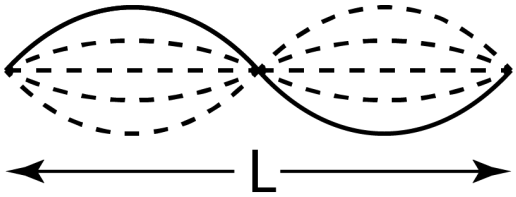
Flipping Physics Lecture Notes:

Standing Waves Introduction
https://www.flippingphysics.com/standing-waves.html

Before we can learn about standing wave patterns, we first need to understand what happens when a wave encounters an end.

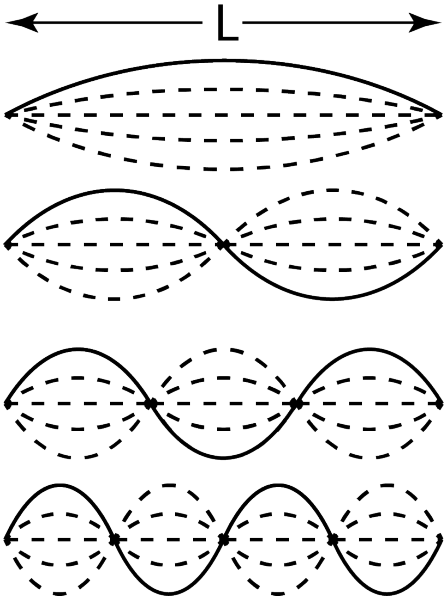
- When a wave pulse comes to a fixed end, it will be reflected and inverted.
  - Fixed end = reflection with inversion.
- When a wave pulse comes to a free end, it will be reflected, however, it will not be inverted.
  - Free end = reflection without inversion.

Today's demonstration involves two fixed ends. In other words, the wave pulses are continuously reflected and inverted. One end is at a constant tension and the other end is oscillating up and down in simple harmonic motion at a known frequency. The wave pulses created by the oscillator are sent down the string, reflected and inverted, and then sent back down the string and interfere with the pulses being sent by the oscillator. At certain frequencies this demonstration sets up standing wave patterns in the string. How does this work? Let's start with this visual of a standing wave pattern:



The length of the string is L. And you can see there is one wavelength in the length of the string.

- Nodes: Locations where the wave interferences cause total destructive interference.
  - There are 3 nodes in the above standing wave.
- Antinodes: Locations where the wave interferences cause constructive interference.
  - There are 2 antinodes in the above standing wave.



Standing wave patterns can only be created at specific wavelengths. This is because, in the case of a string, both ends are fixed and are therefore nodes. To the left are some options for possible standing wave patterns in a string.

Notice each standing wave pattern is comprised of an integer multiple of half wavelengths.

- The 1st standing wave pattern has 1 half wavelength.
- The 2nd standing wave pattern has 2 half wavelength.
- The 3rd standing wave pattern has 3 half wavelength.
- The 4th standing wave pattern has 4 half wavelength.
- The 5th standing wave pattern would have 5 half wavelengths.
- And I bet you can guess the pattern.

It is very important to understand that standing wave patterns will only be created at specific wavelengths and therefore only specific frequencies. In the example of a string vibrating with two nodes on either end, the standing wave pattern must have an integer multiple of half a wavelength.

They are called standing wave patterns because the waves appear to stand still. However, please realize, standing waves are not "standing still". They are the constructive and destructive interference of the waves which are traveling back and forth through the medium.