LAB 41: SOUND WAVES

In this inquiry activity, students will discover the relationship between length and pitch (frequency), tension and pitch, and mass per unit length and pitch without being instructed first. Many students confuse pitch and volume, so the teacher may have to demonstrate the difference in class before assigning this activity.

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Topic: Interactions of Sound Waves
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Post-Lab Answers

1. Longer lengths produce lower-pitched sounds (frequencies). Shorter lengths produce higher-pitched sounds.
2. Higher tension produces higher-pitched sounds. Lower tensions produce lower-pitch sounds.
3. Higher mass (per unit length) produces lower frequencies. Lower mass per unit length produces higher frequencies.

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QUESTION

How do tension, length, and mass per unit length affect the frequency of a vibration?

SAFETY

Standard safety precautions apply.

MATERIALS

Thick rubber band, thin rubber band, glass or plastic soda bottle, ruler

PROCEDURE

Vibrating objects that compress and stretch masses of air create sound waves. Your vocal cords vibrate, the head of a drum vibrates, a clarinet reed vibrates, and the resonator of a guitar vibrates to make sound.

The pitch (tone, musical note) that comes out of a wind instrument, a percussion instrument, and a string instrument are all controlled by different factors.

1. Place the plastic ruler over the edge of the table so that 3 inches are hanging off the table. Pluck the ruler and notice the note that it emits.
2. Allow 3 inches to hang over and pluck it again. Did the pitch get higher or lower?
3. Allow 6 inches to hang over and pluck it again. Did the pitch get higher or lower?
4. Hold the thin rubber band between a finger and your thumb and stretch it lightly. Pluck it and notice the note it emits.
5. Stretch the rubber band tighter and pluck it again. Did the pitch get higher or lower?

6. Stretch it even more and pluck it again. Did the pitch get higher or lower?
7. Perform the same experiment with the thick rubber band. Were the notes higher or lower pitched than when you stretched the thin rubber band by the same amount? You can put them both side by side on your fingers and compare.
8. Practice blowing across the top of your bottle to produce a musical note. The bottle should hang straight down and touch your lip. You should blow straight across the top of the bottle smoothly and gently. Notice the note that it produces.
9. Now fill the bottle 1/3 with water and blow across it again. Did the pitch get higher or lower?
10. Now fill the bottle ½ with water and blow across it again. Did the pitch get higher or lower?
11. Now fill the bottle 2/3 with water and blow across it again. Did the pitch get higher or lower?
12. Arrange your data in a manner that you deem appropriate.

Post-Lab Questions

1. How does the length of the vibrating object affect its frequency?
2. How does the tension of a vibrating object affect its frequency?
3. How does the mass of a vibrating object affect its frequency?

Extension

Find someone who has a guitar or other string instrument and see how your analysis stands up. See which string is thickest: the high frequency (high pitch; treble) or the low frequency (low pitch; bass). With the person's permission, change the tension in a string and see how it affects the pitch. When you push on one of the strings (shortening the string), how does the frequency change?