Sound and Sound Waves
Honors Physics: Class Examples

Velocity of a String:

Example 9
When the tension in a particular cord is 75.0 N, the wave velocity is 130.0 m/s. If the length of the cord itself is approximately 26.0 inches (1 in = 25.4 mm), what is the mass of the cord?

$F_T = 75.0\ N$
$v = 130.0\ m/s$
$L = *26\ in.$

$$v = \sqrt{\frac{F_T}{m/L}}$$

$$v = \sqrt{\frac{F_T \cdot L}{m}}$$

$$v^2 = \frac{F_T \cdot L}{m}$$

$$v^2 \cdot m = F_T \cdot L$$

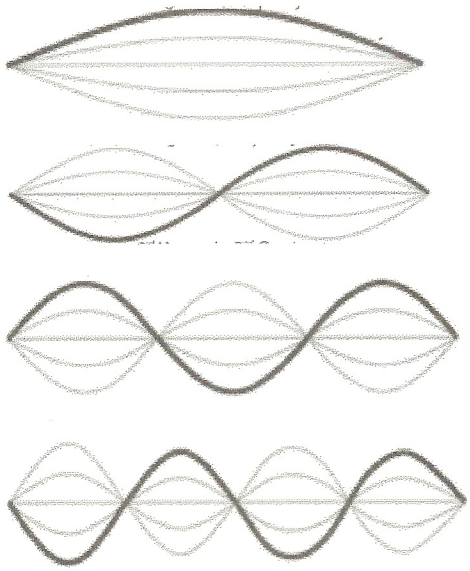
$$m = \frac{F_T \cdot L}{v^2}$$

$$L = \frac{26\ in}{1} \left| \frac{25.4\ mm}{1\ in} \right| \left| \frac{1\ m}{1000\ mm} \right| = 0.6604$$

$$m = \frac{(75.0)(0.6604)}{(130)^2}$$

$$m = 2.93 \times 10^{-3}\ kg$$

Standing Waves: Strings



Fundamental (lowest frequency)
First Harmonic (f_1)
Number of Loops = 1

Second Harmonic (First overtone)
Number of Loops = 2
$f_2 = 2 \cdot f_1$

Third Harmonic (Second overtone)
Number of loops = 3
$f_3 = 3 \cdot f_1$

Fourth Harmonic (Third overtone)
Number of loops = 4
$f_4 = 4 \cdot f_1$

Example 10
A particular string on a piano is 1.50 m long and has a tension of 400.0 N. It vibrates with a fourth-harmonic frequency of 110.0 Hz.
A. What is the mass of this string?
B. What are the first three harmonics of this string?

$L = 1.50\ m$
$F_T = 4.00\ N$
$f_4 = 110.0\ Hz$

$$v = \sqrt{\frac{F_T}{m/L}}$$

$$f_n = n\left(\frac{v}{2L}\right)$$

from above Ex. #9

$$m = \frac{F_T \cdot L}{v^2}$$

$$m = \frac{(400)(1.50)}{(82.5)^2}$$

$$m = 0.0882\ kg$$

$$f_n = n\left(\frac{v}{2L}\right)$$

$$110 = \frac{4 \cdot v}{2(1.50)}$$

$$110 \cdot 3 = 4 \cdot v$$

$$330 = 4 \cdot v$$

$$v = 82.5\ m/s$$

$f_4 = 110.0\ Hz$

$f_4 = 4 \cdot f_1$

$110.0 = 4 \cdot f_1$

$f_1 = 27.5\ Hz$

$f_2 = 2 \cdot f_1 = 55\ Hz$

$f_3 = 3 \cdot f_1 = 82.5\ Hz$