PhysicsTutor

Standing wave on a string combined with sound.

Knight, 21.38

Problem:

- A violinist places her finger so that the vibrating part of the 1.0 g/cm string has a length of 30 cm, then draws the bow across it.
- A listener in a 20°C room hears a note with a wavelength of 40 cm.
- What is the tension in the string?

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- String: wave propagation speed is related to mass density (given) and tension force (wanted)

Equations associated with ideas:

string: $v_w = \sqrt{\frac{F_s}{\mu}}$; $\mu = \frac{M}{L}$

$\lambda_{str} \cdot f = v_w$;

$\lambda_n = \frac{2L}{n}$, $n = 1, 2, \ldots$ standing wave modes

sound: $v_s = 343 \ \frac{m}{s}$ @ $T = 20°C$

$\lambda_s \cdot f = v_s$

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- This we will get from the known wavelength on the string _________ and from the frequency determined by the sound wave
- The frequency of the sound wave we find from $v_s = \lambda_s' f$

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- $v_{str} = \lambda_1 f = 0.6 \cdot 857.5\ \frac{m}{s} = 514.5\ \frac{m}{s}$
- $v_{str}^2 = \frac{F_t}{\mu} \therefore F_t = \mu v_{str}^2 = 10^{-3} \cdot 2.65 \cdot 10^5\ \frac{kg\,m^2}{m\,s^2}$

$= 2.65 \cdot 10^2\ N = 265\ N$

- reasonable? $\approx$ weight of 27 kg mass $\rightarrow$ substantial
- Note: $\lambda_s \neq \lambda_{str}$, but $f_s = f_{str}$

why? string pulls sound board @ f