Problem 14.50

A piccolo is .32 meters long and open at both ends.

a.) What's the lowest frequency the piccolo can play if the speed of sound in air is 340 m/s?

b.) If the highest note the piccolo can sound is 4000 Hz, what must be the distance between adjacent antinodes?

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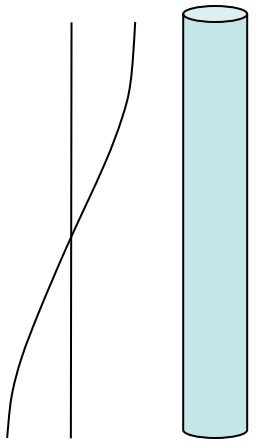

With both ends acting like antinodes, the wave form associated with the lowest frequency will look like the form shown to the right. In that case, there are two quarter-wavelengths in L. That is:

$$?\left(\lambda/4\right) = L$$

$$\Rightarrow \quad 2\left(\lambda/4\right) = L$$

$$\Rightarrow \quad \lambda = 2L = 2(.32\,\text{m}) = .64\,\text{m}$$

Knowing the wave velocity, we can write:

$$v = \lambda\nu$$

$$\Rightarrow \quad \nu = \frac{v}{\lambda}$$

$$\Rightarrow \quad \nu = \frac{340\,\text{m/s}}{.64\,\text{m}}$$

$$\Rightarrow \quad \nu = 531\,\text{cycles/sec}$$

b.) If the highest note the piccolo can sound is 4000 Hz, what must be the distance between adjacent antinodes?

The distance between antinodes is equal to half the wavelength of the wave in question. At 4000 Hz, we can write:

$$v = \lambda \nu$$

$$\Rightarrow \quad \lambda = \frac{v}{\nu}$$

$$\Rightarrow \quad \lambda = \frac{340\ m/s}{4000\ Hz}$$

$$\Rightarrow \quad \lambda = .085\ m/cycles$$

Half this yields an antinode to antinode distance of .0425 meters, or 4.25 cm.