Sound Waves

PROBLEM

Does sound behave like other waves?

INTRODUCTION

Experimental evidence shows that sound has the properties of waves. Sound can produce interference with a characteristic wavelength. When you listen to a pair of speakers, two sounds reach your ear at the same time. What you hear is the addition of the two waves. Beats are an example of the interference of sound waves of different frequencies. The sound gets alternately loud and soft as the waves drift in and out of phase with each other. Sometimes they are in phase and the result is twice as loud. A moment later they are out of phase and they cancel out, leaving periods of quiet. The alternation of loud and soft is what we hear as beats. Another example of interference can be caused by identical waves. Suppose you have two identical sound waves and you are standing where you can hear them both. For certain positions, one sound wave reaches your ear in the opposite phase with the other wave and the sound gets softer. Move over a little and the two sound waves add up to get louder. In this investigation, you will: experiment with a sound wave interference phenomenon called "beats."; use interference to measure the wavelength of sound; and explore resonance.

MATERIALS *(per group)*

Data Collector; Meter stick; Sound generator; Speakers; Tuning fork

PROCEDURE

1. Set up the sound generator, speakers, and Data Collector as shown at right. Choose timer mode and select the frequency function. When the sound generator is in sound mode, you will hear a base frequency at 440 Hz coming from both speakers. Switch the unit from sound mode to beats mode by pressing the mode button.

2. In beat mode, turning the frequency dial changes the frequency of the sound produced by the second speaker from 440 Hz to 439 Hz and as far down as 430 Hz. The first speaker continues to play the base frequency. In beat mode adjust the frequency to read 439 Hz. Stand back and listen to the sound when both are at equal volume.

3. Cover one speaker with your hand and turn it away so you can listen to the uncovered speaker by itself. Swap speakers and do the same so you can listen to the other speaker by itself. Note if you tell the difference between the sound produced by each speaker.

4. Listen to both at equal volume again and listen to the combination. Adjust the frequency between 439 and 430 Hz. Listen to the combinations of sound.

5. Another example of interference is easy to demonstrate. Put the sound generator back in sound mode. Place one speaker about 1/2 meter behind the other. Set the frequency between 400 and 800 Hz. Stand 3 or 4 meters in front of one speaker and have your lab partner slowly move the rear speaker away from you. Note what happens to the volume as the speaker moves.

6. When two speakers are connected to the same sound generator in sound mode, they both make the exact same sound wave. If you move around a room you will hear places of loud and soft volume based on the difference in phase of the sound waves produced by the two speakers. Try to make an approximate measure of the wavelength of sound by changing the separation of the two speakers. Keep the observer and both speakers in the same line. The observer will hear the sound get loud and soft and loud again when the distance between speakers has changed by one wavelength. Using a meterstick, measure this distance. Record the wavelength and the frequency in the table on the next page. Check your measurement by calculating the wavelength. Record the result.

$$\lambda = \frac{v_{sound}}{f}$$ [*NOTE*: $v_{sound} = 343\ ^{m}/_{s}$]

7. Many objects that can create sound also have natural frequencies and resonance. When they vibrate, these objects can produce a characteristic sound at their natural frequency. A tuning fork is a good example. Select a tuning fork and tap it on your knee or another firm (but not hard) surface. Listen to the sound. Note how many frequencies you hear.

8. Use the sound generator to measure the frequency of the resonance by matching the frequency of the sound generator with the sound you hear from the tuning fork. When you get to within about 15 Hz of the frequency you will hear the rapid oscillation of beats as the frequencies created by the tuning fork and the sound generator begin to be close in value but are not yet exactly the same. As the frequency from the sound generator and from the tuning fork get closer together the beats become slower. The frequency of sound from the speakers is the same as the sound from the tuning fork when you no longer hear any beats. Try several different tuning forks and use the table below to record describe the tuning form (small, medium, large), the listed resonant frequencies, and the measured resonant frequencies.

9. Strike a tuning fork and hold the bottom end against a hard, thin surface such as a window. Note what happens to the volume.

OBSERVATIONS

1. Is there a noticeable difference between a sound of 440 Hz and 439 Hz? ____________________

2. What happens to the frequency of beats as the frequency difference between the speakers increases? ____________________

FREQUENCY AND WAVELENGTH		
Frequency (*f*)	Measured Wavelength (λ)	Calculated Wavelength (λ)

RESONANT FREQUENCY OF TUNING FORK		
Tuning Fork Description	Listed Frequency (Hz)	Measured Frequency (Hz)

3. What happens to the volume of a tuning fork when it is held on a surface? ____________________

CONCLUSIONS

1. Why do we usually not hear interference from sound systems with two speakers? ____________________

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2. Describe the relationship between the size (or shape) of the tuning fork and the frequency at which it was resonant? ____________________

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3. What happens to the volume of the sound produced by the tuning fork when it is touched to a surface? Why? ____________________

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