

Answer on Question 66261, Physics, Mechanics, Relativity

Question:

A stretched string of mass 20 g vibrates with a frequency of 30 Hz in its fundamental mode and the supports are 40 cm apart. The amplitude of vibrations at the antinode is 4 cm . Calculate the velocity of propagation of the wave in the string as well as the tension in it.

Solution:

a) We can find the velocity of propagation of the wave in the string from the wave speed formula:

$$v = f\lambda,$$

here, v is the velocity of propagation of the wave in the string, f is the frequency, λ is the wavelength.

If the length of the string is L , the fundamental mode is the one produced by the vibration whose nodes are the two ends of the string, so L is half of the wavelength of the fundamental mode. Then, the wavelength of the fundamental mode will be equal to $\lambda = 2L$ and we can calculate the velocity of propagation of the wave in the string:

$$v = f\lambda = f2L = 30\text{ Hz} \cdot 2 \cdot 0.4\text{ m} = 24 \frac{\text{m}}{\text{s}}.$$

b) We can find the tension in the string from the formula:

$$v = \sqrt{\frac{T}{\mu}},$$

here, v is the velocity of propagation of the wave in the string, T is the tension in the string, $\mu = M/L$ is the mass per unit length of the string.

Then, from this formula we can calculate the tension in the string:

$$v^2 = \frac{T}{\mu},$$
$$T = v^2\mu = v^2 \frac{M}{L} = \left(24 \frac{\text{m}}{\text{s}}\right)^2 \cdot \frac{0.02\text{ kg}}{0.4\text{ m}} = 28.8\text{ N}.$$

Answer:

a) $v = 24 \frac{m}{s}$.

b) $T = 28.8 \text{ N}$.

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