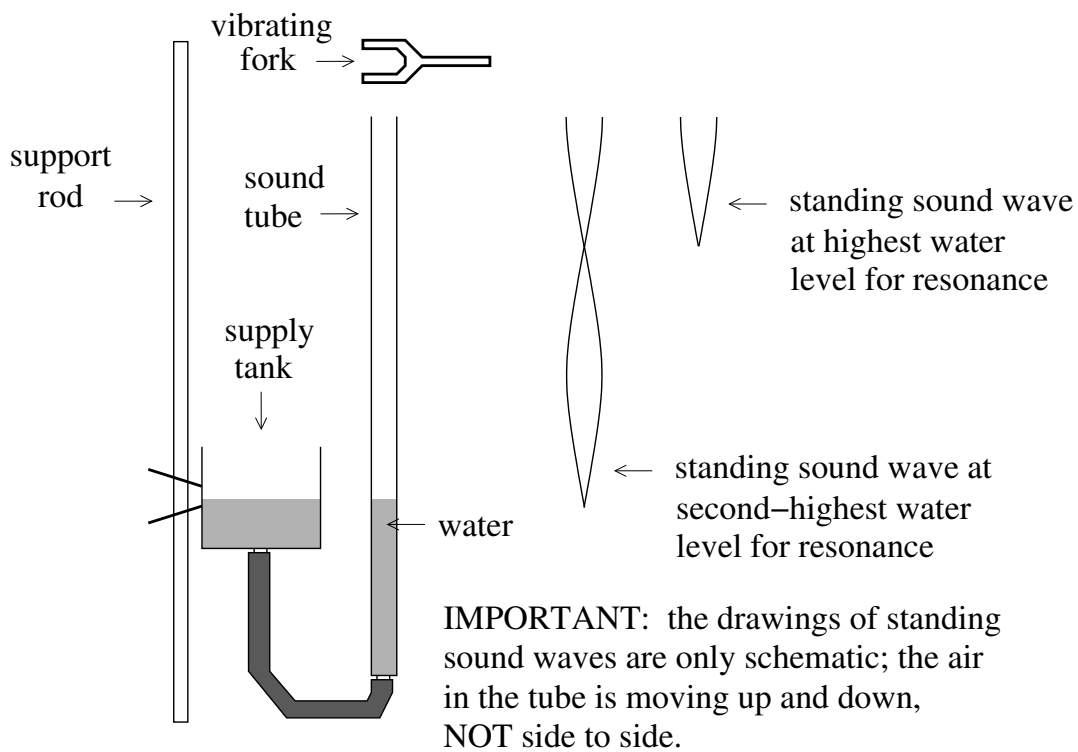


### EXPERIMENT 8: SPEED OF SOUND IN AIR

Introduction: In this lab, you will create standing sound waves in a column of air confined to a tube. You will be able to change the frequency of the sound waves by creating the sound with labeled tuning forks, and you will be able to change the length of the air column. While you cannot see the standing sound waves, you will be able to detect their existence by the loud sound that they produce. Since you will thus know both the wavelength of the sound waves and the time for one vibration of the source of the sound, you will be able to calculate the speed of sound.



#### Procedure

1. By raising or lowering the supply tank, you can change the water level in the sound tube. Adjust the water level so that the tube is nearly full of water.
2. Select a tuning fork and record the frequency of your selected fork in Data Table 8.1. To sound the fork, strike the tines with a rubber hammer (for fork frequencies above 1000 Hz, use a wooden hammer); each group member should listen closely to the sound from the vibrating fork so that the tone of the fork can be recognized.
3. Hold the vibrating fork just above the opening of the sound tube. Slowly lower the water level while listening for the loud sound that will be produced by a standing sound wave in the tube; the loud sound must be of the same tone as the fork (for

some forks, the resonant tube may produce loud sounds of higher pitch than the pitch of the fork). Lower the water level as far as possible; as the water level is lowered, use a water-erase marker to make dots on the tube to indicate the approximate water levels which result in a loud sound.

4. Whenever a standing sound wave is created in the tube, there is a node (a place where the “little boxes of air” are not moving) at the surface of the water. We will use the highest, and second highest, resonant water levels as our two node locations. Slowly raise the water level; as the rising water reaches each of the highest resonant levels, make a careful adjustment to produce the loudest possible sound. Mark the resonant level as precisely as possible. Measure, from the top of the tube, the position of each marked level (a tape measure is provided). Record those positions in Data Table 8.1.
5. Repeat steps 2, 3, and 4 with two different forks. Clean the tube when you are done.
6. Record the room temperature for this day in the space below Data Table 8.1.

Data Table 8.1

frequency (Hz)	position of highest resonant water level (cm)	position of second highest resonant water level (cm)	node-node distance (cm)

Today’s room temperature is \_\_\_\_\_ °C.

Data Table 8.2

frequency (Hz)	node-node distance (m)	wave length (m)	period (s)	wave speed (m/s)

## Results

1. Fill in the remaining columns of Data Table 8.1. The node-node distance is the absolute value of the difference between your measured position for the highest resonant level and your measured position for the second-highest resonant level. Show your calculations for one of your three frequencies in the space below.
  
2. Transfer your results for the three frequencies to Data Table 8.2, changing the units of node-node distance from cm to m. Then fill in the remaining entries for that Table. The wavelength is twice the distance between nodes. The time for one vibration is the reciprocal of your tuning fork frequency. The measured speed of sound is the wavelength divided by the time for one vibration. Show your calculations for one of your three frequencies in the space below.
  
3. Make a graph of your measured wavelengths versus period (period on the horizontal axis). Using (0.0 s, 0.0 m) as a good data point will give you four data points. Draw a best fit line and find its slope to determine the average value of the speed of sound for your experiment. Clearly show your calculation of slope on your graph.
  
4. In Data Table 8.2, you have three different determinations of the speed of sound in air. What is the percent difference between your largest determined value and your smallest determined value? Show your calculation in the space at the top of page 4 (use your average value of speed, from part 3, in the denominator).

5. Report your value for the speed of sound, with uncertainty. The uncertainty in your reported value is plus or minus half of your percent difference in step 4 above (for example, if your average value is 340 m/s and your percent difference is 20%, your reported value would be 340 m/s  $\pm$  10.0%).
6. Now that you have a measured value for the speed of sound, describe how you would do a similar experiment to determine the frequency of an unlabeled tuning fork.

### Going Further

1. You can compare your reported value of the speed of sound with the accepted value at the temperature of your lab room. That value is given by

$$v(\text{at temperature } T_{room}) = 331.4 \text{ m/s} + \left(0.6 \frac{\text{m/s}}{^{\circ}\text{C}}\right) T_{room}$$

Use your recorded room temperature to calculate the speed of sound in your room on the day of your experiment. Then compare your reported value to the accepted value by calculating a percent error.

