Tune the Air

Designing an instrument around resonance

PHS.6.4 "Enrichment: Use an engineering design process to design and build a musical instrument to demonstrate the influence of resonance on music.*"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the design goal, circle two features that affect the air inside the instrument, and number the testing and revision steps. Use your marks to trace how the maker turns a sound into a working design.

The Straw-Pipe Challenge

1. At a school makerspace, Nia wants to build a small instrument that plays three distinct notes. She chooses drinking straws, tape, and a cardboard holder. Each straw will be open at the top and sealed with tape at the bottom. Blowing across an open end disturbs the air inside. The trapped air vibrates most strongly at certain frequencies, a response called resonance. That strong response helps produce a clear tone. In a pipe sealed at one end, a longer air column has a lower main resonant frequency than a shorter one. Nia plans pipes of different lengths rather than identical pipes.

2. Before building the full instrument, Nia makes one pipe and tries several ways of blowing across its rim. A steady stream of air produces a clearer note than a hard puff. She checks the tape seal because escaping air can weaken the tone. Then she cuts two more straws to different lengths, keeping their widths the same. This lets her test how length affects pitch without also changing width. She mounts the pipes so their open ends are level and records each note with a phone tuner. The tuner readings give her a way to compare pitches beyond what she hears.

3. Nia's first set includes two notes that sound almost alike, so it does not meet her three-note goal. She changes the length of one pipe and tests the set again. She also compares each pipe's sound with its taped end sealed and then briefly unsealed. Opening the end changes which frequencies the air column supports, so the comparison helps her investigate resonance rather than just loudness. During each comparison, she blows across the same rim in the same way. Her finished design must produce three distinct notes on repeated tries. If one note remains unreliable, she will revise that pipe instead of calling the instrument finished.

2 ANSWER WITH EVIDENCE

Use the passage

1. A student makes three sealed straw pipes of equal length and gets nearly the same note from each. What should the student change to meet Nia's design goal, and why?

2. A student tests whether pipe length affects pitch but also changes the width of every pipe. How should the student improve the test?

3. One pipe makes a clear note on some tries but barely sounds on others. What two checks from Nia's process could help identify the problem?

4. A group claims its sealed pipe's tone is shaped by resonance. What comparison from Nia's process could help test that claim, and what must stay the same?

3 YOUR TURN

Your own words

Design a three-note instrument using three identical plastic bottles and water. In one paragraph, explain how you would build and play it, test whether the air inside shapes its sound, decide if it meets a measurable goal, and revise it if needed.

ANSWER KEY

Tune the Air

HIGH SCHOOL · PHS.6.4

PART 1 · READ AND MARK

Underline the design goal, circle two features that affect the air inside the instrument, and number the testing and revision steps. Use your marks to trace how the maker turns a sound into a working design. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	A student makes three sealed straw pipes of equal length and gets nearly the same note from each. What should the student change to meet Nia's design goal, and why?	**Change at least one pipe's length while keeping it sealed. Different air-column lengths have different main resonant frequencies and can produce distinct notes.**
2	A student tests whether pipe length affects pitch but also changes the width of every pipe. How should the student improve the test?	**Use pipes of the same width and vary only their lengths, so a pitch difference can be linked to length.**
3	One pipe makes a clear note on some tries but barely sounds on others. What two checks from Nia's process could help identify the problem?	**Check that the bottom seal is secure and that the air is blown steadily across the rim.**
4	A group claims its sealed pipe's tone is shaped by resonance. What comparison from Nia's process could help test that claim, and what must stay the same?	**Compare the pipe with its bottom sealed and unsealed, keeping the pipe and blowing method the same. A change in tone would support the claim.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would put different amounts of water in three identical bottles and blow across each opening to make a note. My goal is three notes with different tuner readings on three tries each. To test the air's role, I would change the water level in one bottle, then compare its tuner readings before and after. I would keep the bottle and my blowing method the same because changing the water level changes the air space. If two bottles still produce nearly the same note, I would adjust one water level and test again.

Accept designs that use a controlled change to the air space and a repeatable way to compare notes. Students need not predict the exact pitches of the bottles.