

45. (a) Since the string has four loops its length must be two wavelengths. That is,  $\lambda = L/2$ , where  $\lambda$  is the wavelength and  $L$  is the length of the string. The wavelength is related to the frequency  $f$  and wave speed  $v$  by  $\lambda = v/f$ , so  $L/2 = v/f$  and  $L = 2v/f = 2(400 \text{ m/s})/(600 \text{ Hz}) = 1.3 \text{ m}$ .
- (b) We write the expression for the string displacement in the form  $y = y_m \sin(kx) \cos(\omega t)$ , where  $y_m$  is the maximum displacement,  $k$  is the angular wave number, and  $\omega$  is the angular frequency. The angular wave number is  $k = 2\pi/\lambda = 2\pi f/v = 2\pi(600 \text{ Hz})/(400 \text{ m/s}) = 9.4 \text{ m}^{-1}$  and the angular frequency is  $\omega = 2\pi f = 2\pi(600 \text{ Hz}) = 3800 \text{ rad/s}$ .  $y_m$  is 2.0 mm. The displacement is given by

$$y(x, t) = (2.0 \text{ mm}) \sin[(9.4 \text{ m}^{-1})x] \cos [(3800 \text{ s}^{-1})t] \text{ .}$$