Wavelength and sound essay sample

Verification of the relationship between frequency of sound and its wavelength and the determination of the velocity and the speed of sound in different mediums was the main focus of this experiment. The speed of sound and its velocity was determined using the resonance tube apparatus and Kundt's tube respectively. A vernier microphone was used to note the time interval between wavelengths. The results obtained on the second and third experiment gathered a minimal compared error compared to the first experiment. Introduction

Sound is a longitudinal wave in a medium. Sound waves usually travel out in all directions from the source of sound, with an amplitude that depends on the direction and distance from the source.

A sound wave is a pressure disturbance that travels through a medium by means of particle-to-particle interaction. As one particle becomes disturbed, it exerts a force on the next adjacent particle, thus disturbing that particle from rest and transporting the energy through the medium. Like any wave, the speed of a sound wave refers to how fast the disturbance is passed from particle to particle. While frequency refers to the number of vibrations that an individual particle makes per unit of time, speed refers to the distance that the disturbance travels per unit of time.

The speed of any wave depends upon the properties of the medium through which the wave is traveling. The phase of matter has a tremendous impact upon the elastic properties of the medium. In general, solids have the strongest interactions between particles, followed by liquids and then gases.

For this reason, longitudinal sound waves travel faster in solids than they do in liquids than they do in gases.

The objectives of this experiment is to verify the relationship between frequency of sound and its wavelength, to determine the speed of sound by means of a resonating air column and lastly, to determine the velocity if sound in a solid using a vibrating rod.

Theory

The formula used in to get the velocity of sound is;

$V = f\lambda$

V = Velocity

f = Frequency engraved in the tuning fork

λ = Computed wavelength of sound produced

The formula used to get the wavelength λ is:

$\lambda = 4L + 0.3D$

λ = Wavelength

L = Change in level of the water

The formula used to get the theoretical velocity of air is: $V = 331 + 0.6T$

V = velocity

T = Temperature of the water in degrees Celsius

The formula used to get the Frequency of sound produced is: $f = V/\lambda$

f = Frequency produced

V = Theoretical velocity obtained in Activity 1

λ = Twice the average if the distances between two consecutive displacement nodes

The formula used to get the speed of sound (Vr) is:

Vr = fλr

Vr = Speed of sound

f = Frequency of the sound and

λr = Wavelength of sound in the rod

The formula used to get the wavelength of sound in the rod is: λr = 2L

λr = Wavelength of sound in the rod

L = Distance between two nodes

The Formula used to get the theoretical speed of Sound in the rod is: Vr

Vr = Theoretical velocity of sound in solid

Y = Young's modulus (2. 0×1011 n/m2)

ρ = Density of steel (7860 kg/m3)

Methodology

Activity 1

The resonance tube apparatus was filled with completely. A tuning fork was struck with a rubber mallet. The vibrating tuning fork was placed over the top of the glass tube. The water vessel was slowly lowered until the loudest sound was heard. The point where the sound was heard was marked. The vibration of the fork was made sure as the vessel was lowered. The fork was struck again if the vibration stopped. The distance between the point where the loudest sound was heard and the top of the glass tube was measured. This was recorded as L. The data gathered was converted to meters. The diameter of the resonance tube was measured and the wave length of the sound produced was computed. Two more trials were made and the average wavelength was determined. The velocity of sound in air inside the glass tube was computed using the average wavelength and the frequency engraved in the tuning fork. The temperature was determined in degrees Celsius of air inside the glass tube. The thermometer was made sure that the water is not touched. The speed of sound in air at that temperature was computed. The percent error was computed by comparing the speed of sound in air and the speed of sound in the resonating tube. The speed of air was used as the accepted value. The procedure was repeated for the other tuning forks. The data and observation was recorded.

Activity 2

The vernier microphone was connected to the channel 1 of the interface. The microphone was positioned near the open end of a closed tube. The file " 32 Speed of Sound" in physics was opened. A snap of a finger or a clap of the hand was done near the tube and the collection of data was done. The time interval between the start of the first vibration and the start of the echo vibration was observed in the graphed shown on the computer screen. The time interval was noted as the time for sound to travel through the tube and back. The speed of sound was computed by dividing the length of the tube by half of the time interval obtained. The percent error was computed with the same accepted value used in activity 1. Activity 3

A thin layer if cork dust was placed uniformly inside the Kundt's tube. The rod was clamped at its center. The rod with a piece of cloth with coarse powder was rubbed. The vibration of the rod produced a sound of high frequency. A wave patter was observed in the cork dust inside the glass tube. The distance between two consecutive displacement nodes was measured. The average of these distances was computed and the frequency if the sound was determined. The speed of sound was determined using the frequency obtained. The theoretical speed of sound and the percent error was also computed.

Results and Discussions

Table 1.

Frequency of tuning fork	384 Hz
Wavelength (m)	0. 3727 m
	0. 3727 m
Average Wavelength	0. 3727 m
Experimental speed	143. 88 m/s
Theoretical Speed	346 m/s
% error	58%
Frequency of tuning fork	1024 Hz
Wavelength (m)	0. 1607 m
	0. 1607 m
Average Wavelength	0. 1627 m
Experimental speed	166. 60 m/s
Theoretical Speed	346 m/s
% error	84 %

In table 1, the wavelength of each frequency was acquired by subtracting the final volume of water and the initial volume. The frequency of the tuning fork was obtained by the engraving on the fork. The average wavelength was computed by combining the acquired wavelength per trial and dividing it by two. The experimental speed was computed by multiplying the frequency and the average wavelength. A large percent error could be the result of the environmental noise that could interrupt the sound waves and causing it to affect the results. Table 2

Length of tube| 0. 59 m|

Trial 1| 0. 00332 s|

Trial 2| 00. 00294 s|

Average| 0. 00313 s|

Experimental speed| 377 m/s|

Theoretical speed| 346 m/s|

% error| 9. 6%|

The length of the tube was computed using a ruler. The time per trial was computed by subtracting the first peak by the second peak in the graph. The average was achieved by adding the first trial and the second trial and dividing it by two. The experimental speed was achieved by achieved by dividing the diameter by the average time. The theoretical speed used was the computed value from activity 1. A relatively small percent error was observed because the sound inside the tube was enclosed thus, preventing further disturbance in the acquired sound waves. Figure1. First Trial

In figure 1, the two peaks were the time the sound bounced back to the microphone Figure2. Second trial

In figure 2, the sound immediately bounced back to the microphone Table 3

Average distance between node to node| 0. 045 m|

Wavelength of sound in air| 0. 14m|

Frequency of sound| 2471 Hz|

Length of rod| 0. 91 m|

Wavelength of sound in rod| 1. 82 m|

Experimental speed of sound in the rod| 4497 m/s|

Theoretical speed of sound in the rod| 5063 m/s|

% error| 11%|

The average distance between node to node was measured using a ruler. The wavelength was acquired by multiplying the average distances between nodes by two. The frequency was computed by dividing the theoretical value from activity 1 by the wavelength. The length of the rod was calculated using a ruler. The wavelength of the sound in the rod was computed by multiplying the frequency acquired by twice the length of the rod or the wavelength of sound in the rod. The theoretical speed of sound was computed by the square root of the young’s modulus over the density of the rod. A minimal amount of error in this experiment could be the result of using a ruler, creating a misreading of the exact distance and measurement because of the ruler’s small least count range. Conclusion

Sound waves travel faster in more dense objects. Thus, sound travel faster in solid objects than through air. Sound also have many factors which could affect its pattern. Application

1.) What is the relation between frequency and wavelength of sound produced in a medium? Frequency is equal to the velocity of the sound over its wavelength and the wavelength is equal to the velocity of sound over its frequency, meaning that frequency and wavelength are inversely proportional. The longer the wavelength the lower the frequency and vice versa 2.) What is the use of water in activity 1?

It serves as a wall so that a sound may bounce back creating an echo and reaching the ears of the observers. 3.) In medical practice, ultrasound in the range of 1 to 5 megahertz is being used as an imaging modality the associated wavelengths in a typical human tissue range from 0. 3mm to 0. 06mm. Find the velocity of ultrasound in the tissue. 1540 m/s on soft tissue. The velocity of sound on the tissue depends on the elasticity and density of a given tissue or organ. 4.) The outer ear of a human may be thought as a closed pipe 2. 7cm long on the average. What frequency would be most effectively detected by the ear at 30oC? The velocity of the sound in a 30 degrees celcius temperature is 349 m/s2 and if you divide it by twice the distance of the ear in kilometres, you will acquire 1293 Hz. 5.) Suppose that we increase the temperature of the air through which sound a wave is traveling. A.) what effect does this have on the velocity of the wave? Explain.

B.) For a given frequency, what effect does increasing the temperature have on the wavelength of the wavelength of the sound wave? Explain. A.) The velocity of the sound will decrease because air travel faster on lower temperatures. This is because the molecules of the air are more compact compared to higher temperature meaning more vibrations will occur and thus producing sound. B.) The wavelength of the sound will increase because the velocity will decrease. 6.) If you were lying on the ground, would you hear footsteps sooner or later with you ear touching the ground or not? If your ears are touching the ground, you will hear the footsteps sooner than not because the vibrations and sound created by the footsteps will travel to the compact molecules of the soil thus making the velocity of the sound a lot faster compared to the sound traveling through air.

References

1.) http://www. physicsclassroom. com/class/sound/u11l2c. cfm 2.) http://www. transtutors. com/physics-homework-help/sound/velocity-of-sound. aspx 3.) Young, H., Freedman, R. (2004). University Physics with Modern Physics. California: McGraw-Hill.