Sound, and Magnetism.

(Internship, Final Report, Ammar Ahmed Khan)

Objectives

In this project, we will,

1. Try to measure the speed of sound using the resonance method.

2.Try to measure the hearing loss of a test subject.

3. Try to find ways of quantifying loudness.

4. See how magnitude of emf induced varies with speed of magnet, and try to find a value of g.

5.Try to understand resonance in an L-Shaped tube.

Measuring speed of sound.

Aim:

In this experiment, our main aim is to calculate the speed of sound in air. we will try to se resonance, in an air column, to try and find out the speed of sound.

Method:

We will generate white noise. White noise contains all frequencies, and of the same intensity, this is very advantageous to us. The sound is generated using a speaker, and the signal is received using a microphone. The length of the column chosen was 1.25m. The signal, after passing through the column is input to the computer, and analyzed in Labview. We use spectral measurements to obtain a frequency against amplitude distribution. From this distribution we calculate the resonant frequency of the column. We then use the formula:

$$f = (n \times v) \div (2 \times L) \tag{1}$$

This allows us to calculate the speed at various modes of oscillation, a table from an experiment is shown below:

For clearer results: To make the graphs clearer, we canceled out the effects due to background noise. This was done in Matlab, by subtracting matrices, and then plotting the new matrix, in which effects due to background noise was canceled. Also to get even clearer results, a plot was made in which both background and non-resonating white noise were canceled out, this was also done in matlab, and it helped to clarify results even more.

Sample graphs are shown below:

Mode of Oscillation, (n)	Resonant Frequency (Hz)	Speed of Sound (m/s) V=2nf/L L= length of column=1.25m
9	1180	327.8
10	1324	331
11	1450	329.5
12	1592	331.7
13	1724	331.5

Figure 1: Table of results.

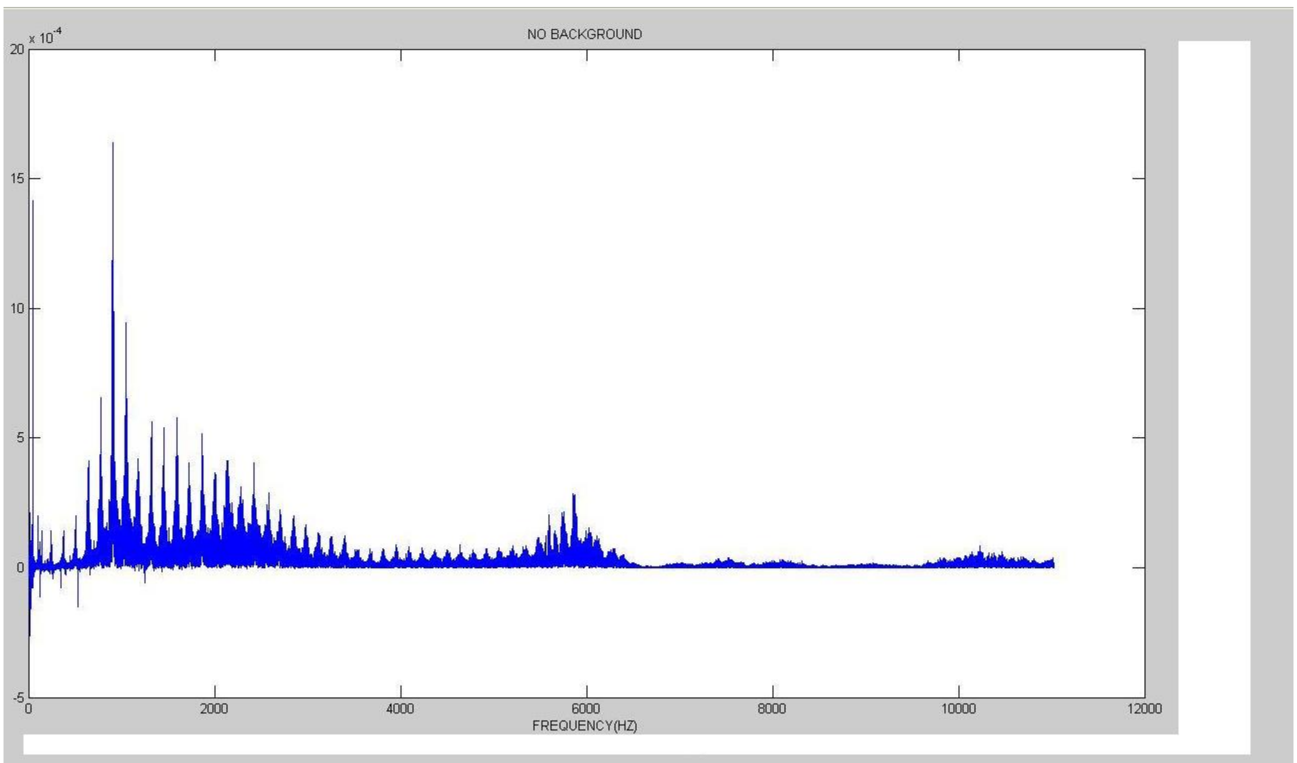

Figure 2: With only background noise removed.

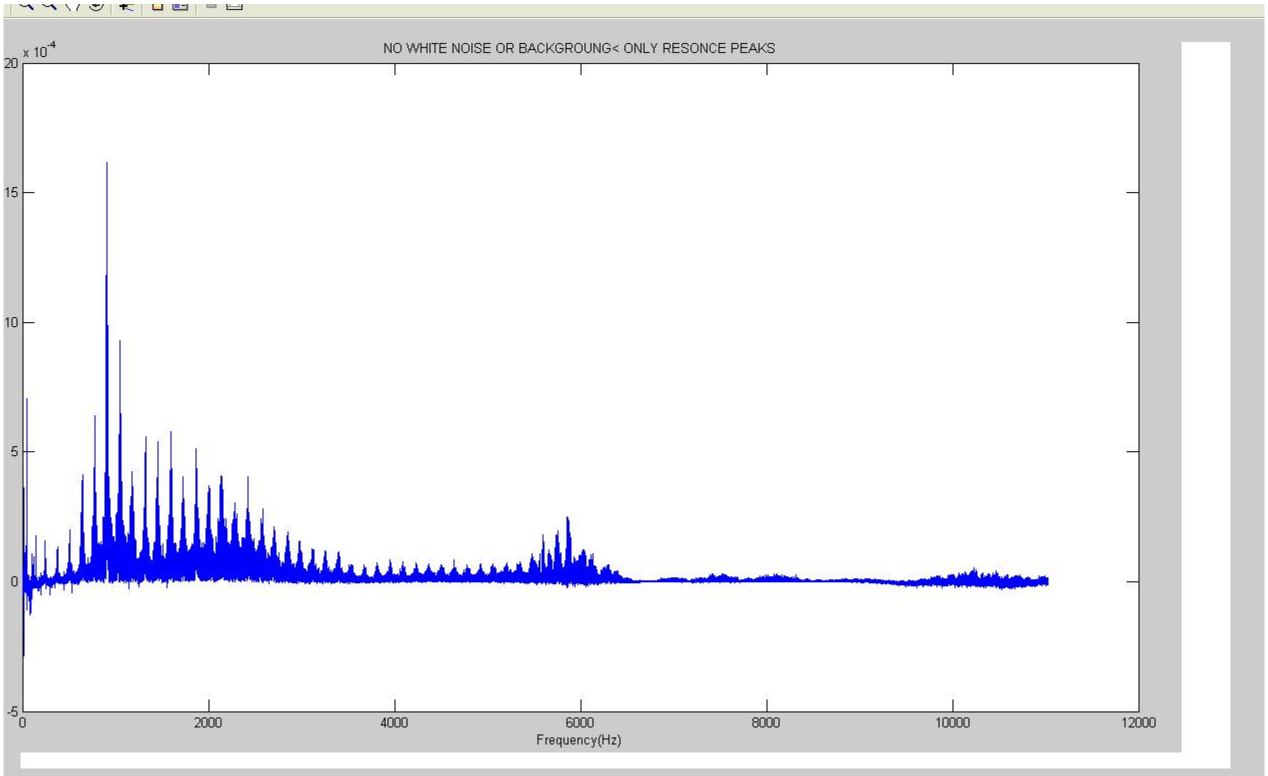

Figure 3: with background noise removed, and white noise also, only resonance peaks left.

Measuring Hearing Loss:

The main idea of this experiment is to see whether we can measure hearing loss, for an individual without proper audiometry equipment.

To achieve this, we must first decide on a reference frequency, which is given a level of 0 decibel, all other frequencies are analyzed in reference to this frequency.

In our case, we used 4000 Hz as a reference.

In this experiment, we use a signal generator to produce sine waves. These sine waves are heard as sound using a microphone. At each frequency, the amplitude is varied, it is decreased up until the listener can no longer detect the presence of the sound. Then using a multimeter, the voltage of the signal is measured and then compared to that of the 4000 hz signal, a formula is used to convert he difference into decibels. This is done by comparing the voltage level at 4000hz, to that at which no more sound can be heard at the sample frequency, we use this to find the number of dB at that sound level.The formula is:

$$Db = 20 \times \log(v2/vref) \tag{2}$$

The procedure is repeated at different frequencies, and a table is made, to calculate the hearing loss, we find the average of the decibel measures , and that is taken to be a rough estimate of the hearing loss of that listener.

To decrease the sound level to undetectable levels, we use resistors, as b default the strength of the signal is too much for it not to be heard. The results can be ploted, for convenient results

The results of a particular experiment are given below:

Reference 4000 Hz	Decibel: 0	Voltage :.04
100	35.9	.19
500	33.56	.16
1000	27	.11
1500	21.9	.09
2000	13.9	.025
2500	11.4	.022
3000	8.79	.042
3500	7	.032
4500	-2	.011
5000	-7.3	.006
6000	9	.04
7000	10.1	.045
8000	-4.8	.008
9000	-7.3	.006
10000	-8.9	.005
11000	-10.9	.004
12000	-6.02	.007
13000	9.11	.04
14000	32.6	.6
15000	26.6	.3
16000	31.0	.3
0	0	0

L-tube experiment.

In the L-tube experiment, we try to observe how sound wave resonance takes place in a bent tube. Now, the resonance of sound wave in straight columns, with both ends closed and one end open are very well understood, and give predictable results. What is interesting is, to try to find similar results, for an L-shape configuration. In this experiment, we will use L-shaped tubes of different lengths, namely: 40-40 cm, 50-50 cm, 50-40 cm.
A signal generator will be connected to a speaker, which will produce the sound. The frequency of the sound will be changed. The data will be fed into the computer using a microphone, and the waveform will be analyzed, frequencies at which large amplitudes are obtained will be identified, and then for each configuration, fundamental, and second harmonic frequencies will be noted down, and then we will try to find a link between the frequencies.
Results, from different lengths are shown below:

Tube	Fundamental frequency	Second resonant frequency	Third resonant frequency
50-50	433	970	1140
50-40	450	1140	1380
40-40	430	1100	1340

Figure 4: d.

Loudness

The main objective of this experiment is to try to calculate loudness, and see how is it related to other parameters such as frequency of the signal and the amplitude. There is no real way to quantify loudness, as it is a perceived phenomenon, and the same sound can have different loudness for different people. What we can do, is to find its relationships to other parameters, and that will be the main goal of this experiment.
To see the relationship between frequency and loudness, we use a signal generator; to listen to the sound played in the headphones. A listener listens, as the frequency is varied. The amplitude is kept constant throughout the whole experiment. The first thing to do is to check the whole frequency spectrum to see where the listener finds the loudest sound, that frequency is noted, and assigned a value of loudness =1. After that, we begin from 100 Hz, and continue on to 20000Hz, the user tells the loudness at each frequency on a scale from 0-1. The results are then plotted, and a very interesting graph forms.
Another very exciting prospect highlighted in this experiment is that listeners will be able to identify particular frequency at which they will hear a particularly loud sound, these will be the fundamental resonant frequency of their ear canal.
A graph obtained from an experiment is shown below:

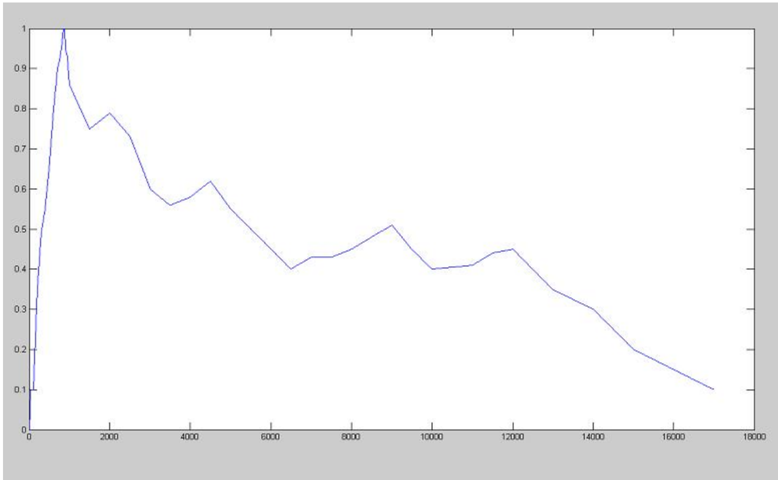

Figure 5: Frequency against Loudness.

Amplitude-Loudness:

In this experiment, we will try and get a relationship between amplitude and loudness. As we all know,

The listener listens through headphones, as a sine wave of a fixed frequency is produced, then, the amplitude is gradually increased, so see what kind of a change is perceived in the loudness. The results we got were an indication of a quadratic relationship. This is further supported by the observation that a 10 times increase in intensity gives rise to a doubling of loudness(1), using this fact, and keeping the quadratic relationship in mind, we come up with the formula:

$$Loudness \backsim (amplitude^2)/5 \tag{3}$$

A plot of this relationship is shown below:

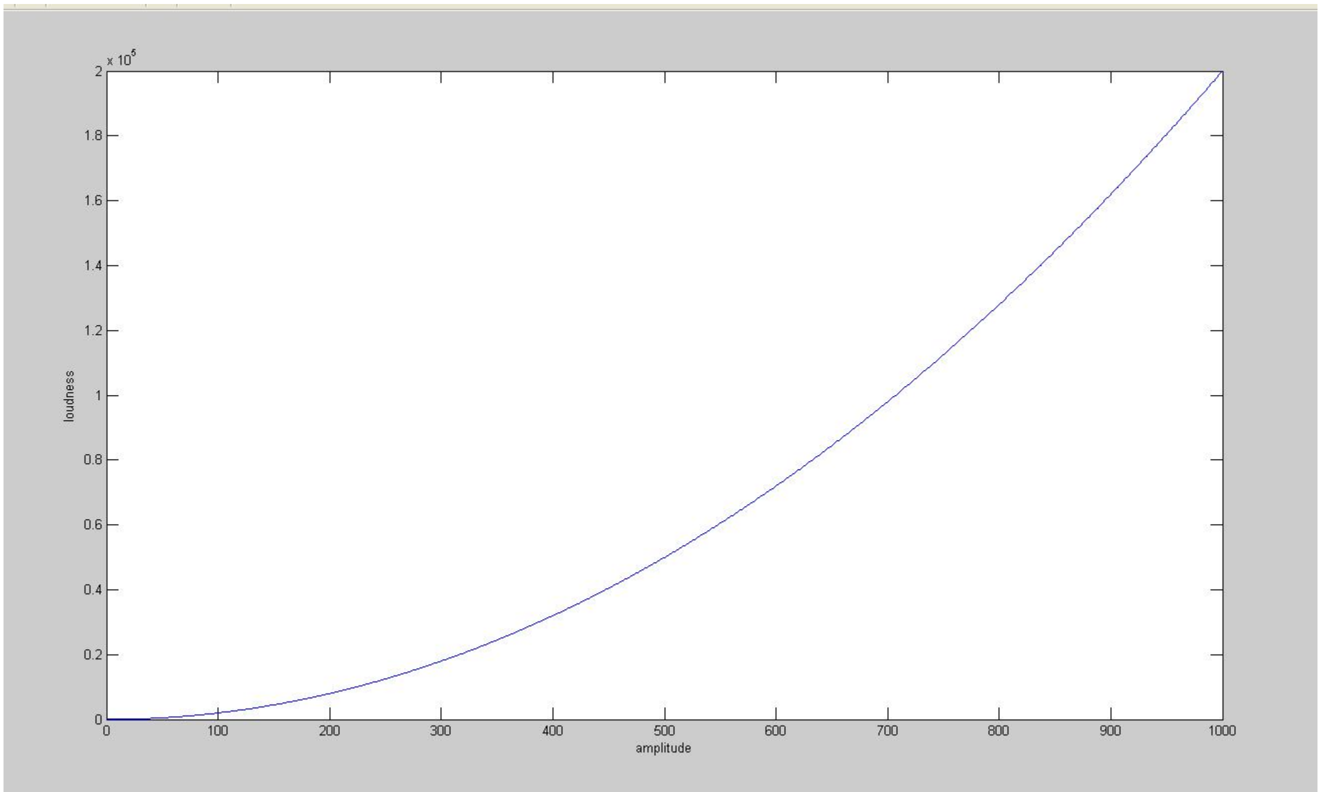

Figure 6: Amplitude against Loudness.

Hence, in this experiment, we see the relation of frequency and amplitude to the perceived loudness by an individual.

Electricity and magnetic

The main aim of this experiment is to calculate induced emf, as a magnet falls through a solenoid.

Also, we will see how the induced EMF is related to the velocity of the magnet, differences in magnitude of the induced EMF and the duration of the pulse are noted.

The Emf induced in seen on the computer screen, using DAQ, in Labview.

To get good results, the experiment is performed by dropping the magnet from rest, from various heights, a typical table of results is shown below:

Height, in cm, above the solenoid	Duration of pulse, seconds(s)	Emf induced, (average) (v) volts
17	.13	.49
50	.09	.72
70 90	.8 .06	.85 1
117	.02	1.2

Figure 7: .

In the actual experiment, two pulses will be seen, one positive, and one negative, it should be noted that the waves seen are not periodic, as they are merely pulses. The average og the magnitudes of both these pulses should also be noted down.

Also, we can calculate the value of G in this experiment, this can be done by analyzing any one reading.

We have to note down the peak to peak times from the graphs I labview, using those times, we use the formula : S=v*t, where S is the length of the solenoid to calculate the average velocity in the solenoid.

After that we use the formulas: V2=2*a*s, where s is the distance from which the magnet was thrown,Plus half the length of the solenoid.

References

[1] http://wiki.answers.com/Q/How _ are loudnessandfrequencyrelated