion with the same frequency and amplitude. According to Eq. (10.17) the maximum acceleration of each particle in the wave is then $a_{max} = [-\omega^2 A\cos\omega t]_{max} = \omega^2 A = (2\pi f)^2 A$. In this case, the waveform is $y = 0.040\sin(2\pi x)$ which, when compared with the standard form in Eq. (11.2), $y = A\sin(2\pi x/\lambda)$, yields $A = 0.040\,\mathrm{m}$ and $\lambda = 1.0\,\mathrm{m}$. Thus

$$a_{max} = (2\pi f)^2 A = \left(\frac{2\pi v}{\lambda}\right)^2 A = \left[\frac{2\pi(2.0\,\mathrm{m/s})}{1.0\,\mathrm{m}}\right]^2 (0.040\,\mathrm{m}) = 6.3\,\mathrm{m/s^2},$$

where we used $f = v/\lambda$.

1.54

he dimensions of the quantities in the equation $v = KY^a\rho^b$ are as follows: v in $[L][T]^{-1}$, Y $[M][T]^{-2}[L]^{-1}$; and ρ in $[M][L]^{-3}$. Equate the dimensions of both sides of the equation to tain

$$[L][T]^{-1} = ([M][T]^{-2}[L]^{-1})^a\,([M][L]^{-3})^b = [M]^{a+b}[T]^{-2a}[L]^{-a-3b}.$$

uate the powers of $[M]$, $[T]$ and $[L]$ on both sides: $1 = -a - 3b$ (for $[L]$); $-1 = -2a$ (for]); and $0 = a + b$ (for $[M]$). Solve for a and b: $a = \frac{1}{2}$, $b = -\frac{1}{2}$. Thus

$$v = KY^{1/2}\rho^{-1/2} = K\sqrt{\frac{Y}{\rho}}.$$

11.79

Use Eq. (11.8), $I = P/A$. Here $P = 50\,\mathrm{W}$, and $A = 4\pi R^2$, with $R = 10\,\mathrm{m}$; so

$$I = \frac{P}{4\pi R^2} = \frac{50\,\mathrm{W}}{4\pi(10\,\mathrm{m})^2} = 0.040\,\mathrm{W/m^2} = 40\,\mathrm{mW/m^2}.$$

Since I is the power passing through a unit cross-sectional area, the power intercepted by detector of area A' is $P' = IA'$, and so the energy E that passes through the detector during time interval Δt is $E = P'\Delta t = IA'\Delta t$. Plug in $A = (1.0\,\mathrm{cm^2})(10^{-2}\,\mathrm{m/cm})^2 = 1.0\times10^{-4}$ and $\Delta t = 1.0\,\mathrm{s}$ to obtain

$$E = P'\Delta t = IA'\Delta t = (0.040\,\mathrm{W/m^2})(1.0\times10^{-4}\,\mathrm{m^2})(1.0\,\mathrm{s}) = 4.0\times10^{-6}\,\mathrm{J} = 4.0\,\mu\mathrm{J}.$$