Date of Lab 4/26 Date of Submission 5/5

Laboratory Report

Title
表題 Resonance of a Pipe and a Tune fork

Homeroom	Section	Name 氏名	
11K	1		Shutomo Iwai

Lab Partners 共同実験者 Lilian | Hanagan

Summary

In this experiment, we observed the phenomenon of resorance that occurs when the frequency of tuning fork and the natural frequency of air column match. I calculated the theoretical wavelength of the sound and the length of the air column when the resonance occurs, and compared those values with my experiment results. As a result, when the frequency of tuning fork and the natural frequency of air column match, the resonance phenomenon occurs and the sound resounds.

・Meet a deadline ・Write logically ・Write clearly ・Write with your own words
・締切り守って ・論理的に ・わかりやすく ・自分のことばで

Teacher Comments

Good experiments and discussions.

1 Due 提出期限	2 Summary 要旨	3 Intro. 序	4 Method. 方法	5 Results 結果	6 Table/Fig. 表/図	7 Discussion 考察	8 Clearness わかりやすさ	9 General 全般
+				+	+	+ + +	+	+ + + +

* Write your report in Japanese or in English * Use this form as a cover sheet.
* Submit your reports by the seventh day after your lab.

Introduction

Objectives

Observe the resonance phenomenon that occurs when the frequency of tuning fork and the natural frequency of air column match.

Calculate the wavelength of the sound from the length of the air column when resonance occurs.

Theory

① **Resonance**

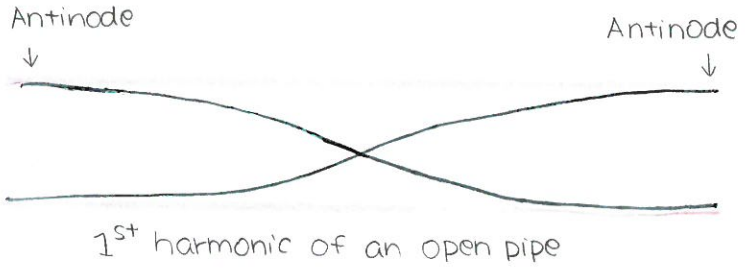
Resonance is a phenomenon in which a vibrating system or external force drives another system to oscillate with greater amplitude at specific frequencies. In this experiment, the resonance phenomenon occurs when the frequency of tuning fork and the natural frequency of air column match, the sound will become bigger when it occurs.

② **Air column**

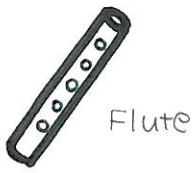
Air column is a pipe with air oscillating in it. The phenomenon of resonance will occur when its natural frequency and the frequency of tuning fork match.

③ **Open pipe**

Open pipe is a tube that both ends are uncovered or open. Both ends of an open pipe must be antinodes.



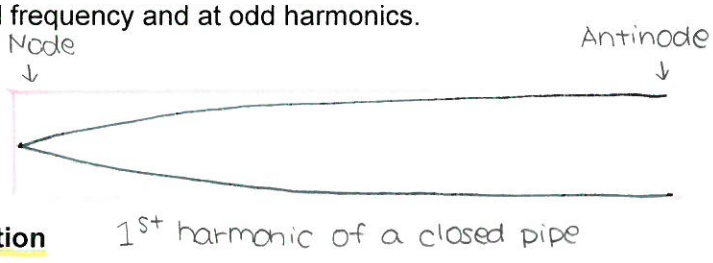
Example :



Flute

④ **Closed Pipe**

Closed pipe is a tube with one open end and one closed end. Closed end of a closed pipe must be node, open end of a closed pipe must be antinode. Closed pipe will produce resonant standing waves at a fundamental frequency and at odd harmonics.



Example :

Mike bottle

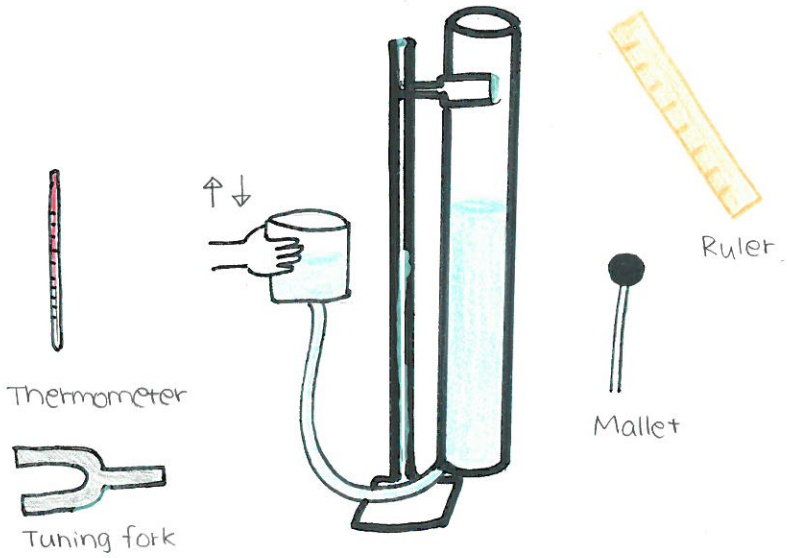
⑤ **End correction**

End correction is a short distance applied or added to the actual length of a resonance pipe, in order to calculate the precise resonance frequency of the pipe.

Experimental

Apparatus

- Air/water column with rubber tube and a cup
- Tune forks
- Mallet
- Thermometer



Methods

① Measuring the temperature of the air column and use the formula below to calculate the speed of sound.

Speed of sound: $V = 331.5 + 0.6t =$ m/s

② Use the speed of sound and the frequency of 8 tuning fork to calculate the theoretical wavelength and the length of air column in resonance.

Wavelength: $\lambda_{theo} = V/f$

Length of air column in resonance: $A_{theo} = \lambda_{theo}/4$ (First harmonic)

$B_{theo} = 3\lambda_{theo}/4$ (Second harmonic)

③ Move the surface level of water to the area of A_{theo} and B_{theo}, and find the experimental A_{exp} and B_{exp} by the resonance between the tuning fork and the air column.

④ Use the value of A_{exp} and B_{exp} to calculate the experimental wavelength, frequency, and the location of antinode at the open end.

Wavelength: $\lambda_{exp} = 2(B_{exp} - A_{exp})$

Frequency: $f_{exp} = V/\lambda_{exp}$

Location of antinode: $\Delta A = A_{theo} - A_{exp}$

$\Delta B = B_{theo} - B_{exp}$

⑤ Calculate the length of air column in resonance of third harmonic.

Length of air column in resonance: $C_{theo} = B_{exp} + \lambda_{exp}/2$ (Third harmonic)

Results

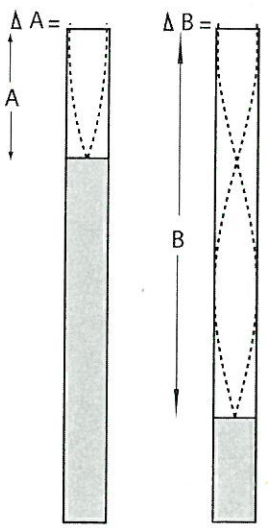
Temperature of the air column: t = 24℃

Speed of sound: $V = 331.5 + 0.6t$

$= 331.5 + 0.6 \times 24$

$= 345.9$ m/s

Tune Fork		Theoretical (theo)			Experimental (exp)						
	Frequency f (Hz)	λ_{theo} (cm)	A_{theo} (cm)	B_{theo} (cm)	A_{exp} (cm)	B_{exp} (cm)	C_{theo} / C_{exp} (cm)	λ_{exp} (cm)	f_{exp} (Hz)	ΔA (cm)	ΔB (cm)
C Do	512	67.6	16.9	50.7	16.6	50	84.5 / 83.5	66.8	518	0.3	0.7
B Ti	480	72.1	18.0	54.1	18.2	53.5	90.2/88.3	70.6	490	-0.2	0.6
A La	426.7	81.1	20.3	60.8	20.5	60	101 / 98.8	79	438	-0.2	0.8
G Sol	384	90.1	22.5	67.6	21.5	67	113 / 114	91	380	1.0	0.6
F Fa	341.3	101.3	25.3	75.8	24.5	75.3	126/128	102	339	0.8	0.5
E Mi	320	108.1	27.0	81.0	26		135 /			1.0	
D Re	288	120	30.0	90.0	28.7		150/			1.3	
C Do	256	135	33.8	101	32.5		169/			1.3	



Discussion

From the table of experiment results, we can know that the experimental values are very close to the theoretical values, this means that the resonance phenomenon occurred when the frequency of tuning fork and the natural frequency of air column match. We did this experiment carefully and we got a very good data. But there are still some differences between the experimental values and the theoretical. The reason of that may be misreading the scale and mishearing the resonance in the air column. I will become more careful in the next experiment for better results.

Also, we can know that the location of antinode is not same with the open end of the pipe from the experiment results. The position of antinode of the standing wave is little out of the open end of air column and it is called end correction.

Conclusions

When the frequency of tuning fork and the natural frequency of air column match, the resonance phenomenon occurs and the sound resounds.

The position of antinode of the standing wave is little out of the open end of air column. (End correction)

By using the wavelength of each tuning fork we can calculate the length of air column in resonance.

Opinions

This experiment is simple and easy to understand. It also deepens my understanding of the resonance. When I know that the reason of sometimes even the frequency of the earthquake was small, the building was destroyed is resonance, I was surprised. I think the resonance is one of the important phenomenon among our daily life and it was a good experiment.

References

Takahiro Asai and Kana Fukuchi's reports

https://www.physicsforums.com/threads/end-correction.75691/

http://www.physicsclassroom.com/class/sound/Lesson-5/Resonance

https://www.google.co.jp/search?q=air+column+resonance&biw=1536&bih=722&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwjpnouK5tfTAhUIOiYKHQI8ASoQsAQILA#spf=1