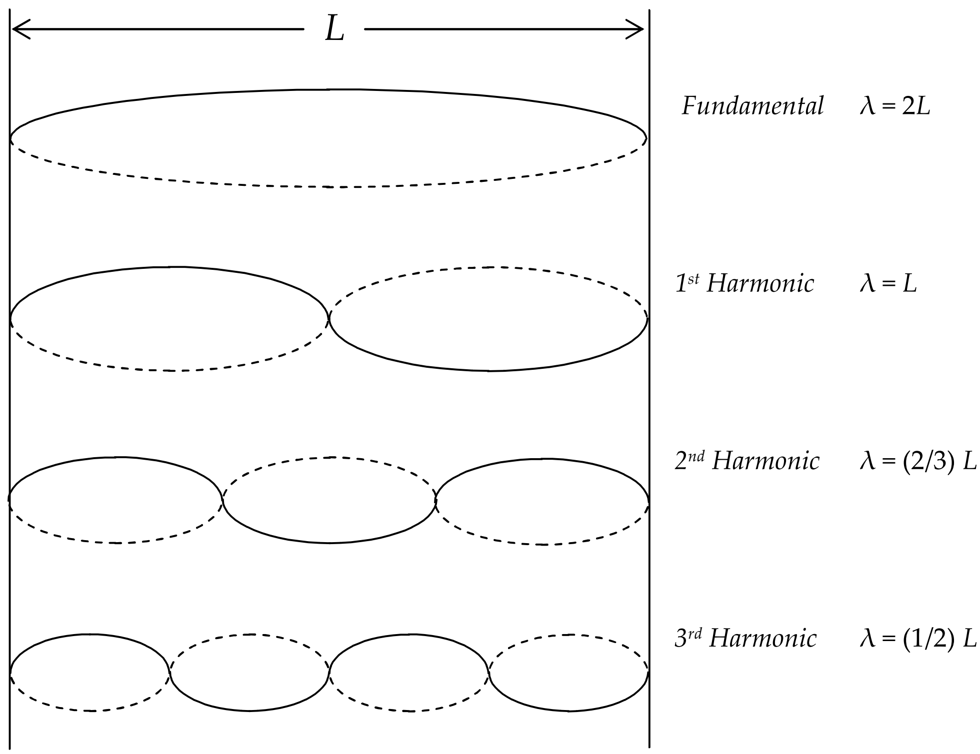
Wave Speed

Introduction:

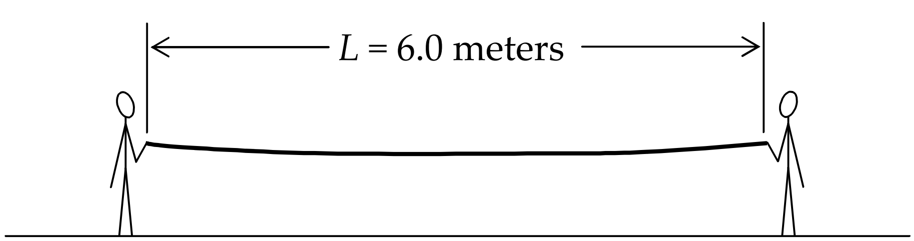
There are two distinct ways to measure the speed of waves through a medium. The first method involves timing the motion of a single wave pulse as it travels a certain distance in the medium. The wave speed is simply $v = d / t$, where d is the distance traveled and t is the travel time. The second method involves setting up a standing wave. The figure below illustrates several standing wave patterns along a string of length L:



To determine the wave speed for any of these standing waves, use $v = f\lambda$, where f is the frequency of the standing wave and λ is its wavelength.

The purpose of this experiment is to compare these two different methods of measuring wave speed. Make sure your group has a meterstick, masking tape, rubber tubing (with handles), and a stopwatch.

Preliminary Set-Up:



1) Designate two group members to stretch the tubing to a length $L = 6.0$ meters and to hold it in place as shown in the diagram above. A third group member should place a piece of masking tape on the floor below each end of the tubing so that the 6.0 meter length is maintained throughout the experiment.
2) The third group member will also serve as the timer and recorder of the data.

Data Collection:

Method 1:

1) One of the holders should pluck his/her end of the tubing so that a well-defined wave pulse travels along the length of the tubing. Note that the pulse reflects off of the opposite end of the tubing and returns to its origin. Practice making this pulse before you proceed to Step 2.
2) Time two "there and back" motions for the pulse. The total distance d traveled is 24.0 m.
3) Record your time in your data table and calculate the wave speed as d / t.
4) Repeat Steps 2 and 3 four more times. Compute the average speed from your data.

t [seconds]	v [meters/second]

Average speed = ____________________________ m/s

Method 2:

1) One of the holders should shake his/her up and down to make the fundamental standing wave.
2) Time 20 complete oscillations (up-down motions) of the tubing. Record the time t in your data table. Calculate the frequency f and the wave speed $v = f\lambda$.
3) Repeat Steps 1 and 2 for as many harmonics as possible. Compute the average speed.

t [seconds]	$f = 20 / t$ [hertz]	λ [meters]	v [meters/second]
		12.0	
		6.0	
		4.0	
		3.0	
		2.4	

Average speed = ____________________________ m/s

Questions: Please answer neatly in complete sentences. Use an additional sheet if necessary.

1) The *percent discrepancy* is a measure of how close one numerical quantity is to another. Calculate the percent discrepancy between the average speeds obtained using the two different methods:

$$\text{Percent discrepancy} = \frac{100 \cdot \left|\text{Method 1} - \text{Method 2}\right|}{\text{Method 1}} = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \%$$

Note that the formula has an *absolute value* so your answer should be positive!

2) Would you say that your results are *consistent*, that is, have a percent discrepancy less than 10%?

3) If you answered "yes" to Question 2, describe at least two ways to decrease the percent discrepancy even further.

4) If you answered "no" to Question 2, describe at least two experimental problems that may have caused your large percent discrepancy.