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SCIENCE PERFORMANCE TASK

Discovering the Speed of Sound in Open Air

How can you determine the speed of a sound wave for a given sound wave?

Phenomenon We experience sound in many ways, such as through talking, music, and noise. However, we do not hear sound as soon as it happens. During a lightning storm, we see the lightning before we hear the thunder from the lightning. Jets, when flying at a certain speed, can cause a booming sound because sound travels at a finite speed.

In this lab, you will develop a method to determine the speed of sound in air. You will have access to tools that produce sound waves at different frequencies to compare the speed of sound each tool makes.

Focus on Science Practices

SEP 3 Plan and Carry Out Investigations
SEP 4 Analyze and Interpret Data
SEP 5 Use Mathematics and Computational Thinking
SEP 6 Construct Explanations

Materials Per Group

- Clamp holders, 2
- Clamps, universal extension, 2
- Graduated cylinder, 250-mL
- Petroleum jelly (optional)
- Plastic tube, clear, 1” diameter, 2 ft
- PVC tube, white, ½ ” diameter, 2 ft
- Rubber stopper, #5
- Ruler, metric
- Support stand
- Tuning forks, set of 8
- Tuning fork activator
- Water, 200-mL

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Safety

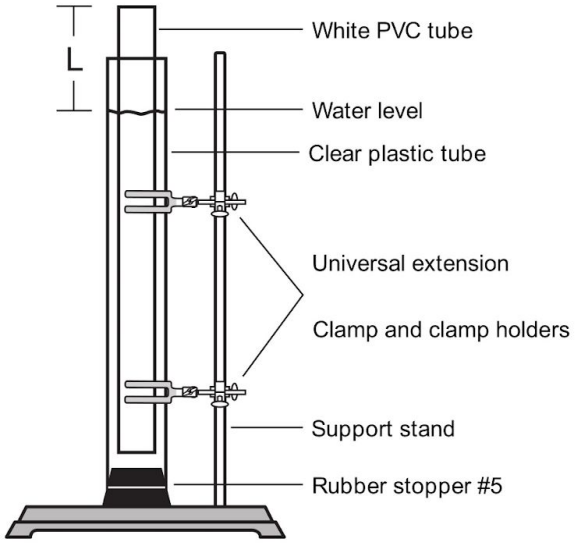
This lab is considered to be nonhazardous. Please follow all laboratory safety guidelines.

Procedure

Part I

1. Set up a support stand and attach one universal extension clamp to the top of the rod, and a second universal extension clamp to the bottom of the rod.
2. Place a rubber stopper in the bottom of the clear plastic tube.
3. Attach the clear plastic tube to the support stand using the universal extension clamps as shown in Figure 1. The rubber stopper should be resting on the base of the support stand.

Figure 1



4. Place the white PVC tube inside of the clear plastic tube.
5. Fill a large graduated cylinder with 200 mL of water.
6. Make sure the end of the clear plastic tube is completely sealed by pouring a small amount of water into the tube and watching for any leaks. Petroleum jelly may be put around the edge of the stopper if leaking does occur.

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7. Pour the rest of the water from the graduated cylinder into the sealed plastic tube. The water should be near the top of the tube but not overflowing.

Part II

8. **SEP Plan an Investigation** Plan a procedure to determine the speed of sound in open air using the apparatus you set up. How can the apparatus help you determine your dependent variable(s)? Use the provided materials in your procedure. Use the provided table as a guide.

   Record your detailed procedure. Before you carry out your investigation, get your teacher's approval.

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Table 1

Speed of Sound					
Frequency (Hz)	**Tube Length (cm)**	**Tube Length "L" (m)**	**Wavelength (m)**	**Speed of Sound (m/s)**	**Average Speed of Sound (m/s)**
256					
288					
320					
341					

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Analyze and Interpret Data

1. **SEP Use Math** Show the formula needed to calculate wavelength. Show the calculations for one of the frequencies you tested. Remember to use the correct units. Complete the Wavelength column of the data table for the other frequencies.

2. **SEP Use Math** Show the formula needed to calculate the speed of sound. Show the calculations for one of the frequencies you tested. Label the answers with the correct units. Complete the Speed of Sound column of the data table for the other frequencies.

3. **CCC Patterns** Look at your data in the frequency and wavelength columns of the data table. As the frequency increases, what happens to the wavelength?

4. **SEP Construct an Explanation** Based on your data, what similarities and/or differences do you notice between the different frequencies and the speed of their respective sound waves? Use the equation from question 2 to explain how the similarities and/or differences occur.

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5. **SEP Use Math** The expected average speed of sound for all those tuning forks in air at STP, standard temperature (273 K) and pressure (1 atm), is 331 m/s. How does your measured average speed of sound in air compare to the actual accepted value? Calculate the percent error between your measured average and the accepted average speed of sound.

6. **SEP Use Math** An easy way to estimate the speed of sound in air produced by a 256 Hz tuning fork is to calculate the following 331.5 m/s + 0.6(*T*) ; where *T* is the temperature measured in Celsius. Measure the temperature in your lab or classroom using a thermometer. Calculate the expected speed of sound produced by a 256 Hz tuning fork at that temperature and compare it to the expected speed in a very hot area, where the temperature is 38°C.

7. **SEP Apply Scientific Reasoning** In general, do you think the speed of sound would increase or decrease if it travels through a liquid or solid? Explain the reasoning for your answer.