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**Birzeit University**

physics 211

**Experiment No.5**

**The Helical Spring**

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**-Abstract:**

\* The aim of the experiment:

To find the speed of the sound waves in air.

\* Tools :

Resonance tube, signal generator, oscilloscope, microphone, and an amplifier.

**- Theory :**

For a tube closed at one end, the condition for resonance is resulting from the formation of a node at the closed end and an antinode at the open end , we know that :

L1 + e = ……..eq(1)

L2 + e = ……..eq(2)

Where e is called the end correction, by the subtracting eq(2) – eq(1) (L2-L1) +(e-e) =

L2-L1 =

But we know that the vs = λf , where f is the frequency and vs is speed of sound in air ,then:

= L2-L1

→ vs = 2f(L2-L1)

- **Procedure :**

1- the signal generator is connected to one microphone to produce the audio signal , and the other tools are connected.

2- resonance will occur when the height of the air column is an integer multiple of a quarter wave length on the first order and three quarters of a wave length on the second order, these lengths are recorded against frequency.

**-Data:**

|  |  |  |  |
| --- | --- | --- | --- |
| L2(cm) | L1(cm) | 1/f(T in sec) | Frequency(Hz) |
| 72 | 24 | 2.86×10 -3 | 350 |
| 62 | 19 | 2.50×10 -3 | 400 |
| 63 | 25 | 2.22×10 -3 | 450 |
| 51 | 16 | 2.00×10 -3 | 500 |
| 45 | 14 | 1.81×10 -3 | 550 |
| 42 | 13 | 1.67×10 -3 | 600 |
| 38 | 12 | 1.54×10 -3 | 650 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 338 | 348 | 341 | 350 | 342 | 344 | 336 | vs(m/s) |

vs (average) = (343 ± 5) m/s

from the graph (L2-L1) vs. 1/f:

Slope = 189 m/s

Intercept = -0.035 m = e= 0.035

The speed of sound = slope ×2 = 170 ×2 = 378 m/s

L1 vs. 1/f

From the graph L1 vs. 1/f :

Slope = 94 m/s = vs

Intercept = -0.02036= e = 0.02 m

L2 vs. 1/f

From the graph L2 vs. 1/f :

Slope = 260 m/s = vs

Intercept = 0.00937 m = e

vc.avg. = (244± 80) m/s

eavg. = (0.02 ± 0.01) m

**-Calculations:**

vs = 2f(L2-L1)

vs = 2 ×350×(72-24) = 336 m/s

vs = 2×400×(62-19) = 344 m/s

vs = 2×450×(63-25) = 342 m/s ………etc.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0.01 | 0.015 | 0.015 | 0.015 | -0.06 | 0.025 | 0 | e(m) |

e (average) = (3 ± 1) ×10 -3 m.

to find e from :

L1 + e = , but λ= vs/f

Then:

e =

e =

e =

e = ……etc.

**-Result and Conclusion :**

vs (average) = (343 ± 5) m/s

vs (from the graphs) = (344±80) m/s

e (average) = (3 ± 1) ×10 -3 m.

e(from the graphs) = (0.02±0.01)m

The value of the speed of the sound wave is acceptable because the 2∆r ≤ d ,then 2(5) ≤ (348-338) , 10 =10 .

The value of the end correction(e) is acceptable because the 2∆r ≤ d ,then 2(1) ≤ (4-2) , 2=2 .

We have systematic errors in the experiment , when we take the value of frequency it not exact , and random error when we measure L1,L2 .

\*From the graphs:

The value of the sound wave is acceptable because the 2∆r ≤ d, then 2(80)≤ (424-264) , 160 = 160 .

The value of the end correction(e) is acceptable because the 2∆r ≤ d, then 2(0.01) ≤ (0.03-0.01), 0.02 = 0.02 .

The value of the end correction (e) in experimental is near to the value of theoretical , also the speed of sound wave .