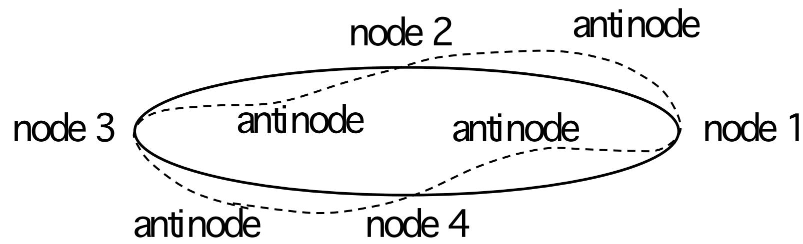
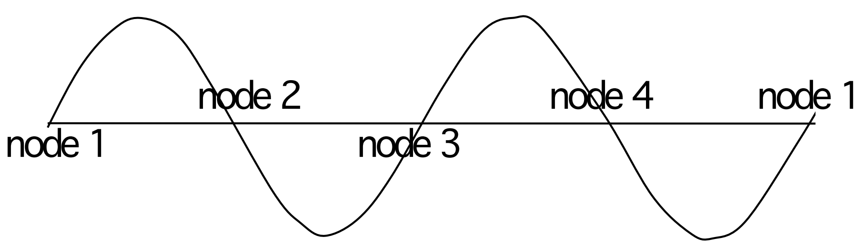
Problem 14.48

A standing wave is set up around the periphery of a crystal goblet with four nodes and four antinodes equally spaced around the .20 meter circumference of it rim. If transverse waves move around the glass at 900 m/s, an opera singer would have to produce what frequency to shatter the glass?

A standing wave is set up around the periphery of a crystal goblet with four nodes and four antinodes equally spaced around the .20 meter circumference of it rim (the dotted line more or less denotes the vibratory pattern of the glass—I' ve numbered the nodes for ease of observation below). If transverse waves move around the glass at 900 m/s, an opera singer would have to produce what frequency to shatter the glass?





To the left we have a waveform that has four nodes and four antinodes. The total length from start to finish will be the circumference of the rim, or .20 meters.

We again need to use the relationship $v = \lambda\nu$. To do that, we need the wavelength. Sooo:

"How many quarter-wavelengths are there in the waveform?" Looking at the sketch, we can write:

$$?\left(\lambda_3/4\right) = L$$

$$\Rightarrow \quad 8\left(\lambda_3/4\right) = L$$

$$\Rightarrow \quad \lambda_3 = 4/8\,L = 1/2\,(.2\text{ m}) = .1\text{ m}$$

Putting what we know together, we can write:

$$v = \lambda\nu$$

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

$$\Rightarrow \quad \nu = \frac{900\text{ m/s}}{.1\text{ m}}$$

$$\Rightarrow \quad \nu = 9000\text{ cycles/sec}$$