

Mach 1 Lab

Teacher's Guide

Topic:

Sound and Music

The following information is provided to the student:

Question:

What is the speed of sound? (using distance-time data)

Purpose:

To determine the speed of sound using the time it takes to travel a certain distance.

A complete lab write-up includes a Title, a Purpose, a Data section, a Conclusion and a Discussion of Results. The Data section should record the results of several measurement trials in a well-organized table with column headings and units clearly shown. Speed values should be calculated and the work for one calculation should be shown. The average speed value should be determined; non-representative data should not be included in the averaging; this should be noted in the Data section. The Conclusion should respond to the question raised in the Purpose section (as always). The Discussion of Results should include an error analysis. The reliability of the data set should be discussed; comments should pertain to both accuracy and precision. Any trials not included in the average speed calculation should be discussed; the reason for their non-inclusion should be explained. The average speed value should be compared to the theoretical value; a percent error calculation should be made; work should be clearly shown.

Materials Required:

Computer interfaced microphone; long hollow tube; meter stick; thermometer.

Description of Procedure:

A long hollow tube is placed on the lab table. A computer interfaced microphone is placed on the lab table next to the open end of the hollow tube. A sound is created near the opening of the tube. The sound travels the length of the tube and back. The computer display shows a strong peak, indicating the first detection of the created sound and a secondary peak amplitude indicating that the reflected sound has returned from the opposite end of the tube. Ignoring the abundance of *noise*, students determine the time elapsed between the two peak amplitudes and measure the down and back distance. The speed is calculated from the data. Trials are repeated to insure accurate results.

Alternative Materials and Procedure:

Alternative materials and procedures are not recommended.

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. Allow students to experiment with a variety of variables in order to obtain satisfactory results. Some students may clap; others may hit the table with a meter stick; and still some may shout. Some students might cover the end of the tube; others might allow the sound to reflect off the open end. Some students may make a loud sound while others experiment with softer sounds.
2. Students should run many trials, looking for consistent results. Some trials will be quickly discounted before measurements are made. Some trials will be omitted because the results are clear outliers. Many trials are needed to identify a pattern in the results. An average of several trials should be computed.
3. This is a great opportunity to collect class data. Emphasize that the pooling of a large amount of data is representative of the manner in which scientists operate – cooperatively rather than competitively. Compute a class average and compare the value to that expected based on the room temperature.
4. While the results of this lab tend to be very good, it is not a squeaky clean lab. Students have to do a considerable amount of problem-solving in order to obtain reasonable results. Perhaps the greatest value of the lab lies in the challenge which it poses to students in order to obtain simple distance and time data.

Auxiliary Materials:

None

Scoring Rubric:

S2. Mach 1 Lab	Score
<p>___ Included, labeled and organized all parts of the lab report.</p> <p>___ Data section includes a table of data with several trials; column headings are labeled; units are shown. Speed values are accurately calculated; work is shown in organized fashion with a labeled unit. Results are reasonably accurate. An average speed value is calculated; outlying data is clearly omitted from the averaging process. Class data is shown.</p> <p>___ Conclusion states the experimentally-determined speed of sound in air.</p> <p>___ Discussion of Results includes an accurate and thorough error analysis. Analysis discusses both the accuracy and the precision of the results; outlying data trials are identified. A percent error calculation is performed; work is clearly shown.</p>	___/___

Connections to The Physics Classroom Tutorial:

The following reading is a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/sound/u11l2c.cfm>

Connections to Minds on Physics Internet Modules:

There are no sublevels of Minds on Physics on the topic of the speed of sound.