Air columns and pitch

FizziQ activity · Elementary · 45-60 min

Scan to open in FizziQ

Blowing into water-filled tubes, primary pupils change the pitch, identify notes with the FizziQ Junior note recognizer on tablet and link tube length to frequency.

Learning objectives

- Discover the relationship between air column length and produced sound pitch.
- Use the FizziQ Junior Notes measurement instrument to identify a musical note.
- Compare produced notes with those from the FizziQ Junior Flute synthesizer.
- Develop an experimental approach: hypothesis, measurement, analysis, conclusion.
- Document observations in the digital experiment notebook.

Instruments and sensors

Notes measurement instrument · Microphone

Materials

- Smartphone or tablet with the FizziQ Junior app
- 3 transparent plastic test tubes per group
- A graduated ruler
- A pipette or small container for pouring water
- Water
- Note: the protocol remains adaptable to any comparable sound/pitch analysis tool.

Protocol

1. Separate the class into groups of 3-4 students. Distribute to each group three transparent plastic tubes, a ruler, and a pipette with water.

2. Ask each student to gently blow into the open end of an empty tube to produce a sound. Help students position their mouth and breath if needed.

3. Open FizziQ Junior and access the Flute musical instrument. Specify that only white keys will be used, not semitones.

4. Ask students to compare the empty tube sound with Flute notes. Which note is closest? Students add this observation to the experiment notebook.

5. Ask them to add a little water to one of the tubes, then blow again. What happens? Has the note changed? Is it higher or lower?

6. Propose the following challenge: find the right water height to obtain exactly the next note in the scale (for example if the empty tube gave a D, obtain an E).

7. When the water amount corresponds to the target note, students measure the water height with the ruler, take a photo of the tube, and add everything to the experiment notebook.

8. Students repeat the exercise to obtain the following note in the scale and document their results in the notebook.

9. Have them reflect: how do you get higher or lower notes? Is the note very sensitive to water amount? Are water height intervals between two notes identical?

10. Pool results from all groups on the board. For each note, compare the water heights found. Are results consistent between groups?

11. Explain the principle of air column resonance: water reduces the available air column length, which increases frequency and makes the sound higher-pitched.

12. Choose a tube with a certain water height and ask groups to find three ways to identify the note: by ruler and calculation, by comparison with the Flute synthesizer, and by the Notes measurement instrument.

13. Present the FizziQ Junior Notes measurement instrument which analyzes sounds and automatically determines the played note. Let students use it for their different tubes.

14. Students document the entire session, their measurements, and conclusions in the FizziQ Junior experiment notebook.

Expected results

Students will observe that an empty tube produces a low note and that by adding water, the sound becomes progressively higher-pitched. They will notice that to move from one note to the next in the scale, they need to add an approximately regular amount of water.

The FizziQ Junior Notes instrument will confirm the correspondence between produced sound and scale note. Differences between different groups' results are expected due to difficulty blowing perfectly regularly and dosing water precisely. The note's sensitivity to water amount will be noticed: a small change in water level noticeably modifies sound pitch.

Questions

- Why does the sound become higher-pitched when you add water to the tube?
- Does the produced note depend only on water height or also on tube diameter?
- Why is it difficult to get exactly the same note every time you blow?
- Can you create a complete scale with different-sized tubes without adding water?
- How do flute or organ makers use this principle to manufacture their instruments?

Going further

- Use bottles of different sizes instead of test tubes to explore lower sounds.
- Try to play a simple melody with several tubes tuned to successive notes.
- Compare notes obtained by blowing into the tube with those obtained by tapping the tube with a pencil.
- Measure the exact frequency with the Notes instrument and plot a graph of frequency vs. water height.
- Explore semitones by finely adjusting water amount.