133.

Problem 17.47E (HRW)

Two sinusoidal waves with identical wavelengths and amplitudes travel in opposite directions along a string with a speed of $10\ \text{cm s}^{-1}$. *The time interval between instants when the string is flat is* 0.50 s. *We have to find the wavelength of the waves.*

Solution:

As the two identical waves are moving along a string in opposite directions with a speed of $10\ \text{cm s}^{-1}$, they can be represented by the functions

$$y_1 = a\sin k\left(x - 10t\right),$$

and

$$y_2 = a\sin k\left(x + 10t\right).$$

The resultant wave is

$$y = y_1 + y_2 = a\left(\sin\left(kx - 10kt\right) + \sin\left(kx + 10kt\right)\right),$$
$$= 2a\sin kx\cos 10kt.$$

The time interval T between instants when the string is flat is 0. 50 s. This implies

$$10\left(\text{cm s}^{-1}\right)k\times 0.5(\text{s})=\pi,$$

or

$$10\times\frac{2\pi}{\lambda}\times 0.5=\pi,$$

or

$$\lambda=10\text{ cm}.$$