FONDATION
La main à la pâte
POUR L'ÉDUCATION À LA SCIENCE

Sound Volume
Scientific challenge

Physics / Sound

Middle School / High School

Duration of the challenge	20/30 minutes (or 50 min if the 2 extensions are implemented)
Material	Phone or tablet with Fizziq application
Phenomena or concepts approached	Sound volume. Sound meter. The ear is a fragile organ. Sound is a mechanical vibration of matter.
Glossary	Noise level, decibels sound level meter.

Student Challenge

« How does the sound volume (expressed in dB) vary according to the distance you are from the source (e.g. speaker)?

You and your classmates will have to give a clear account of this, with measures to support it.»

Once the challenge has been launched, you can give the students about ten minutes to explore the application (individually or in groups depending on the number of phones or tablets available) and choose the sensors they feel are relevant to use.

Extensions are proposed to work on sound insulation and/or on the link with high and low sounds.

Possible prerequisites

The duration of this challenge will depend on the students' mastery of the app. If this is the first time they are using it, it would be useful to introduce them to the app and the different possibilities it offers. You will find this information below.

Technical remarks:

- More information on the measuring devices can also be found directly in the application by pressing the "i" icon (top right of the screen) in the Instruments tab.
- As the app continues to be improved, new measuring instruments will be added, and you will find information about these tools in the application directly.

Aids

These aids are intended for teachers or students.
You can consider different ways of using it:

- Read them out to the pupils (possibly rephrasing them).
- Print them, cut them out and distribute them as required (e.g. by group).

Links to some useful sites and instructions

- https://www.fondation-lamap.org/en/fizziq: Here you will find the various teaching documents available in relation to the use of the FizziQ application, including challenges for pupils that you can adapt to suit your objectives and your classes.

- https://en.fizziq.org: You will find protocols there, so you can get inspiration to create your own protocols.

- https://www.youtube.com/channel/UCIEd0gCCnvvN4-oT037YV8A: You will find videos of less than 2 min each allowing a quick introduction to the application.

Below you will find information about the measurements that can be carried out in this challenge with the "microphone" sensor of tablets or telephones. The level of explanation you will find here is more suitable for adults who want to understand how the sensors work. For pupils, the choice may be to let them explore the different tools and measuring devices if you have the time. How quickly they can get to grips with it will depend on how familiar they are with the application (if Fizziq has already been used at another time in class).

Tool: The sound level meter (Microphone-volume meter)

The sound level meter measures the sound volume picked up by the microphone. It is expressed in decibels, or dB.

Remark

The decibel scale is logarithmic: a 40 dB source is 100 times more intense than a 20 dB source, and the most discreet sound a human ear can perceive is zero decibels. An ordinary conversation reaches about 60 dB, the sound of a mixer is often 90 dB, and sounds above 140 dB are painful to the human ear. Continuous exposure to sounds above 90 dB can lead to hearing loss.

Accuracy

The data update frequency is greater than 250 hertz, i.e. 250 measurements per second.
Smartphones have more or less sensitive microphones, and the volume measurement will vary from one to the other.

Triggers (in "tools")

They are used to program the start or end of a recording.
With triggers, you can create a timer that will start and end a measurement, or a sound timer that will start and end the recording if a loud sound is detected.
The possibilities are immense!
There are two triggers, one to start recording and one to stop it. Each trigger can be activated by time or measurement value. Use the pull-down menus to program the triggers and adapt them to the needs of the current experiment.
Caution: The shutter release will start after the REC button is pressed.

Realization of the challenge

Before answering the challenge....

Ask students to find out where the volume sensor is (the microphone) and find a simple way to check that it is in the intended location.
To do this, it is "enough" to measure the ambient sound level (or of a piece of music played by a speaker, for example) by continuously moving a finger on the telephone and when it passes in front of the microphone, check that the recorded sound level becomes very low).
Once they have understood that this sensor is the microphone of their tablet or telephone, you can make them aware of the importance of looking for the position of the microphone before starting any measurement, so as not to distort the results (by putting their hand in front of the microphone for example...).

Points of attention

- It is interesting to ask the students about the choices made and the conclusions to be drawn from these different ways of proceeding.
- Necessity to use a fairly powerful loudspeaker. On can use FizziQ to produce a sound of constant intensity(in the "Tools" of the Fizziq application, you can generate a sound with the synthesizer). Clarify (or make the students aware after a few quick tests) that it is necessary to work with a sound of constant intensity.

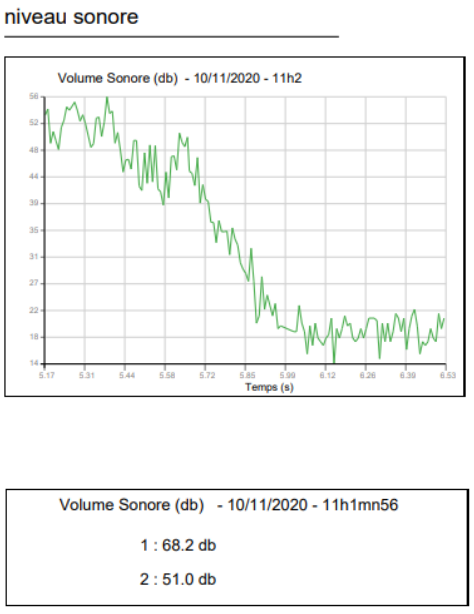
- Avoid working on a speaker that emits music. Possibility of extension with work on frequencies: bass/treble sound and possibility of working with a GBF.
- It is necessary to carry out the tests group by group in a large room or outdoors and avoiding noise disturbance, otherwise the slightest noise would interfere with the measurements (avoid a corridor or medium-sized room to avoid the phenomenon of reverberation, or limit the number of groups carrying out the measurements at the same time).
- Students can have several ways of measuring the variation in loudness as a function of the distance between the source and the receiver: by continuously recording the sound level and moving away (if possible at a constant speed) from the source (then "directly" observing the decrease in sound level on the graph) or by taking sound level measurements at specific distances. This second method is more precise and can be used to create a table and then a graph of the sound level as a function of distance.
- If measurements are made while moving around, care must be taken to ensure that the student moves slowly without touching the microphone and without moving the mobile phone too much. Repeated distance measurements may be preferable, but this can be part of the analysis of the different approaches taken by the pupils.

Use of the sound level meter, advantage :

Very simple to implement and therefore great freedom to carry out the measures. As the measurements are very simple and quick, this allows for numerous back and forth between new hypotheses and testing before establishing out a protocol and a precise report of their observations.
Working on the noise level in relation to the programme with a simple everyday tool. Avoids the need to invest in sound level meters.

Examples of measures

Example of a screen from the Fizziq application



Example of part of the experience booklet obtained

The FizziQ application is very intuitive to use. On the screen above, you can see that you can record the sound level (here by gradually moving away from the source). The student can then, using the slider below the recorded graph, change the observation range by changing the minimum and maximum on

the axes. This makes it possible to keep only the part of the measurements that is of interest for the conclusion.
The pupils can then send their report (the experience book) using the tool of their choice by creating a pdf document.

To remember:

Sound propagates in material media: gases, liquids or solids.
The auditory sensation of sound volume is given by the magnitude "sound volume", measured in decibels (dB) with a sound level meter.
An object that produces sound is called a **sound source**.

The ear is a fragile organ. Above 80dB, the listening time must be limited.
To listen to music safely, I need to
- keep me away from powerful loudspeakers as the sound level decreases with distance ;
- take regular breaks ;
- limit my listening sound level if I use headphones.

Important (on all levels): Precisions of measurements in science:

The result of a measurement is inevitably a little different from the true value because a measurement is never perfect.
It depends not only on the person who took the measurements, but above all on the measuring device itself (you can see this by comparing the measurements taken with different devices).
Repeatedly, the same measurement gives similar but different values. To get closer to the true value, the average value is often calculated.
Link to mathematics: to represent histograms of measurements taken by pupils.

Possible extensions:

- What happens when we are subjected to several sound sources? Do the decibel numbers add up?
- What are the risks for our hearing: a documentary analysis can complement this investigative work.

For example: Document analysis and experimental verification
"A risk prevention brochure states that "3 dB more" means that the number of identical sound sources has been multiplied by 2. Can you prove this and give your teacher an accurate report (including your measurements)? »

Give a scale of risks (use one of those proposed in pupils' textbooks, for example).
For a noise level L = 85 dB, the exposure time should not exceed 8 hours per day.
For a sound level L = 100 dB, the exposure time must not exceed 15 minutes per day.

- Link to the challenge on "Bass or Treble": Do the bass sounds pass through the walls of my room as well as the treble sounds?

Possible link with Technology :

- What is the best sound insulation between wood, tiles and polystyrene (or any other material)? This work can also be carried out in the physical sciences, we can add the test of insulating materials such as "double glazing", a door, a wall (in the classroom for example or even at home). Possibility of making models with different materials between a sound source and the telephone or the tablet used to take measurements. For the sound produced and in order to ensure a constant sound intensity, it is possible to use a second smartphone to produce a sound (in the application's "tools"). You will then be careful to ensure that only the materials have an influence on the sound intensity received by making the pupils aware that the distances between the different parts of the model must remain constant (between the sound emitter and the material and between the material and the sound level meter) but also, more generally, all the other factors that can influence the measurement (ambient noise, the way in which the sound level meter is placed, etc.).
- Possibility to work on the evolution of needs and therefore the technical solutions to be provided with the evolution of smartphones and the appearance of more and more complete devices. This can be an opportunity to make students aware that the equipment they use is full of often cutting-edge technology and that a tablet or smartphone is made up of several elements and components (technical solutions - technology programme) that make it possible to respond to technical needs

Middle school programs

<u>Signals</u>
Characterise different types of signals (light, sound, radio...). Use the properties of these signals.
Sound signals
Notion of frequency: audible sounds, infrasounds and ultrasounds.
E.g.: The examples discussed focus on natural phenomena and concrete devices: thunder, sonar... The proposed activities help to make pupils aware of hearing risks.

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Acknowledgements
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In partnership with Trapeze.digital

FizziQ

Date of publication
November 2020

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