Making Sound

All of the objects listed below make sounds. Put an X next to the objects you think involve vibrations in producing sound.

___ guitar strings

___ drum

___ dripping faucet

___ barking dog

___ piano

___ screeching brakes

___ radio speaker

___ crumpled paper

___ car engine

___ chirping cricket

___ singer

___ popped balloon

___ drum

___ wind

___ wood saw

___ clapped hands

___ bubbling water

___ rustling leaves

___ hammer

___ flute

___ thunderstorm

___ two stones rubbed together

___ snapped fingers

Explain your thinking. What "rule" or reasoning did you use to decide which objects involve vibrations in producing sound?

Making Sound

Teacher Notes

Purpose

The purpose of this assessment probe is to elicit students' ideas about sound production. The task specifically probes to determine whether students recognize that sounds result from vibrations produced by an object or by objects or materials in contact with the object listed.

Related Concepts

sound, vibration

Explanation

Sound is a form of energy caused by back-and-forth vibrations. All the objects on the list involve the production of sound as a result of vibration of the object itself or the material it comes in contact with, such as air. Some vibrations are obvious, such as watching the strings plucked on a guitar. Other vibrations are so small that you can't see them. Some vibrations that cannot be seen can be felt. For example, when you put your fingers over your vocal cords, you can feel the vibrations created when you speak. The loudness of a sound depends on the size of vibrations. The size of vibrations is called their amplitude. Increasing or decreasing the amplitude changes the loudness of a sound. Leaves rustling in a gentle wind create sound with a low amplitude of vibrations, whereas a blaring radio speaker creates sound with a high amplitude. Vibrations also affect the pitch of a sound. Pitch describes how high or low the notes are that are produced by the vibrations of the object. Pitch is affected by changing the frequency of the vibrations—how quickly or slowly the object vibrates. The more vibrations

that occur per second, the higher the frequency and the higher the pitch of the sound.

Curricular and Instructional Considerations

Elementary Students

By the end of the elementary grades, most students have had opportunities to learn about sound and how sound is made. Early ideas about sound are connected to position and motion of objects. Teaching and learning about sound is primarily observational and includes having students identify different types of sound and their sources, observe vibration of sound-making objects, and relate loudness and pitch to different types of sound production. The emphasis at this developmental stage is on the objects, even though in some cases it is the air that is in contact with the object that is the source of vibration. Because the notion of vibrating air is a more abstract idea at the elementary level and not directly observable, the national standards focus on vibrating objects at the elementary level. Ideas about vibration and pitch are grade-level expectations described in the national standards. Students at this level often learn about sound through the context of musical instruments. As a result students may become context-bound in their understanding of how sound is produced and may fail to generalize across different examples.

Middle School Students

In middle school, students build on their elementary grade observations to develop explanations about sound and how it travels. Students at this level begin to understand the abstract notion of air as a source of vibration resulting from contact with an object. Students begin to develop ideas about waves and transmission through different types of materials. The probe is useful at this level to determine whether through prior instruction students developed generalizations about sounds resulting from vibrations or if the context they learned ideas in limited their understanding about sound production.

High School Students

In high school, students continue to build more sophisticated understandings about sound and sound waves. The probe is useful at this level to determine whether students may still have a limited context in understanding basic ideas about how sound is produced.

Administering the Probe

Make sure students are familiar with the items on the list. You may wish to remove items that elementary students have little or no familiarity with. This probe can also be used as a card sort. In small groups, students can sort cards listing each item into two groups—those that make sound by vibration and those that do not. Listening carefully to students' discussions with each other as they sort can lend insight into their thinking.

Related Ideas in *National Science Education Standards* (NRC 1996)

K–4 Position and Motion of Objects

★ Sound is produced by vibrating objects. The pitch of the sound can be varied by changing the rate of vibration.

5–8 Transfer of Energy

- Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.

Related Ideas in *Benchmarks for Science Literacy* (AAAS 1993)

K–2 Motion

★ Things that make sound vibrate.

3–5 Motion

- How fast things move differs greatly.

6–8 Motion

- Vibrations in materials set up wavelike disturbances that spread away from the source. Sound and earthquake waves are examples. These and other waves move at different speeds in different materials.

Related Research

- Children's explanations of how sound is produced can be sorted into three groups that involve (1) physical properties of sound-producing materials, such as thickness, hardness, and elasticity, (2) the size of the force needed to produce the sound, and (3) vibrations (Driver et al. 1994).
- Reference to movement or vibration increases with age (Driver et al. 1994).
- A study by Asoko, Leach, and Scott (1991) used different contexts to have students explain how sound is produced. They used examples such as a guitar string, a horn, cymbals, and two stones clashed together. The results of their study suggest that students do not have a generalized theory of sound being produced by vibration that can be transferred across different contexts. The researchers suggest that "teachers should plan to give children experience of sound production in less obvious contexts as well as in contexts where the vibrations are more clear. It may be useful to allow the children to experiment with applying vibration ideas developed in obvious contexts to less obvious contexts with a view to developing a generalized theory."
- Failure to recognize the role of vibration in sound may be linked to the failure to recognize the involvement of air as a medium in which vibrations are transferred. The role of the ear does not appear to be problematic and may serve as a useful context to develop the idea of vibrations in air (Driver et al. 1994).

Suggestions for Instruction and Assessment

- Explicitly develop the generalization that

★ Indicates a strong match between the ideas elicited by the probe and a national standard's learning goal.

all objects and materials that produce sound vibrate or cause surrounding objects or materials to vibrate, regardless of the examples used to investigate sound production. Be aware that a specific context may limit students' thinking.

- Provide opportunities to experience vibrations in objects where the vibration is not obvious. For example, putting your hand on a hard surface and feeling the vibration as someone pounds on the hard surface is one way of confirming that rigid objects vibrate.
- Connect the idea about how we hear sound to vibrations from the source to the medium that carries the vibrations to our ears.
- Have students investigate objects like tuning forks to observe differences in the vibrations.

Related NSTA Science Store Publications and NSTA Journal Articles

American Association for the Advancement of Science (AAAS). 2001. *Atlas of science literacy.* (See "Waves," pp. 64–65.) New York: Oxford University Press.

Driver, R., A. Squires, P. Rushworth, and V. Wood-Robinson. 1994. *Making sense of secondary science: Research into children's ideas.* London and New York: RoutledgeFalmer.

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Keeley, P. 2005. *Science curriculum topic study: Bridging the gap between standards and practice.* Thousand Oaks, CA: Corwin Press.

Palmer, D. 2003. Modeling the transmission of sound. *Science Scope* (Apr.): 32.

Robertson, W. 2003. *Sound: Stop faking it! Finally understanding science so you can teach it.* Arlington, VA: NSTA Press.

Stepans, J. 2003. *Targeting students' science misconceptions: Physical science concepts using the conceptual change model.* (See section on sound.) Tampa, FL: Showboard.

Related Curriculum Topic Study Guide
(Keeley 2005)
"Sound"

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American Association for the Advancement of Science (AAAS). 1993. *Benchmarks for science literacy.* New York: Oxford University Press.

Asoko, H. M., J. Leach, and P. H. Scott. 1991. A study of students' understanding of sound 5–16 as an example of action research. Paper prepared for the symposium "Developing Students' Understanding of Science" at the annual conference of the British Educational Research Association, Sept. 2, 1990, London, England.

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