NAME _____ DATE _____ CLASS _____

Holt Physics

Problem 13B

HARMONICS

PROBLEM

A piano wire vibrates with a fundamental frequency of 440 Hz when the speed of sound on the wire is 550 m/s. What is the length of this wire?

SOLUTION

Given: $v = 550$ m/s $n = 1$ $f_1 = 440$ Hz

Unknown: $L = ?$

Choose the equation(s) or situation: The fundamental frequency can be found by using the equation for standing waves on a vibrating string:

$$f_n = \frac{nv}{2L}, n = 1, 2, 3, \ldots$$

Rearrange the equation(s) to isolate the unknown(s): Rearrange the equation above to solve for the length of the wire.

$$L = \frac{nv}{2f_n} = \frac{(1)(550 \text{ m/s})}{(2)(440 \text{ Hz})} = \boxed{0.625 \text{ m}}$$

ADDITIONAL PRACTICE

1. A saxophone plays a tune in the key of B-flat. The saxophone has a second harmonic frequency of 466.2 Hz when the speed of sound in air is 331 m/s. What is the length of the pipe that makes up the saxophone? Recall that a saxophone should be treated as a pipe closed at one end.
2. A clarinetist plays a clarinet on a cold day. At one point she produces the sound of middle F sharp, which has a frequency of 370 Hz, by playing the third harmonic of low B. If the speed of sound in the air is 331 m/s, what is the length of the clarinet? Recall that a clarinet resembles a pipe closed at one end.
3. A penny whistle plays a tune in the key of G with a fundamental frequency of 392.0 Hz. The speed of sound in air is 331 m/s. What is the length of the penny whistle? Treat the penny whistle as a pipe closed at one end.
4. An organ pipe that is open at both ends has a fundamental frequency of 370.0 Hz when the speed of sound in air is 331 m/s. What is the length of this pipe?
5. What is the fundamental frequency of a viola string that is 35.0 cm long when the speed of waves on this string is 346 m/s?
6. What is the fundamental frequency of a mandolin string that is 42.0 cm long when the speed of waves on this string is 329 m/s?

7. What is the fundamental frequency of a cello string that is 0.85 m long when the speed of waves on this string is 499 m/s?

8. A pipe that is open at both ends has a fundamental frequency of 277.2 Hz. If the pipe is 0.75 m long, what is the speed of the waves in the pipe?

9. A pipe that is closed on one end has a seventh harmonic frequency of 466.2 Hz. If the pipe is 1.53 m long, what is the speed of the waves in the pipe?

10. A pipe that is open at both ends has a fundamental frequency of 125 Hz. If the pipe is 1.32 m long, what is the speed of the waves in the pipe?