Tubular Melodies: Explore sounds with tubes, water and FizziQ Junior!

Activity Description

In this educational activity, students explore fundamental concepts of music and acoustics. As they blow in plastic tubes partially filled with water, pupils will be challenged to find three different ways to determine the musical note of the sound the tube produces.

This activity allows students to develop the basics of scientific reasoning by studying the links between the height of water in the tubes and the frequency of the notes produced. They learn how musical instruments and sounds are created, as well as the effects of changing the acoustic properties of an object.

Students develop their listening skills, their critical thinking and their creativity. They are required to work as a team and communicate their observations and conclusions. By documenting their experiments, results and conclusions in an experiment notebook, students improve their skills in analysis, synthesis and communication.

Type of activity
Physics - Music - Indoors

Material
3 clear plastic test tubes per group
A ruler
FizziQ Junior on a smartphone or tablet

Features of FizziQ Jr
Measurement: Notes
The flute musical instrument

Instructions:

- **The goal of this activity is for students to find 3 different ways to determine the musical note of a specific sound.**
- Divide the class into groups of 3 or 4 students. Each group will take three plastic tubes and one pipette with water.
- Have each student blow gently into the open end of the tube to produce a sound. The first time is not always easy and some students may not be able to create a clear note. Help them position their mouth and breath correctly.
- In the following we will use the musical instrument “Flute” from the FizziQ application but only the white keys, not the black semitones keys.
- Can they find which note is closest to the sound the empty tube makes? What is this note?
- Now ask them to add a little water to one of the tubes and then blow again. What is going on ? Has the note changed?
- Propose the following challenge to them: put the right height of water to obtain exactly the note which follows in the scale that which they obtained with an empty tube (for example if the note was D, the note which they must obtain is E).
- When they get the amount of water that corresponds to the note, the students measure the height of water with the ruler and take a picture of the tube to add to the notebook.
- Then they redo the exercise with the next note in the scale and once again write down the information in the notebook.
- Once they have completed these challenges, have them reflect on how much water was added each time. How do you get higher or lower notes? Is the note very sensitive to the amount of water? Are the differences in water heights in the tube between two notes the same?
- All these conclusions, and photos of the experiments must be added to the experiment notebook as well as their conclusions
- Share all the results in the class and ask the students how much water they put in the tube for each music note. Write the results on the board.
- Are all these results identical, is the same note always created with the same height of water? If there are conflicting results, ask them to repeat the experiment.
- Explain why a sound is produced when blowing into the tube and why the note is different if water is added (see scientific explanations below).
- Now choose a tube and put a certain height of water in it and ask the groups to find three ways to recognize the note.
- One of these ways will use the ruler, another the correspondence with a note of the synthesizer, and finally a last one will use the Notes measurement instrument which allows to measure the frequency of sounds and to deduce the note played.
- Explain how this latest device works, which analyzes sounds and makes it possible to deduce the frequency of notes. Let them use it for the various tubes that they

have. Give them applications of this instrument such as electronic guitar or piano tuners.

- During the session, students will have added copies of the instruments to their FizziQ Junior experiment notebook. Now they will be able to document the session and their conclusions in the experiment notebook.

Scientific background

Here are a number of scientific concepts to know before carrying out the experimentation session in class:

Acoustic : Acoustics is the study of sounds, their production, transmission and reception. Sounds are vibrations that propagate in the form of mechanical waves in a material medium (solid, liquid or gaseous). There are several characteristics of a sound that make it unique:

Frequency : The frequency is the number of cycles that the sound wave describes in one second. The higher the frequency, the higher the sound, like a bird's whistle. Conversely, the lower the frequency, the lower the sound.

Intensity : The intensity of a sound, or sound volume, is related to its amplitude, that is to say to the strength or energy of the sound wave. A loud sound has a high amplitude, while a soft sound has a low amplitude. Loudness is measured in decibels (dB).

Timbre : Timbre is what makes it possible to distinguish two sounds of the same pitch and the same volume, but produced by different instruments or sources. For example, a guitar and a piano can play the same note at the same volume, but the difference between the two is recognized by the timbre.

Frequency and musical note: Musical notes are organized according to a specific frequency system, called the musical scale. For example, the standard "la" note (also called "la 440") has a frequency of 440 Hz. Each successive note in the musical scale has a proportionally higher or lower frequency. The relationship between the frequency of a sound and the musical note is based on a specific musical system, usually the Western tempered scale, where note frequencies follow a geometric progression. The scale is divided into 12 equal semitones in an octave. An octave is a musical interval in which the frequency of the upper note is twice the frequency of the lower note. For example, if the "la" (A) has a frequency of 440 Hz, then the upper octave of the "la" (A) will have a frequency of 880 Hz.

Resonance and air column: Resonance is a phenomenon that occurs when the frequency of a vibrational system is stimulated by a corresponding external frequency, thus amplifying the vibration. In the context of the activity, the plastic tubes form columns of air that resonate when a student blows on their end. The length of the air column determines the frequency at which it resonates and therefore the pitch of the note produced. When a student blows into the tube, they create a vibration of the air inside the tube. This vibration propagates in the form of sound waves, which are amplified by the resonance of the tube. The pitch of the note produced depends on the frequency of the sound waves, which is determined by the length of the tube, its diameter and the speed of sound.

Water level and frequency: When students add water to the tubes, they change the length of the column of air available for resonance. By adding water, the air column becomes shorter, which increases the resonant frequency and makes the note higher. Conversely, by removing water, the air column lengthens, which lowers the resonant frequency and makes the note lower. If we assume that the notes are equally distributed within an octave, then the height of water in the tube that must be added to pass from one note to another is the same. In reality the notes are not evenly distributed in an octave but we can nevertheless make this approximation within the framework of this exercise.

How to find the musical note of a sound: Pupils will discover that there are three different ways they can identify the note of a sound

- **Calculus :** as they have measured the interval between two consecutive notes, students can deduct the note by adding the interval several times and each time count one note on the scale until they reach the desired height..
- **Calibration :** pupils use a calibrated instrument, in our case the Flute instrument, to identify which is the closest note to the sound they hear. They deduct the note of the sound. This is how tuning fork works.
- **Direct measurement :** specific measurement instruments, such as the Notes instrument of FizziQ Junior, can be used to measure and analyze sound frequencies. These instruments work by recording sound waves and converting them into digital data, which can then be analyzed to determine the frequency and pitch of notes. Electronic guitar and piano tuners also use sound spectrum analyzers to measure the frequency of notes and adjust the tuning of the instrument accordingly.

By documenting their results and conclusions in their FizziQ Junior Experiment Notebook, students can develop a deeper understanding of scientific concepts related to the creation of sounds and musical notes, as well as practical applications of these concepts in the world. real.

Security

Students should be careful when using their tablets. They shouldn't get distracted, drop the tablet on the floor, or get water on it. Tablets are fragile objects.

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