Experiment 11

Sound Waves

11.1 INTRODUCTION

In this experiment, you will

- Become familiar with measuring oscillating signals with an oscilloscope,
- Measure the frequency and wavelength of standing sound waves in an air tube, and
- Measure the speed of sound in different gases.

11.2 THE EXPERIMENT

The apparatus consists of a horizontal tube with a small speaker at one end and a small microphone that can be moved along the axis of the tube to measure the sound intensity at different locations.

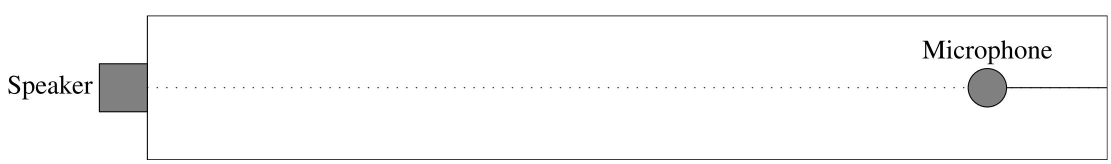

Figure 11.1: Sound wave apparatus.

The speaker is driven by a function generator, allowing you to control the amplitude and frequency of the sound waves. For certain resonant frequencies, standing sound waves can be produced in the tube; the nodes and antinodes of these standing waves can readily be detected and measured with the microphone, thus allowing you to determine the wavelength.

Then, using the relationship $v = f\lambda$, the speed of sound can be determined.

11.2.1 Standing Sound Waves

1. Turn the amplitude knob on the function generator all the way down. Switch on the function generator using the switch on its back and then adjust the frequency to about 400 Hz.

2. The speakers can be damaged if the signal from the function generator is too large. Turn the amplitude knob on the function generator up to a very small amplitude; the 8 o'clock position works well. You should be able to hear a very quiet, low-pitched hum if you put your ear close to the speaker.

3. Turn on the oscilloscope and press the `AutoScale` button. You should see a yellow trace that represents the sinusoidal voltage supplied to the speaker by the function generator.

4. Next, you need to monitor the sound intensity picked up by the microphone. Turn the microphone on. Connect the microphone to the green input of the oscilloscope (Channel 2) and press the `AutoScale` button again.

   If everything is working correctly, the oscilloscope will simultaneously show the voltage driving the speaker on Channel 1 (yellow) and the voltage reported by the microphone on Channel 2 (green). You will probably find that the microphone signal is rather ragged. That's ok – once you find a standing wave in the next part, you should get a much cleaner signal.

5. Slide the microphone to the end of the tube opposite from the speaker. Slowly vary the frequency until the amplitude of the microphone signal is maximized. This is referred to as a resonance. You will likely need to change the vertical scale and vertical shift of Channel 2 to ensure the entire microphone waveform remains onscreen. You don't need to measure the amplitude of the signal, just the frequency at which that amplitude reaches a maximum value.

6. If this resonance has a flat top, it's an indication that the microphone signal is saturated. Turn down the amplitude on the function generator until the microphone signal looks more sinusoidal.

7. Now, slowly slide the microphone along the axis of the sound tube. Record the number of nodes you observe. You don't need to record their exact positions; just enough information to make a rough sketch of the standing wave pattern.

8. Make a rough sketch of the standing sound wave. Use the length of the tube and your sketch to determine the wavelength of the wave.
9. Return the microphone to the end of the tube opposite the speaker and vary the frequency until you find another resonance. Record the frequency and then make another sketch to determine the wavelength. Repeat the experiment to determine the frequencies and wavelengths of six different standing waves.
10. Use your data to determine the average speed of sound waves in your apparatus. Determine the uncertainty in your value, and compare your experimental result to the expected value.

11.2.2 The Speed of Sound in Argon

Consult your instructor to help you fill your tube with argon. As the tube fills, the microphone will pick up a noisy signal due to the sound of the flowing argon.

Repeat your experiment to determine the speed of sound in argon gas. Compare the speed of sound in argon to the expected value.

TURN OFF YOUR MICROPHONE. Let's save the batteries for the next lab group!

As always, discuss sources of error and ways in which the experiment or write-up could be improved.