**Birzeit University**

**Physics department**

**Physics 211**

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**Experiment number: (7)**

**Experiment name: sound waves**

**Date: /2012**

**Instructor: Dr. Wael .Q**

**Main result:**

**Vs (average)= 339.854 ± 0.44 (m/s)**

**e1 (L1) =0.012 ± 0.007**

**e2 (L2)= 0.011 ±0.010**

**Abstract:**

**This experiment aims at the generation of sound waves and measuring their speeds by creating longitudinal waves in an open tube containing air ,by adjusting the level of water in the tube the speed of the wave and the correction of the end of tube can be calculated which was done and the results were:**

**Vs (average)= 339.854 ± 0.44 (m/s)**

**e1 (L1) =0.012 ± 0.007**

**e2 (L2)= 0.011 ±0.010**

**Theory:**

**For a tube closed at one end , the condition for resonance formation is resulting from the formation of a node at the end closed end and the antinode at the open end . this leads to the following conditions for the first and the second resonances as shown schematically in figure 1:**

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**In which water will be the closed end that we manipulate to study the change of length which would lead to the speed of the sound wave .**

**L1+ e =λ/4**

**L2+ e = 3λ/4**

**Where e is called the end correction (the antinode occurs outside the tube ) . by subtracting the two equations from one another one gets :**

**L2-L1 = λ/2**

**Which using λ ƒ= vs where ƒ is the frequency and Vs is the speed of the sound in air , gives for Vs**

**Vs= 2 ƒ(L2-L1)**

**Experimental :**

**Procedure:**

**Using the apparatus which includes a tube filled with water and a signal generator and an air horn**

1. **Adjust the frequency of the signal generator .**
2. **By pulling the tube down or up adjust the height of the water column so you can hear the high voice of the horn (resonance)**
3. **Record that to be you first height L1**
4. **Adjust the height lowering the tube downwards to get your second height which is supposed to be 3 times that of the first one .**
5. **Repeat step 1 to five for 7 frequencies from 350 Hz to 700 Hz and record your data .**

**Your frequency should be taken from the timer not from the signal generator .**

**Data :**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| frequency (Hz) | 356 | 402 | 444 | 501 | 549 | 600 | 652 | 701 |
| 1/f (s) | 0.002808989 | 0.002487562 | 0.002252252 | 0.001996008 | 0.001821494 | 0.001666667 | 0.001533742 | 0.001426534 |
| L1 (cm) | 23 | 20 | 18 | 16 | 14.5 | 13 | 12 | 11 |
| L2 (cm) | 70 | 61.5 | 55 | 50 | 45.5 | 41 | 37 | 35 |

**Data analysis :**

**For L1 vs 1/f :**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| L1 (m) | 0.23 | 0.2 | 0.18 | 0.16 | 0.145 | 0.13 | 0.12 | 0.11 |
| 1/f (s) | 0.002808989 | 0.002487562 | 0.002252252 | 0.001996008 | 0.001821494 | 0.001666667 | 0.001533742 | 0.001426534 |

**L1+ e =λ/4 – L1 = Vs /4f – e**

**The slope = Vs/4= 85.817 ±3.32 (m/s)**

**Vs= 343.268 ±3.32 (m/s)**

**e1 =Y intercept =0.0122 ± 0.0068 (m)**

**For L2 vs 1/f :**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| L2 (m) | 0.7 | 0.615 | 0.55 | 0.5 | 0.455 | 0.41 | 0.37 | 0.35 |
| 1/f (s) | 0.002808989 | 0.002487562 | 0.002252252 | 0.001996008 | 0.001821494 | 0.001666667 | 0.001533742 | 0.001426534 |

**Slope = 252.33 ± 4.76 ( m/s)**

**e2 = Y intercept =0.0107 ±0.0098**

**L2+ e =3λ/4 ----------------L2 = 3Vs /4f – e**

**Slope = 3Vs /4**

 **Vs = 336.44 ± 4.76 (m/s)**

**Vs (average)= 339.854 ± 4.04 (m/s)**

**Results and conclusion :**

**Vs (average)= 339.854 ± 0.44 (m/s)**

**e1 (L1) =0.012 ± 0.007**

**e2 (L2)= 0.011 ±0.010**

**Theoretical value of the speed of sound at sea level = 340.29 m / s \*\***

**Experimental =339.854**

**Percentage error = [abs (theoretical value – experimental value)/theoretical value]\*100%**

**= [(340.29-339.854)/340.29]\*100%**

**=0.13%**

**Discussion of results:**

**The results obtained were lower than that of the theoretical because the theoretical was calculated at the sea level and a temp of 25 c but according to NASA researchers the altitude increase affects the speed of sound lowering it as the altitude increases(\*\*\*) also as the temperature decrease the speed of sound is lowered\* the experiment we conducted took place at 850 m higher than sea level (\*\*\*\*) and at 15 c temperature .**

**Sources of error:**

**While the height of the water column was taken resonacase was heard over a range of 0.1m but we took just one of the numbers in that range so the precise number isn’t exactly put .**

**Conclusion:**

**The speed of sound at the physics lab at Birzeit university at 15 c and a height of 850 m was Vs = 339.854 ± 0.44 (m/s)**

**References:**

\*www.nasa.gov

\*\*Google calculator

\*\*\*http://www.grc.nasa.gov/WWW/k-12/Missions/Jim/Project1ans.htm

\*\*\*\*http://birzeit.edu/about\_bzu/p/2481.