Speed of Sound-Resonance Tube

Purpose:

A traveling wave is characterized by a speed (v), a frequency (f), and a wavelength (λ). The relationship between these three quantities is given by v= (f)λ. When two wave of the same speed and frequency travel in opposite directions in some region of space, they can produce standing waves. When standing waves are produced in a tube, the amplitude of vibration becomes very large, and the system is said to be in resonance.

Materials:

 1. Resonance tubes

 2. Tuning Forks

 3. Rubber Hammer

 4. Thermometer

Your Mission!

1. Describe the theory of standing waves in sound.

2. Describe resonance of sound.

3. What are tuning forks?

4. How to calculate wave speed, wavelength, frequency, and harmonic in a close-end system.

5. Complete this experimental procedure.

 a. Measure the room temperature in the air and record it in Data Table 1.

b. Insert the smaller tube into the larger tube and all the way down so that the open end is about 5 cm from the closed end.

c. One partner should hold a tuning fork just outside the tube while the fork is struck repeatedly with the rubber hammer. It is important to keep the fork vibrating continuously with a large amplitude. With the tuning fork vibrating, another partner should slowly pull the out the smaller tube while listening for a resonance. The sound should become very loud when a resonance is reached. Attempt to measure the position of each resonance to the nearest millimeter. Insert the tube and pull it out several time to produce three trials for the measured position of the first resonance. Record the values of the three trial in Data Table 2. Record the frequency of the tuning fork in Data Table 2.

d. Repeat the procedure to locate as many other resonances as possible. Depending on the frequency of the tuning fork used, either three or four resonances should be attainable. Record in Data Table 2 the location and number of resonances that are attainable.

e. Repeat d with a second tuning fork of a different frequency. Record your data in Data Table 3.

f. Calculate the accepted value of the speed of sound from the measured room temperature. Record in Data Table 2.

g. Calculate the wavelengths that are appropriate. If four resonances were found, then all three values of λ can be determined.

h. Calculate the mean and standard error for the number of independent wavelengths measured for each tuning fork.

i. From the values of λ and the and the known values of the tuning fork frequencies, calculate the experimental value of v, the speed of sound.

j. Calculate the percentage of error in the experimental values of v compared to the accepted value of the speed of sound in Data Table 1.

k. Repeat this process in two different locations with marked differences in temperature. Record in Data Tables and calculation tables b and c.

Data Table 1

|  |
| --- |
| Room Temperature = ®C |
| Accepted Speed of Sound= m/s |

Data Table 2

|  |
| --- |
| Tuning Fork Frequency |
| Trial | L₁ (m) | L₂ (m) | L₃(m) | L₄(m) |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |

Calculations Table

|  |  |  |  |
| --- | --- | --- | --- |
| $$L\_{1}= m$$ | $$L\_{2}= m$$ | $$L\_{3}= m$$ | $$L\_{4}= m$$ |
| $$λ\_{1}=2\left(L\_{2}-L\_{1}\right)= m$$ | $$λ\_{2}=\left(L\_{3}-L\_{1}\right)= m$$ | $$λ\_{3}=^{2}/\_{3}\left(L\_{4}-L\_{1}\right)= m$$ |
| λ= m | $$v=fλ$$ | % error=  |

Data Table 3

|  |
| --- |
| Tuning Fork Frequency |
| Trial | L₁ (m) | L₂ (m) | L₃(m) | L₄(m) |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |

Data Table 1b

|  |
| --- |
| Room Temperature = ®C |
| Accepted Speed of Sound= m/s |

Data Table 2b

|  |
| --- |
| Tuning Fork Frequency |
| Trial | L₁ (m) | L₂ (m) | L₃(m) | L₄(m) |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |

Calculations Table 1b

|  |  |  |  |
| --- | --- | --- | --- |
| $$L\_{1}= m$$ | $$L\_{2}= m$$ | $$L\_{3}= m$$ | $$L\_{4}= m$$ |
| $$λ\_{1}=2\left(L\_{2}-L\_{1}\right)= m$$ | $$λ\_{2}=\left(L\_{3}-L\_{1}\right)= m$$ | $$λ\_{3}=^{2}/\_{3}\left(L\_{4}-L\_{1}\right)= m$$ |
| λ= m | $$v=fλ$$ | % error=  |

Data Table 3b

|  |
| --- |
| Tuning Fork Frequency |
| Trial | L₁ (m) | L₂ (m) | L₃(m) | L₄(m) |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |

Data Table 1c

|  |
| --- |
| Room Temperature = ®C |
| Accepted Speed of Sound= m/s |

Data Table 2c

|  |
| --- |
| Tuning Fork Frequency |
| Trial | L₁ (m) | L₂ (m) | L₃(m) | L₄(m) |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |

Calculations Table 1c

|  |  |  |  |
| --- | --- | --- | --- |
| $$L\_{1}= m$$ | $$L\_{2}= m$$ | $$L\_{3}= m$$ | $$L\_{4}= m$$ |
| $$λ\_{1}=2\left(L\_{2}-L\_{1}\right)= m$$ | $$λ\_{2}=\left(L\_{3}-L\_{1}\right)= m$$ | $$λ\_{3}=^{2}/\_{3}\left(L\_{4}-L\_{1}\right)= m$$ |
| λ= m | $$v=fλ$$ | % error=  |

Data Table 3c

|  |
| --- |
| Tuning Fork Frequency |
| Trial | L₁ (m) | L₂ (m) | L₃(m) | L₄(m) |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |

6. Inform the class about your experiment, variables, observations, analysis, and conclusion.

7. Demonstrate how the resonance works with the tube.