Problem № 9
«Bottle tone»

Team «12FM»

Iovets Vladimir

chnmk@mail.ru

The task

Take an empty bottle and blow air across its mouth to produce a sound. Now fill the bottle with some water and study how the sound changes.

Hypothesis

If the audible sound, created on the edge of the obstacle, amplifies by the reflected air flow, the resultant frequency will depend on the air volume in the bottle.

Aim of the study

Study the dependence between the sound frequency and bottle parameters.

Objectives

1. Study the theoretical material on the research topic.
2. Determine the conditions of bottle sound occurring.
3. Define the dependence between the occurred sound frequency and the bottle and external parameters.
4. Make conclusions.

Theory

The sound is the physical phenomenon, which is represented by the spread of elastic waves of mechanical oscillations in solid, liquid or gaseous environment.

Sound frequency is the number of oscillations in the time unit(frequency is measured in hertz). There is dependence between the frequency of sound and the sound tone: the bigger the frequency, the higher the sound is.

It is considered that human can hear sounds with frequency range from 16 up to 20000 Hz

Theory

When you blow into the bottle, part of the air flows into the bottle and another part flows beside.

High pressure occurs in the bottle throat, then air flows divide in two and one of them goes in the bottle throat, then the pressure falls and the flow that goes into the throat resumes. This process is cyclical and creates elastic oscillations of air, which are actually sound.

Division of air flow in the bottle throat.

Experimental part

In our experimental part we used 6 different bottle types:

Glass and plastic bottle (0.5l)

Plastic bottles with different volume (2l and 1l)

Glass bottles with different shape (0.75l)

Under **bottle geometry** we mean its throat shape.

Experiment 1

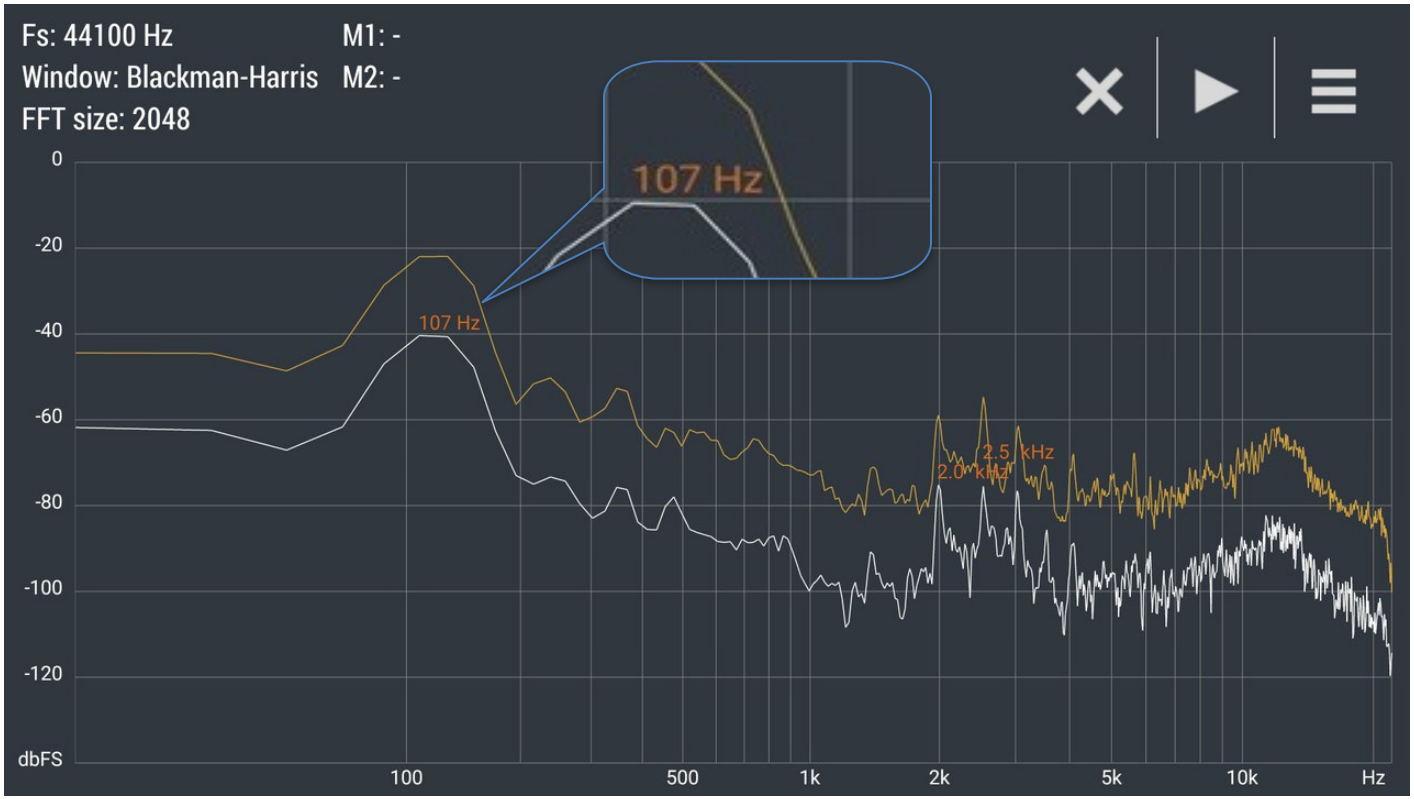
Purpose: to determine the conditions of sound appearance and measure its frequency.

Equipment: plastic bottle (2l) program, Advanced Spectrum Analyzer PRO, even air supply system.

Plastic bottle (2l)

Even air supply system

Experiment 1



Conclusion: to create the bottle sound you should direct the air flow under a small angle to the throat plane. The frequency of such sound is approximately 107Hz.

Experiment 2

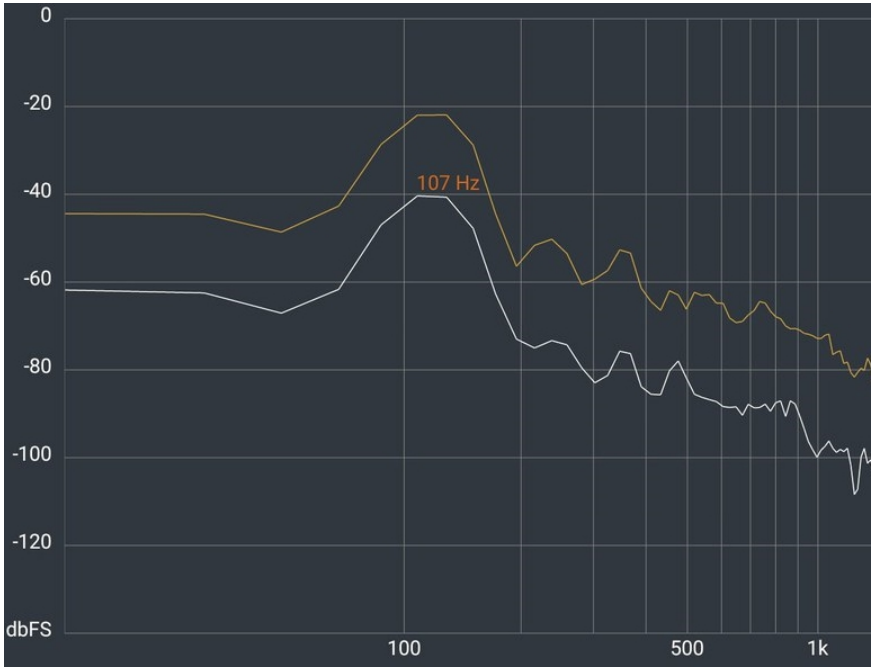
Purpose: to define the dependence between the sound frequency and bottle volume.

Equipment: plastic bottles (2l and 1l), program Advanced Spectrum Analyzer PRO, even air supply system.

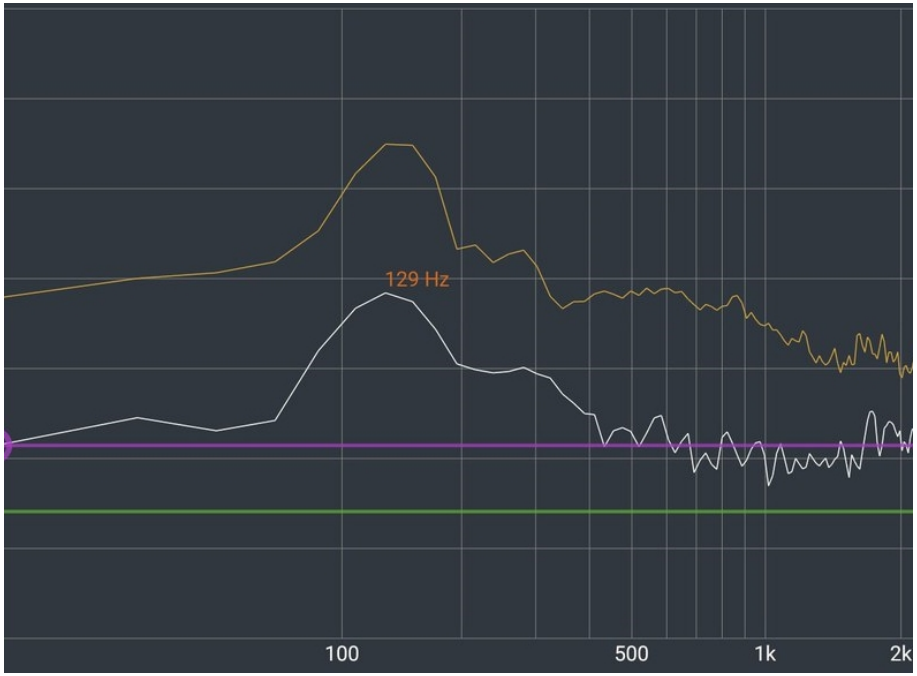
Plastic bottle (2l)

Plastic bottle (1l)

Experiment 2



Plastic bottle (2l)



Plastic bottle (1l)

Conclusion: the less the bottle volume is, the bigger the sound frequency is.

Experiment 3

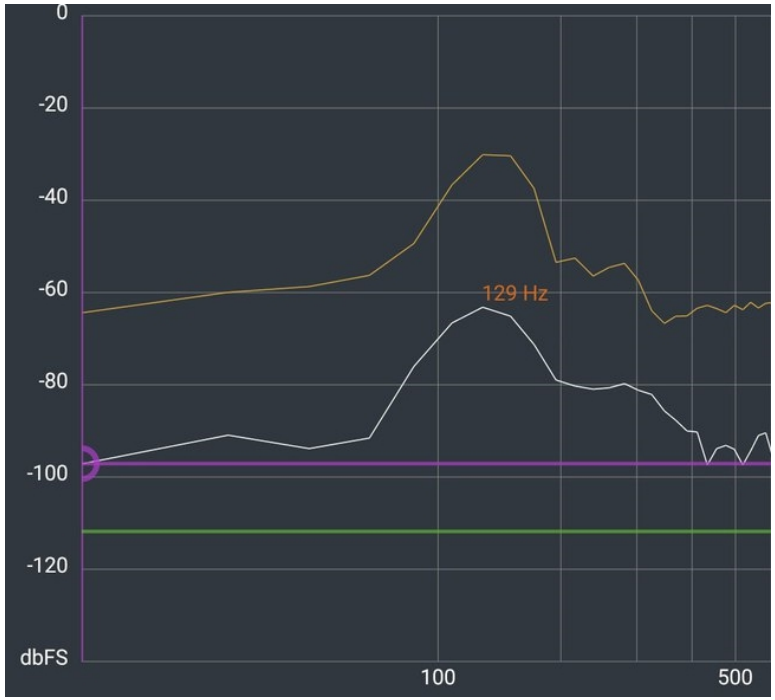
Purpose: to define the dependence between the sound frequency and the bottle material.

Equipment: glass and plastic bottle with a volume of 0.5l, program Advanced Spectrum Analyzer PRO, even air supply system.

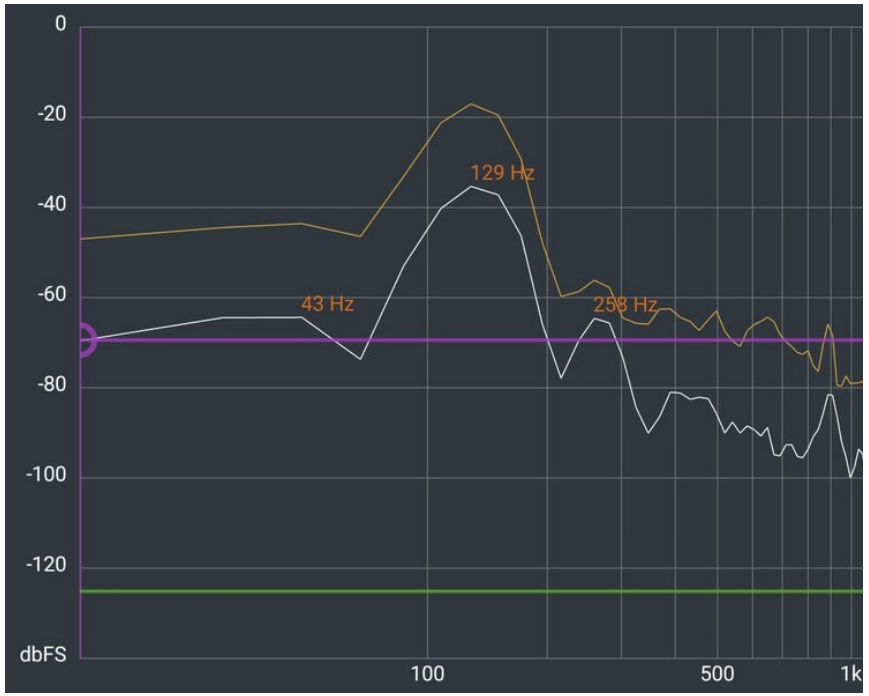
Plastic bottle (0,5l)

Glass bottle (0,5l)

Experiment 3



Plastic bottle (0,5l)



Glass bottle (0,5l)

Conclusion: material that was used to create the bottle does not affect sound frequency.

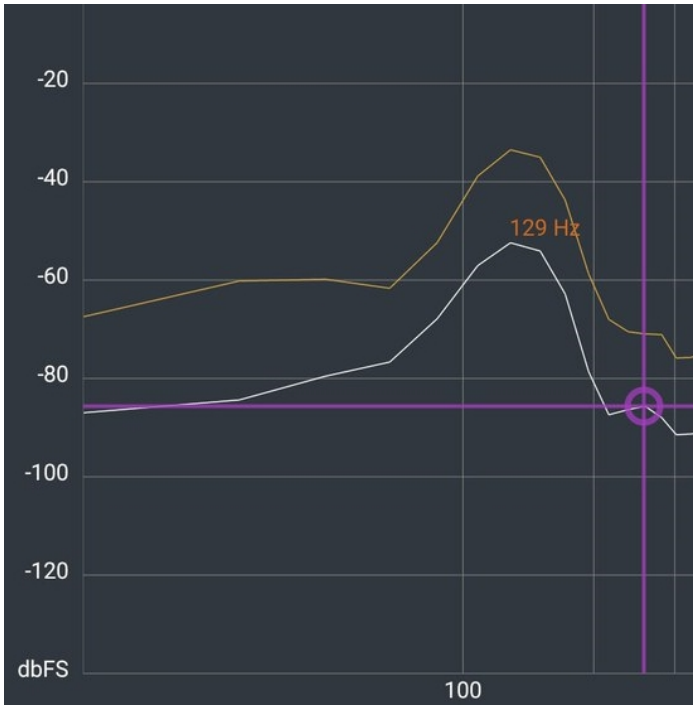
Experiment 4

Purpose: to define the dependence between the sound frequency and the bottle geometry.
Equipment: two glass bottles with the same volume of 0.75l but different shape, program Advanced Spectrum Analyzer PRO, even air supply system.

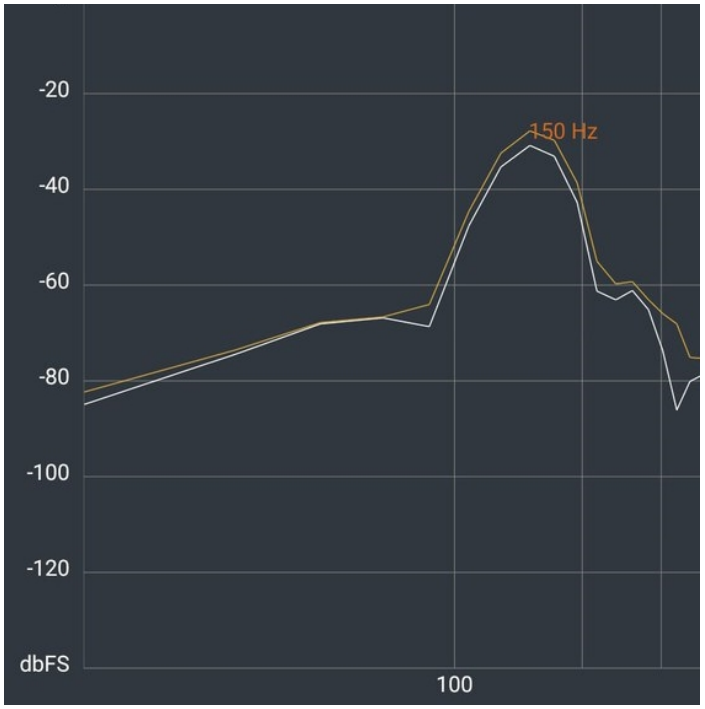
Glass bottle with angles (0,75l)

Glass round bottle (0,75l)

Experiment 4



Glass round bottle (0,75l)



Glass bottle with angles (0,75l)

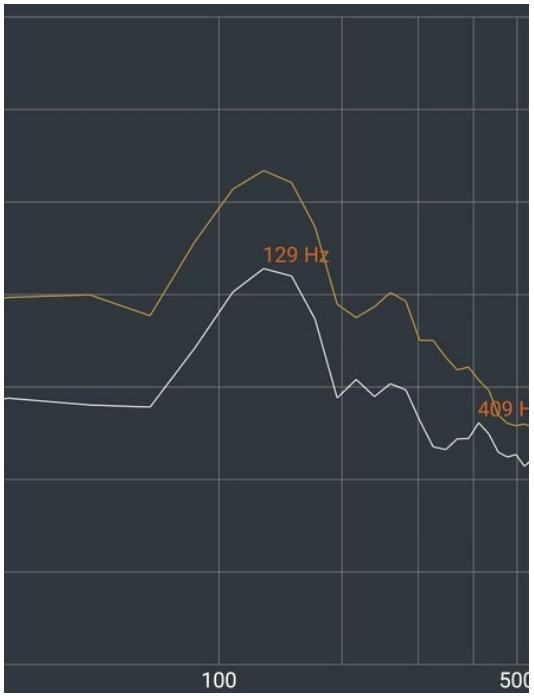
Conclusion: the more rounded the bottle shape is, the less the sound frequency is.

Experiment 5

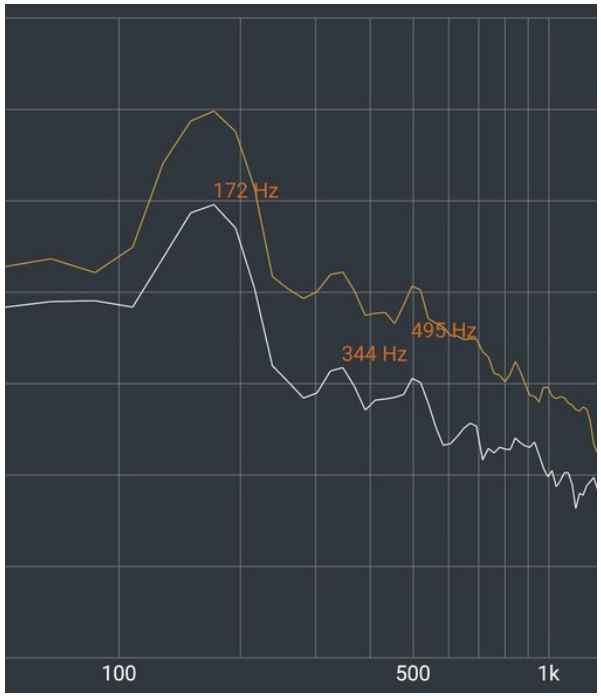
Purpose: to define the dependence between the sound frequency and the volume of air, contained in the bottle.
Equipment: plastic bottle (2l), program Advanced Spectrum Analyzer PRO, even air supply system.

Plastic bottle (2l)

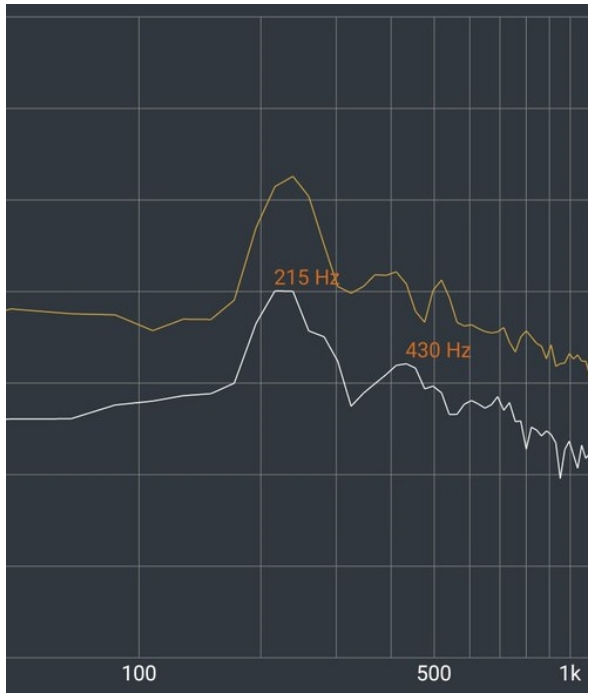
Experiment 5



¼ of volume



½ of volume



¾ of volume

Conclusion: the less air volume is contained in the bottle, the bigger the sound frequency is.

Conclusions:

1. We figured out, what the sound and its frequency are.
2. We conducted experiments, which helped us to figure out what affects sound frequency (bottle volume, shape and content of water in it)
3. The more water is contained in the bottle, the bigger the sound frequency is.
4. The hypothesis was confirmed, the aim of the research and objectives were reached.

References

1. A.V. Peryshkin, E.M. Gutnik «Physics», 9th grade, «Drofa», 2003.
2. A.V. Aganov, R.K. Safiullin, A.I. Skvortsov, D.A. Tayursky "The physics around us. Quality problems in physics ", House of Education, 1998.
   S. A. Chandaeva "Physics and Human", JSC "Aspect Press", 1994
3. http://fizportal.ru/qualitative-56
4. http://fizportal.ru/qualitative-57
5. http://class-fizika.ru/op79-29.html

Problem № 9
«Bottle tone»

Team «12FM»

Iovets Vladimir

chnmk@mail.ru