

Speed of a Wave Lab

Teacher's Guide

Topic:

Waves

The following information is provided to the student:

Question:

What types of variables effect the speed of a wave on a string?

Purpose:

To identify the variables which do and do not alter the speed of a wave on a string.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion and a Discussion of Results. The Data section should include the provided Data table. The Data table should be completed and work should be shown for the indicated rows. The conclusion should state the variables which affect and do not affect the speed of a wave on a string. The Discussion of Results should provide a well-written paragraph in which specific trials are referenced in an effort to explain how the evidence logically leads to the conclusion which was drawn.

Materials Required:

Digital function generator; wave driver; elastic wave cord or rope; meter stick; lab poles and clamps; several 1-kg hooked masses.

Description of Procedure:

An approximately 2-meter length of elastic cord is secured to a clamp on a lab pole at one end of the lab table. A 1-kg hooked mass is secured to the other end of the cord and draped over a clamp at the opposite end of the table. A *wave machine* is set up by connecting the output of a digital function generator to a wave driver. The wave driver is attached to the elastic cord so as to vibrate it up and down. The frequency of the function generator is adjusted in order to force the elastic cord to vibrate with its second harmonic pattern. The length of the elastic cord (from where the vibration begins to the fixed point on the opposite end of the table) is measured. The frequency is reported. Students calculate the wavelength (from the length of the cord) and the speed (from the frequency and the wavelength). Frequency measurements are repeated for the third, fourth and fifth harmonic pattern. The 1-kg hooked mass is replaced with three 1-kg hooked masses in order to alter the tension of the cord (and also the linear density if the cord is elastic). Measurements and calculations are repeated for the second and the third harmonics of this higher tension medium.

Alternative Materials and Procedure:

If a function generator and wave driver or similar means of mechanically creating a periodic vibration of a rope is not available, then two students could create standing waves in a *snakey*. A student (or teacher) vibrates one end of the snakey up and down while a second student holds the opposite end. Wavelengths can be measured using the meter stick and a stopwatch can be used to determine the time for 10 up and down movements (from which the frequency is calculated). The same purpose can be accomplished.

Safety Concern:

The Laboratory

There is always a higher than usual level of risk associated with working in a science lab. Teachers should be aware of this and take the necessary precautions to insure that the working environment is as safe as possible. Student *horseplay* and off-task behaviors should not be tolerated.

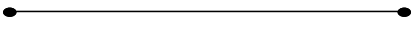

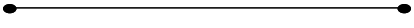


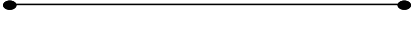
Suggestions, Precautions, Notes:

1. Though costly, mechanical wave drivers and digital function generators are available from many science supply houses. For instance, [Pasco Scientific](#) offers the following models: [PI-8127 Function Generator](#) and [SF-9324 Wave Driver](#).
2. Given the cost and sophistication of the equipment, this lab makes for an ideal demonstration lab. Data can be collected quite quickly (~10-15 minutes) when demonstrated by the teacher. After each measurement, students can perform calculations as the teacher adjusts the frequency output so as to achieve the next harmonic.
3. This lab produces very convincing results which support the following two ideas: (a) the speed of a wave is unaffected by alterations in frequency and wavelength; and (b) an alteration in the properties of the medium will cause the speed of the wave to be changed.
4. Students enjoy watching the standing wave pattern as it is strobed with a strobe light at varying frequencies. If a strobe light is available, consider strobing the standing wave pattern with the room lights turned off. Adjust the frequency of the strobe so as to make the wave cord appear to be standing still. And adjust the strobe rate so that one, two, three, four, ... pictures of the wave cord can be seen during each of its vibrational cycles. (Caution should be taken whenever using strobe lights since viewing strobe lights occasionally induce mild seizures in some students who are prone to seizures.)

Auxiliary Materials:

The following page is provided to the student for completion and inclusion in the Data section of their lab notebook.

Length = _____ m

Harmonic #	Tension	Standing Wave Pattern	λ (m) **	f (Hz)	Speed (m/s)
2nd	Medium				
3rd	Medium				
4th	Medium				
5th	Medium				
2nd	High				
3rd	High				

The Laboratory

** = Clearly show, label and organize your calculations (below) for the first two rows of data:

Scoring Rubric:

W5. Speed of a Wave Lab	Score
____ Included, labeled and organized all parts of the lab report. ____ Data section includes the provided data table; organized and accurate calculations are clearly shown for the requested rows. Standing wave patterns are clearly drawn. Calculations are accurate and complete. ____ Conclusion accurately states the variables which do and do not effect the wave speed. ____ Discussion of Results provides the logical support for the conclusion. References specific results to show how there is a non-effect or an effect of a changing variable upon the wave speed. Uses good logic and good writing.	____/____

Connections to The Physics Classroom Tutorial:

The following readings are a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/waves/u10l2d.cfm>

<http://www.physicsclassroom.com/Class/waves/u10l4d.cfm>

<http://www.physicsclassroom.com/Class/waves/u10l4e.cfm>

Connections to Minds on Physics Internet Modules:

Sublevels 3, 7 and 8 of the Waves module are suitable accompaniments to this lab:

<http://www.physicsclassroom.com/mop/module.cfm>