

## Standing Waves

### Waves on a String

The speed of a wave is determined by the medium in which it travels. For a wave traveling on a string, the speed depends on the string tension and its density (mass/length). As you know, the speed of the wave determines the relationship between wavelength and frequency.

$$v = \sqrt{\frac{T}{\mu}} \qquad v = \lambda f,$$

### Investigate

*Materials and equipment: string, wave driver, function generator, weights, weight hanger, meter stick, digital balance*

Attach the string to the wave driver (basically a speaker that vibrates a post as well as air) and lay the other end of the string over the pulley. Attach a weight hanger to the end of the string nearest the pulley and then add some weight (as much or little as you like) to the hanger. Connect the banana plug cables to the wave driver and then to the function generator. Select the sinusoidal output on the function generator. The function generator powers the wave driver; using the frequency control on the function generator you can vary the frequency of vibration of the string. Make sure that the wave driver is unlocked.

Vary the frequency of the function generator to find frequencies that are just right to create standing waves on the string.

### Challenge

Create a standing wave with as many loops as you can. When you've found the maximum number of clear loops possible, write your result on the board.

### Task

Use an experimental technique of your choosing to determine the mass density,  $\mu$ , of your string. Write your value on the board along with a very short (10 words or less) description of how you found  $\mu$ .

### Plan

After seeing other lab groups' values for linear mass density and considering how you found your value today, what would be a more accurate way to find  $\mu$ ? You don't have to do the experiment but please describe carefully how you could have performed a more careful experiment to come up with a more accurate value.

## Analyze

1. What was the largest number of loops created in lab today? Why do you think the group that won, was able to see more loops than other groups?
2. The longest wavelength that fits on a particular string is called the **fundamental**. Why is it that fundamental for a string fixed at both ends is  $2L$ ? Why can't it be  $4L$  for example? Include a diagram to explain why  $\lambda = 4L$  is physically impossible.

## Other Standing waves:

### Wave on String

In the *Wave on a String* sim set Amplitude = 3, Frequency = 50, Damping to 0 and Tension high.

1. If the sim is set on *Oscillate* with a *fixed end*, what happens as you observe for a minute (literally a minute!)? Describe why this happens.
2. If the sim is set on *Oscillate* with a *Loose end*, what happens as you observe for a minute (again 1 full minute)? Describe why this happens.

### Bose Noise Cancelling Headphones

Try out a pair of the Bose headphones. Explain how it's possible for headphones to create sound that actually lowers the intensity of the external sounds.