National Aeronautics and Space Administration

Senses of Sound

Exploring Sound Through Senses | Suggested Grades: K-8

Activity Overview

Students will engage in a series of demonstrations using a constructed amplifier that illustrates the several principles of sound. Students will learn about motion, forces, transfer of energy, and interactions of energy and matter.

Time: 45 minutes

Materials:

- Single use plastic cup
- Rubber band
- Scissors
- Metric Ruler
- Senses of Sound Worksheet

NEXT GENERATION SCIENCE STANDARDS

- K-2-ETS1-3
- 1-PS4-1
- 3-5-ETS1-3
- 4-PS3-2
- MS-PS4-2

Steps*

1. Optional: watch instructional video prior to starting activity with students https://youtu.be/KoztJbcU_tw
2. Explain to students the principles of sound and why sound is important to NASA.
3. Review the activity discussion questions with the students.
4. Divide the students into groups of 3.
5. Construct amplifier
   a) Before giving cups to students puncture a small rubber band sized hole in the bottom of your cups.
   b) Cut your rubber band so that it is one long piece and tie a knot on one end.
   c) Without stretching, measure the full length of the rubber band from the knot to the other end in centimeters and record this measurement.
   d) Using the recorded length calculate and mark what would be 1/3 and 2/3 the length of the rubber band. Record the measurements on the worksheet.
   e) Pull the rubber band through the hole in the bottom of the cup. The knot should stay on the inside of the cup and the length of the rubber band outside the cup.
6. Allow students to experiment with creating sound using their amplifiers and have them record their observations.
7. Have the first student hold the cup horizontally and hold the rubber band at the 1/3 length and pulled tight. Have the second student pluck the rubber band while the third student puts the amplifier to their ear and listens to the sound being produced. Have students describe and record what they hear, see and feel. To see sound, have students watch the sound waves move through the rubber band when it is plucked.
8. Repeat step 6 for 2/3 the length and the full length of the rubber band. Then rotate to allow all 3 students to hold, pluck and listen. Did they hear, see or feel anything change between the different lengths? Was the sound different when you were doing different roles?
9. For a further challenge, repeat activity using different types and sizes of cups and rubber bands. How do the different materials change what students hear, see and feel?

Example of Step 4 Amplifier

For videos relating to sound and the X-59, please visit:
https://www.youtube.com/playlist?ist=PLTUZypZ67cdvZ3TbQbDiqLdOkrCswmkUZ

*Certain aspects of activity may need to be adapted to adequately align with student's abilities.

Background

As scientists and engineers work to reduce noise pollution from aircraft, a thorough understanding of the physics of sound is necessary. Sound is one of the most important ways we have of sensing our surroundings and communicating with others. Sound itself is a sensation created in the human brain in response to sensory inputs from the inner ear. However, not all sounds are desirable or beneficial.

All sounds are produced by vibrating objects. One of the reasons that there are so many different sounds is that there is an endless variety of materials that can vibrate and produce them. When you talk or sing, two ligaments that are hidden in your larynx vibrate. They are called your vocal cords or vocal folds. Each person has a unique set of vocal cords and a uniquely designed larynx which gives rise to the individual character of a person's voice.

For more information, please visit the following website:
https://www.nasa.gov/sites/default/files/atoms/files/good_vibrations_k-8.pdf

An artist's concept of the low-boom flight demonstrator outside the Lockheed Martin Aeronautics Company's Skunk Works hangar in Palmdale, California.
Credits: Lockheed Martin

New NASA X-Plane Construction Begins Now

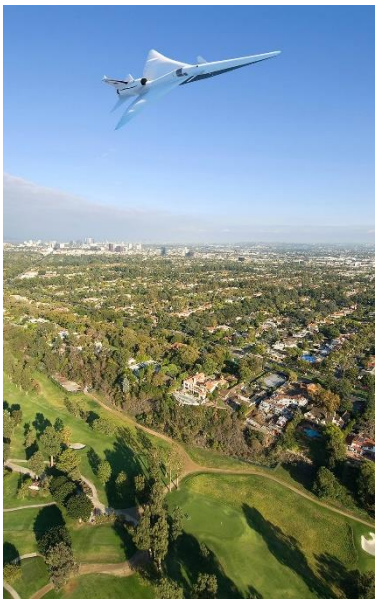
NASA's aeronautical innovators are ready to take things supersonic, but with a quiet twist. For the first time in decades, NASA aeronautics is moving forward with the construction of a piloted X-plane, designed from scratch to fly faster than sound with the latest in quiet supersonic technologies.

The key to success for this mission – known as the Low-Boom Flight Demonstrator – will be to demonstrate the ability to fly supersonic, yet generate sonic booms so quiet, people on the ground will hardly notice them, if they hear them at all.

The answer to how the X-plane's design makes a quiet sonic boom is in the way its uniquely-shaped hull generates supersonic shockwaves. Shockwaves from a conventional aircraft design coalesce as they expand away from the airplane's nose and tail, resulting in two distinct and thunderous sonic booms.

But the design's shape sends those shockwaves away from the aircraft in a way that prevents them from coming together in two loud booms. Instead, the much weaker shockwaves reach the ground still separated, which will be heard as a quick series of soft thumps – again, if anyone standing outside notices them at all.

For more information please visit the following website:
https://www.nasa.gov/lowboom/new-nasa-x-plane-construction-begins-now



Aeronautical innovations are part of a government-industry partnership to collect data that could make supersonic flight over land possible, dramatically reducing travel time in the United States.
Credits: NASA

Suggested Lithograph:

Connections

- How does sound affect your daily life?
- Where do you feel, hear and see sound?
- How does sound affect you physically? ie. mood

For more information and further activities:

- www.nasa.gov/X59
- www.nasa.gov/aeroresearch/stem/X59
- www.nasa.gov/stem/nextgenstem/aeronaut-x/
- www.nasa.gov/aeroresearch

Discussion Questions

1. **All sounds are produced by vibrations.** When something vibrates it moves back and forth and usually does so very quickly. If the vibrations are within the range of human hearing, we detect a sound.

2. **All music instruments produce sounds by something that vibrates.** Ask students to identify what vibrates in the following music instruments:

Instrument	Primary source of Vibration
Guitar	Strings
Piano	Strings
Saxophone	Reed
Trumpet	Player's lips
Drum	Drumhead
Flute	Air inside the flute

3. **Since there is no engine in a glider to make noise, does a glider pilot experience any noise?** Yes, the sound of air rushing over the wings and fuselage (body of the aircraft).

4. **When does an airplane make the most noise? Why?** When taking off and climbing. There are many possible causes for this. Larger aircraft engines generate more noise than smaller aircraft. The sound intensity during takeoff and climbing are produced nearer the ground and do not have as far to travel to a person than when an aircraft is 4,000 meters in altitude. The intensity from a point source of sound obeys the inverse square law ($^1/_{r^2}$). A sound source 2 times farther away will produce only 1/4 the sound intensity.

5. **Ask students to describe their own experiences with noise from aircraft**. They might compare the noise produced by commercial jets, military jets, helicopters and propeller driven airplanes.

6. **What causes all sounds?** Vibrations

7. **What are vibrations?** For example, a guitar string that rapidly moves back and forth is a vibration.

8. **What is pitch?** Highness or lowness of a sound. The degree of height or depth of a tone or of sound, depending upon the relative rapidity of the vibrations by which it is produced.

9. **Compare the pitch of the predominate sound made by a helicopter and a jet engine**. Which do you think produces the higher pitch? Jet engine

10. **What is frequency?** The periodic change in sound pressure.

11. **What units are used to measure frequency?** Cycles per second or in Hertz, Hz.

12. **How is pitch related to frequency?** When frequency increases, the pitch goes up.

13. **Explain noise**. Noise is a random mixture of frequencies.

14. **Do you think that aircraft can produce sounds that humans cannot hear but other animals can?** Yes; both above and below the normal range of human hearing.

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Worksheet

Instructions

Please record all measurements and observations from experiment below.

Length of pre-stretched rubber band: _____cm

Pre-Experiment Observations: _____

_____

Dimensions	Sense	Prior Observations	Up to ear
1/3 length ____cm	Hear		
	See		
	Feel		
2/3 length ____cm	Hear		
	See		
	Feel		
Full rubber band	Hear		
	See		
	Feel		