CH4-4: Standing Waves

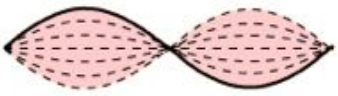
Note: this topic is not covered in CH04 of the textbook. These notes and books and web sites are your best resources for this material.

Standing Waves

Two waves traveling in opposite directions with the same amplitude, frequency, and wavelength (and thus the same speed).

1. Each point oscillates in SHM with the same frequency, but different amplitudes.
2. Points with zero amplitude are ***nodes***.
3. Points with greatest amplitude are ***antinodes***.

$$y = 2Asin(kx)cos(\omega t)$$



Standing Waves on a String

The speed of any wave is

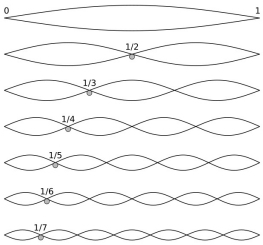
$$v = \lambda f$$

The speed of a wave on a string depends on the tension and the linear density of the string

$$v = \sqrt{\frac{T}{\mu}}$$

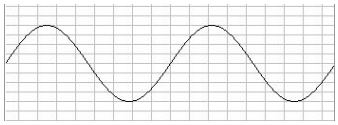
Standing Waves on a String

A standing wave only occurs when the wavelength corresponds to the length of the string in just the right way. In these examples, **the string is fixed at both ends**.



Poll

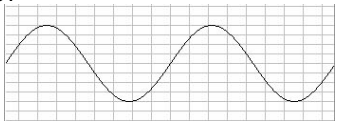
What harmonic (n) is a standing wave with this shape?



1. 2
2. 3
3. 4
4. 5
5. 6

Poll

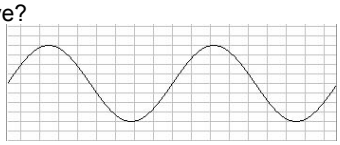
How many nodes and antinodes does this standing wave have?



1. 5 nodes, 4 antinodes
2. 4 nodes, 4 antinodes
3. 5 nodes, 5 antinodes
4. 3 nodes, 2 antinodes
5. 6 nodes, 5 antinodes

Poll

If the length of the string is 2 m, what is the wavelength of the wave?



1. 0.5 m
2. 1.0 m
3. 1.5 m
4. 2.0 m
5. 4.0 m

Wave speed depends on the medium

Newton's second law can be used to derive the speed of a wave on a string. It depends on the tension in the string and the linear density of the string.

Example

Suppose that an A guitar string has a length of 0.765 m and linear mass density of 3 g/m. What tension is required for the A string of a guitar to produce a sound of 110 Hz?

Longitudinal Standing Wave

Displacement node is a pressure antinode

Boundary conditions: closed pipe

Boundary conditions: open pipe

Pipe closed at one end and open at the other end

Pipe open at both ends

Poll

At the open end of a pipe, the ____ is a node and the _____ is an antinode.

1. pressure, displacement
2. displacement, pressure
3. None of the above; both displacement and pressure are nodes
4. None of the above; both displacement and pressure are antinodes.

Poll

At the closed end of a pipe, the ____ is a node and the _____ is an antinode.

1. pressure, displacement
2. displacement, pressure
3. None of the above; both displacement and pressure are nodes
4. None of the above; both displacement and pressure are antinodes.

Poll

What is the harmonic (N) for the standing wave shown below.

1. 3
2. 4
3. 5
4. 6
5. 7

Poll

What is the harmonic (N) for the standing wave shown below.

1. 1
2. 3
3. 5
4. 7
5. 9