

**Problem 1.11** The vertical displacement of a string is given by the harmonic function:

$$y(x, t) = 2 \cos(16\pi t - 20\pi x) \quad (\text{m}),$$

where  $x$  is the horizontal distance along the string in meters. Suppose a tiny particle were attached to the string at  $x = 5$  cm. Obtain an expression for the vertical velocity of the particle as a function of time.

**Solution:**

$$y(x, t) = 2 \cos(16\pi t - 20\pi x) \quad (\text{m}).$$

$$\begin{aligned} u(0.05, t) &= \left. \frac{dy(x, t)}{dt} \right|_{x=0.05} \\ &= 32\pi \sin(16\pi t - 20\pi x)|_{x=0.05} \\ &= 32\pi \sin(16\pi t - \pi) \\ &= -32\pi \sin(16\pi t) \quad (\text{m/s}). \end{aligned}$$

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