Name:_____ Class:_____ Date:_____

Vibrations and Waves

Problem D

WAVE SPEED

PROBLEM

The world's largest guitar, which was built by high school students in Indiana, has strings that are 9.0 m long. The fundamental vibration that can be induced on each string has a wavelength equal to twice the string's length. If the wave speed in a string is 9.0×10^2 m/s, what is the frequency of vibration?

SOLUTION

Given: $f = 50.0$ Hz $L = 9.0$ m

Unknown: $v = ?$

Use the equation for the speed of a wave. The wavelength is equal to twice the length of the string ($\lambda = 2L$).

$$v = f\lambda = f(2L) = (50.0 \text{ Hz})[(2)(9.0 \text{ m})] = 9.0 \times 10^2 \text{ m/s}$$

ADDITIONAL PRACTICE

1. The speed of sound in sea water is about 1530 m/s. If a sound wave has a frequency of 2.50×10^2 Hz, what is its wavelength in sea water?
2. Cicadas produce a sound that has a frequency of 123 Hz. What is the wavelength of this sound in the air? The speed of sound in air is 334 m/s.
3. Human fingers are very sensitive, detecting vibrations with amplitudes as low as 2.0×10^{-5} m. Consider a sound wave with a wavelength exactly 1000 times greater than the lowest amplitude detectable by fingers. What is this wave's frequency?
4. A nineteenth-century fisherman's cottage in England is only 2.54 m long. Suppose a fisherman whistles inside the cottage, producing a note that has a wavelength that exactly matches the length of the house. What is the whistle's frequency? The speed of sound in air is 334 m/s.
5. The lowest vocal note in the classical repertoire is low D ($f = 73.4$ Hz), which occurs in an aria in Mozart's opera *Die Entführung aus dem Serail*. If low D has a wavelength of 4.50 m, what is the speed of sound in air?
6. The highest-pitched sound that a human ear can detect is about 21 kHz. On the other hand, dolphins can hear ultrasound with frequencies up to 280 kHz. What is the speed of sound in water if the wavelength of ultrasound with a frequency of 2.80×10^5 Hz is 0.510 cm? How long would it take this sound wave to travel to a dolphin 3.00 km away?