PhysicsTutor

Standing wave on a string combined with sound.

Knight, 21.37

Problem:

- A beautiful note from a violin reaches your ear with wavelength 39.1 cm.
- The room is warm and the speed of sound is 344 m/s.
- If the tension in the string is 150 N, and the linear density of the string is 0.600 g/m, how long is the vibrating section of the violin string?

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- Frequency of sound wave equals string frequency. Wavelengths are different, since propagation speeds are different.
- String: wave propagation speed is obtained from mass density (given) and tension force (given)

Equations associated with ideas:

sound: $v_s = 344\ m/s\ (T > 20°C)$; $v_s = \lambda_s \cdot f$

string: $v_w = \sqrt{\frac{F_t}{\mu}}$; $\mu = \frac{M}{L}$; $v_w = \lambda_s \cdot f$

standing wave: $\lambda_s \rightarrow \lambda_n = \frac{2L}{n}$ $\quad n = 1, 2, 3, \ldots$

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- We know the propagation speed on the string, and can find the wavelength from the frequency __________
- From the standing-wave relation __$\lambda_1 = \frac{2L}{1}$__ we find for n=1 (fundamental) the string length L

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- $\lambda_1 = \frac{2L}{1} \quad \therefore \quad L = \frac{\lambda_1}{2} = 0.284\ \text{m} = 28.4\ \text{cm}$

→ Frequency is what the longitudinal travelling sound wave and the transverse standing wave have in common.

→ The fundamental ($n=1$) usually dominates.