Velocity of sound

Definitions

Wave Speed: In the case of a wave, the speed is the distance traveled by a given point on the wave in a given interval of time.

Frequency: Frequency of a wave refers to the number of cycles per unit time and it is represented in the next way.

$$f = \frac{1}{T}.$$

Wavelength: Is the distance over which the wave's shape repeats. The wavelength λ of a sinusoidal waveform traveling at constant speed v is given by

$$\lambda = \frac{v}{f} \,,$$

Resonance: when one object vibrating at the same natural frequency of a second object forces that second object into vibrational motion.

Standing wave: is a wave in a medium in which each point on the axis of the wave has an associated constant amplitude.

Problem

For a better understanding of standing waves we will analyze resonance, length and speed of sound in air. To achieve this we will calculate the velocity of sound with several tuning fork resounding in test tubes with water.

Materials

- 512 Hz tuning fork
- 320 Hz tuning fork

- 220 Hz tuning fork
- Test tube
- Water
- Meter

Method

For the experiment we will use three tuning forks of three different frequency, one of 512 Hz, other of 320 Hz and 220 Hz. With each tuning fork we will fill up a test tube with water and see at what length of water the tuning fork resounds better. With the Length and the frequency recollected we will use the formula for the velocity of a wave that as we mentioned before is

$$\lambda = \frac{v}{f}\ , \qquad \lambda \cdot f = V$$

the wave length of the wave will be calculated by replacing elements of the next formula:

$$L = \frac{\lambda}{4} \qquad \lambda = 4L \cdot f$$

After calculating the speed of sound of each frequency we will compare them with the speed of sound already establish and see the difference and discuss the reasons for it.

Data

Frequency of 512 Hz

For this frequency the test tube resounded better when the water length was .165 m. For instance

$$\lambda \cdot f = V \qquad \lambda = 4L \cdot f \qquad V = 4(.165) \cdot 512\frac{m}{s}$$

$$V = 337.92\frac{m}{s}$$

Frequency of 320 Hz

For this frequency the test tube resounded better when the water length was .250 m. For instance

$$V = 4(.250) \cdot 320\frac{m}{s}$$

$$V = 320\frac{m}{s}$$

Frequency of 220 Hz

For this frequency the test tube resounded better when the water length was .380 m For instance

$$V = 4(.380) \cdot 220\frac{m}{s}$$

$$V = 334\frac{m}{s}$$

Frequency Hz	Speed m/s
512 Hz	337 m/s
320 Hz	320 m/s
220 Hz	334 m/s

With the table above we can see the different velocities of each frequency, the three frequencies have similar values and all of them are near to the establish value of the speed of sound, which is 340.29 m/s. But why the speed calculated is not the same as the stables value?

Discussion of error

According to out calculation the speed of sound varies from 320 m/s to 337 m/s and the establish value is 340.29 m/s this difference comes from the uncertainties of the materials such as the tuning forks that are old and used which affects the accuracy of the frequency. Another factor is the environment and the temperature, the speed of sounds depends on the temperature as well and the speed establish is with a temperature of 22° celsius, which probably was not the temperature of the room in which we did the experiment.

Conclusion

In conclusion the speed of sound differs with the temperature and the frequency of the wavelength, we prove this in our experiment but all the values did not have a big difference. All of the speeds were near of 340 m/s, which is the establish value