Standing Waves In Strings

Purpose
The general appearance of waves can be shown by means of standing waves in a string. This type of wave is very important because most of the vibrations of extended bodies, such as the prongs of a tuning fork or the strings of a piano, are standing waves. The purpose of this experiment is to study how the speed of the wave in a vibrating string is affected by the stretching force and the frequency of the wave.

Theory
Standing waves (stationary waves) are produced by the interference of two traveling waves, which have the same wavelength, speed, and amplitude, but travel in opposite directions through the same medium. The necessary conditions for the production of standing waves can be met in the case of a stretched string by having waves set up by some vibrating body, reflected at the end of the string, and then interfering with the oncoming waves. A stretched string has many natural vibration modes (three examples are shown above).

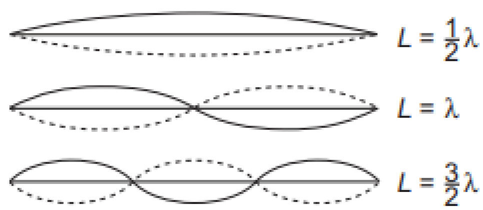

Figure 1. Standing Waves (Fixed Ends)

As seen in the above Figure 1., If the string is fixed at both ends then there must be a node at each end. It may vibrate as a single segment, in which case the length (L) of the string is equal to 1/2 the wavelength (λ) of the wave. It may also vibrate in two segments with a node at each end and one node in the middle; then the wavelength is equal to the length of the string. It may also vibrate with a larger integer number of segments. In every case, the length of the string equals some integer number of half wavelengths. If you drive a stretched string at an arbitrary frequency, you will probably not see any particular mode; many modes will be mixed together. But, if the tension and the string's length are correctly adjusted to the frequency of the driving vibrator, one vibrational mode will occur at a much greater amplitude than the other modes.

Set Up
1)Place a string vibrator on a rod connected to the lab bench.
2)Place a bench-edge pulley at the end of the desk.
3)Drape the string that is attached to the string vibrator and place a mass hanger and approximately 200 grams of mass on the 50-gram mass hanger. Your instructor may ask you to perform the experiment with a constant mass or a variable mass.
4)Connect banana plugs (2) the power output from the PASCO interface (located on the left side of the interface) to the string vibrator.
5)Download and launch the preconfigured PASCO Capstone file to drive the string vibrator from the link below:
https://drive.google.com/file/d/1dMuHeChtWCL9ZZeD2yzY4ZPkznjfWEQt/view?usp=share_link
6)Follow the instructions listed in the Capstone file to run the function generator.

Or, configure Capstone by following these directions.
a)Power up the interface and then Click Hardware Setup
b)Click Signal Generator
c)Click Output 1
d)The default signal output is Sine Wave
e)Change the output frequency to 1 Hz
f)Change the Amplitude to 4 V (Do not exceed 10 V Amplitudes as this will damage the string vibrator). Also, if the metal string vibrator plate strikes the black plastic housing, decrease the amplitude voltage.
g)Turn the signal generator to the *On* position to begin driving the string vibrator.
h)Change the output frequency and/or output amplitude (voltage) by using the arrows to the right of the frequency and amplitude settings.

Standing waves are fun to produce. Be sure to touch the antinodes and nodes that are produced in the strings. See what happens when you touch the nodes and antinodes.

Follow instructions from your instructor about creating experiments, collecting data, and interpreting your data.