

Nodes and Antinodes Lab

Teacher's Guide

Topic:

Waves

The following information is provided to the student:

Question:

How is the number of nodes and antinodes in a longitudinal standing wave related to the vibrational frequency?

Purpose:

To determine the mathematical relationship between the number of nodes and the number of antinodes and the vibrational frequency of a longitudinal standing wave.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion of Results. The Data section should include a table of measurements and node and antinode counts. Some form of numerical analysis (a data plot with linear regression analysis, trial and error equation testing, and/or the use of additional columns of calculated data) should be evident in the Data section. The Conclusion/Discussion should include the stated mathematical equation and a discussion of the evidence which supports such an equation. An error analysis should be included, discussing the degree of certainty to which you hold to your conclusion and identifying outlying data and any possible alternative equations.

Materials Required:

Digital function generator; wave driver; spring; lab poles and clamps; 1-kg hooked mass.

Description of Procedure:

A wave driver is mounted on a lab pole at an elevated position above the lab table. A spring is attached to the amplifier and stretched straight downward and hooked onto a 1-kg hooked mass at rest on the table. The output of a digital function generator is connected to the wave driver. When turned on, a longitudinal standing wave pattern can be established in the spring. Altering the frequency output changes the harmonic number and the wavelength. The frequency is adjusted to a low frequency so as to establish a clearly visible standing wave pattern with nodal and antinodal positions. (It could correspond to the fourth or the fifth or the sixth harmonic; it does not need to be the first or the second.) The actual frequency and the harmonic number is recorded. The frequency is slowly adjusted upward until the next harmonic is established. The new frequency and corresponding harmonic number are recorded. The process is continued several more times in order to collect as much data as possible. Students inspect the data, plot it, analyze it and attempt to establish the relationship between the two quantities.

Alternative Materials and Procedure:

Alternative materials and procedures are not recommended.

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. The rigor of the lab lies in the actual analysis of the data. This task is best left for the students.
3. To demonstrate the true nature of a node and an antinode, place a note card in between two adjacent coils of the spring at both a nodal and an antinodal position. Silence occurs when placed at the nodal position and the sound of *chattering teeth* is heard when placed at the antinodal position.
4. The first harmonic standing wave pattern would have a single antinode at the location of the amplifier and a node at the fixed end where the spring attaches to the 1-kg mass. The second harmonic standing wave pattern would have a visible node between ends and a second node at the fixed end. The third harmonic standing wave pattern would have two visible nodes between ends and a third node at the fixed end. The fourth harmonic standing wave pattern would have ...

Auxiliary Materials:

None

Scoring Rubric:

W7. Nodes and Antinodes Lab	Score
<ul style="list-style-type: none">___ Included, labeled and organized all parts of the lab report.___ Data section includes a table of data organized in a row-column format; column headings and units are provided. Some form of numerical analysis is evident. If a linear regression analysis is used, a sample plot with statistical data is provided. If trial-and-error equation fitting is used, a clear documentation of unsuccessful and successful efforts is provided. (Scratchouts, wrong turns, and scribbles are expected.) All efforts to determine the equation reveal good logic and problem-solving ability; documentation is thorough.___ Conclusion/Discussion reports the equation which best fits the data. The evidence which logically supports the equation is thoroughly discussed. The equation is relatively accurate and consistent with the data. An error analysis is provided: the degree of certainty with the equation is discussed; possible alternative equations are mentioned.	___/___

Connections to The Physics Classroom Tutorial:

The following readings are a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/waves/u10l4b.cfm>

<http://www.physicsclassroom.com/Class/waves/u10l4c.cfm>

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

Connections to Minds on Physics Internet Modules:

The Laboratory

Sublevel 7 of the Waves module is a suitable accompaniment to this lab:

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