

Natural Frequency and Standing Waves Lab

Teacher's Guide

Topic:

Sound and Music

The following information is provided to the student:

Question:

What are the natural frequencies at which a lab pole vibrates at and how can these frequencies be related to the standing wave pattern established in the pole?

Purpose:

To determine the natural frequencies of a vibrating lab pole when held at the one-half (center) mark, the one-fourth mark, the one-sixth mark, the one-eighth mark and the one-tenth mark and to relate these frequencies to the standing wave pattern established in the pole.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion of Results. The Data section should include the provided table – completed and taped in. Once collected, the Data should be analyzed in an effort to find a pattern and a relationship between the resonant frequencies and the standing wave pattern. This analysis should be documented in the lab notebook. Cross-outs, wrong turns, scribble-overs and other signs of investigative efforts should be evident in your lab notebook. The Conclusion/Discussion should include a discussion of how the frequencies relate to the standing wave patterns. Supporting evidence from the data analysis (in Data section) should be explicitly referenced.

Materials Required:

Metal lab pole; computer interfaced microphone; meter stick.

Description of Procedure:

A metal lab pole is held at the midpoint and banged on the floor to produce a resonant sound. The sound of the vibrating pole is captured with the microphone. An FFT analysis is applied and the dominant frequency is recorded. The process is repeated several times to insure reproducible results. The lab pole is then held at the one-quarter location (a distance from one end which is one-quarter of the length of the pole) and the process is repeated. Finally, the same process is repeated for the lab pole being held at the one-sixth, one-eighth and one-tenth location.

Alternative Materials and Procedure:

Any long object which makes a relatively resonant sound when struck is a suitable object for analysis.

Safety Concern:

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:

The Laboratory

1. Most software which accompanies computer interfaced microphones have the capability of conducting a fast Fourier transform (FFT) analysis of a complex waveform. The result of an FFT analysis is that the complex waveform is resolved into a series of dominant frequencies; the frequency values and their relative intensities is typically presented as a sound spectrum chart.
2. The pole tends to make a noisy clang when first hit; but within a second it tends to vibrate with one of its natural frequencies.
3. The location which is held by the student is a fixed point and presumably acts as a node.
4. This lab will require patience on the part of the students - both in the collection of data and in its analysis.

Auxiliary Materials:

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

Holding Position	Dominant Frequency (Hz)	Other Frequencies (Hz)	Standing Wave Pattern
1/2-mark			
1/4 th -mark			
1/6 th -mark			
1/8 th -mark			
1/10 th -mark			

Scoring Rubric:

<p>S3. Natural Frequency and Standing Waves Lab</p> <p>___ Included, labeled and organized all parts of the lab report.</p> <p>___ Data section includes the provided diagram – completed and taped in. The diagrams are consistent with the holding position. Some form of a data analysis is document; analysis reveals suitable effort and good reasoning ability. While the analysis does not need to be <i>squeaky clean</i>, it should clearly document the efforts to relate the resonant frequencies to the standing wave patterns.</p>	<p>Score</p> <p>___/___</p>
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The Laboratory

— Conclusion/Discussion explains how the resonant frequencies are related to the standing wave patterns. The discussion is consistent with the data analysis (in Data section); supporting evidence is explicitly referenced. The discussion is complete, thorough, and reveals both effort and understanding.	
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Connections to The Physics Classroom Tutorial:

The following readings are a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/sound/u1114a.cfm>

<http://www.physicsclassroom.com/Class/sound/u1114b.cfm>

<http://www.physicsclassroom.com/Class/sound/u1114c.cfm>

Connections to Minds on Physics Internet Modules:

Sublevel 5 of the Sound and Music module is a suitable accompaniment to this lab:

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