3M Young Scientist Lab

Classroom Activity | Grades 3-5

The Everyday Science of Sound

GUIDING QUESTION

What makes a sound? What makes sounds louder, softer, higher or lower?

LEARNING OBJECTIVES

Students will be able to:

- conduct a series of demonstrations that illustrate properties of sound.
- describe the movement of sound waves through various mediums and how different sounds produce different waves.
- design a musical instrument that produces at least two different pitches.

OVERVIEW

Sound and music are important parts of our everyday sensory experience. But how often do we think about behaviors of sound or how it is produced, reproduced and detected? The basis for an understanding of sound, music, and hearing is the physics of waves. In this lesson, students will conduct a series of demonstrations that illustrate the science behind how sound is made and heard. The lesson culminates with students designing a musical instrument that can play at least two different pitches.

NEXT GENERATION SCIENCE STANDARDS

- PS3.A: Definitions of Energy
  - Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-2),(4-PS3-3)
- PS3.B: Conservation of Energy and Energy Transfer
  - Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby

changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS3-2),(4-PS3-3 to 4-PS4-3)

- ETS1.B: Developing Possible Solutions
  - At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)

LESSON TIME FRAME

3, 45 minute class periods

BACKGROUND INFORMATION

Sound travels as waves of vibration. The vibrations bump into tiny air molecules that bump into more tiny air molecules close by continuing as the wave travels to the eardrum, which also vibrates! The sound produced is different depending on how big the wave is, how fast the vibration is moving and the medium it is traveling through.

Shhhh, shorter waves, have less energy and create a softer sound. BOOM! Big waves have more energy and create louder sounds. When we hear a high pitched squeak or squeal, the vibrations are fast. Low pitched sounds like the sound that comes out of a bass instrument have slower moving vibrations.

MATERIALS

Teacher Materials/Prep

- Home Connection Resource
- Sound Test student capture sheet
- Design a Musical Instrument student capture sheet
- Index Cards
- Slinky
- Music to play for students
- Print and cut out copies of:
  - Five Finger Reflection
- Print out copies:
  - “Sound Test” Student Capture Sheet
  - “Design a Musical Instrument” Student Capture Sheet

Materials per Student Group

- Wire hanger
- Metal spoon
- Ruler
- Yarn
- String
- Pieces of bell wire
- Several glass bottles
- Water
- Pencils
- "Sound Test" student capture sheet
- "Design a Musical Instrument" student capture sheet
- "Five Finger Reflection" per student

CLASSROOM ACTIVITY

Day 1

Engage

***Teacher Note:** As students enter the room, have music playing in the background. Additionally, this lesson requires students to conduct a series of demonstrations. Ensure that all materials are available and organized. A list of materials can be found above.

1. Divide students into partners and distribute an index card to each partner group. Ask students to write a sentence or draw a picture that describes how they think the sound from a smartphone, tablet or television gets to their ears. At this point, this will probably just be a guess and that's okay!
2. Ask each group to share what is on their card. Which group's answer seems most reasonable? Encourage discussion.

Explore

3. Hold up a Slinky and pass it around. Ask students if they have any ideas about how the Slinky relates to how they hear music. Direct two volunteers to stretch the Slinky out on the floor or on a table as far as they can, with one volunteer firmly holding each end. Direct the student at one end to stroke or pluck the Slinky. What happens? Ask: Do the two ends of the Slinky move toward each other? (No.) What is moving from one end of the Slinky to the other? (A pulse of energy.) Share with students that the Slinky is modeling the way energy in the form of a sound wave travels through a solid, liquid

or gas. Explain that those substances, known as mediums, are made up of molecules, more or less regularly spaced from each other, like the coils of the Slinky. When one of these molecules is moved as the result of a sound source's energy, it pushes against the molecules next to it before returning to its original position; the process is repeated as the sound wave passes through the molecular structure of the medium. Have students practice modeling a sound wave with the Slinky.

***Teacher Note:** This is a good stopping spot for day 1 if time is short. Continue the lesson if time permits.

Day 2

4. Tell groups that they will be conducting a series of "sound tests" that illustrate properties of sound and how sound travels through mediums. Distribute the following materials to each group: Sound Test student capture sheet, one wire hanger, one ruler, several pieces of string, several pieces of yarn, and several pieces of bell wire. Review the directions for each demonstration and direct students to write observations/ answer the questions on the capture sheet as they go.

***Teacher Note:** Younger students should do each demonstration at the same time as you model, while older students can move through the demonstrations at their own pace.

Sound Test 1

Materials: Wire hanger, ruler

Directions: Have one group member hold the wire hanger while another group member taps it with the ruler. Describe the sound you hear on the capture sheet.

Sound Test 2

Materials: Several pieces of string, wire hanger, ruler

Directions: Have each group member wrap a few inches of string on each hand. Place the string-wrapped fingers gently into each ear. Suspend the hanger from the string so that it does not touch anything else. Have another group member tap the hanger with the ruler. How is the sound different than in the first demonstration? Answer the question on the capture sheet.

Sound Test 3

Materials: Several pieces of yarn, wire hanger, ruler

Directions: Have each group member repeat Sound Test 2 using yarn instead of string. How is the sound different from the string? Answer the question on the capture sheet.

Sound Test 4

Materials: Several pieces of wire, wire hanger, ruler

Directions: Have each group member repeat Sound Test 3 using wire instead of yarn. How is the sound different from the yarn? Answer the questions on the capture sheet.

Explain

5. Have each group take turns reporting their findings as recorded on the capture sheet. Ask them to explain why the sound may have been louder or softer in different sound tests, even though the same hanger was used in all.

***Teacher Note:** The speed at which sound travels depends on the medium (yarn, string, etc) in which it is traveling and how the molecules are packed in that medium. The closer together the molecules, the better sound travels (so the better they would be able to hear). Molecules are packed most densely in solids and least densely in gases. When the string and fingers were plugged into the ears, the sound traveled better than just through the air. Solid wire is denser and a better conductor of sound than tightly-woven string, which is in turn a better conductor of sound than loosely-woven yarn.

Engage

6. Another aspect of sound, in addition to volume, is pitch. Ask students if they know the difference between a high sound and a low sound. What high and low sounds can they name? Using their pencils, challenge students to find an object in the classroom they can tap against that will produce a high sound, and an object they can tap against that will produce a lower sound. After a few minutes, allow students to share their objects. What do they think makes these sounds different? Allow students to share their ideas. Then share the following:

    Sound waves reach the eardrum causing them to vibrate. Then the brain perceives these vibrating sound waves as sound! The pitch of a sound (how high or low a sound is) depends upon the frequency of the sound wave, meaning how many times a sound wave vibrates in one second. Faster vibration = higher pitch. To see an online diagram of both a high frequency wave and a low frequency wave, visit this site: https://www.physicsclassroom.com/Class/sound/U11l2a.cfm

Explore

To help students investigate the science behind pitch differences, conduct the demonstration below using student volunteers to help you fill the bottles and blow on them. Encourage

students to answer the questions about this demonstration on the bottom of their "Sound Test" capture sheet. Note: Since multiple children may blow on the same bottles in this demonstration, you will want to ensure that students do not put their mouths directly on the bottles. Additionally, since glass bottles are used, be sure to review the importance of being careful around glass. If students hit the glass too hard, the bottle can tip over and break. Be sure that students do not substitute any other object than the pencil to tap the glass.

Sound Test 5

Materials:

Eight empty glass bottles of the same size, water, pencil

Directions:

Arrange the bottle in a row and first fill one close to the top with water. Blow across the top of the bottle and observe the sound (pitch) coming from the bottle. Fill the second bottle with a little less water than the first and blow across it, observing its sound. Continue to fill each bottle with a little less water than before and blow on them. What differences can you hear in the pitch of the bottles? Then tap on the first bottle with a pencil. Observe the sound (pitch) coming from the bottle. Tap on the remaining bottles and observe the sounds coming from each. Write down your observations on the capture sheet.

Explain

Ask students which bottle produced the highest pitch and to explain why bottles that were filled with more water produced different sounds than those filled with less water.

***Teacher Note for clarification:** Different sounds are produced by changing the length of the object or air volume through which the air vibrates. Shorter air columns produce higher pitches than longer air columns.

***Teacher Note:** Tell students that they will design a musical instrument tomorrow. Talk to them about the types of materials that you can provide and what they can bring at home to build their own. The "Design a Musical Instrument" student capture sheet shares material examples.

Day 3

Elaborate

7. Finally, challenge student groups to combine all of the information they have learned about sound in the design of their own musical instrument! Distribute the "Design a Musical Instrument" capture sheet. The sheet directs students to design an instrument

using materials that can be gathered from home that will (a) make sound; and (b) be played in at least two different pitches. You may want to first discuss features of their instrument that could be manipulated to change pitch: length, mass, liquid, volume, etc.

Evaluate

8. Ask each group to present their instrument explaining why they used the materials they did, how sound is heard through their medium, and how they planned and executed different pitches.

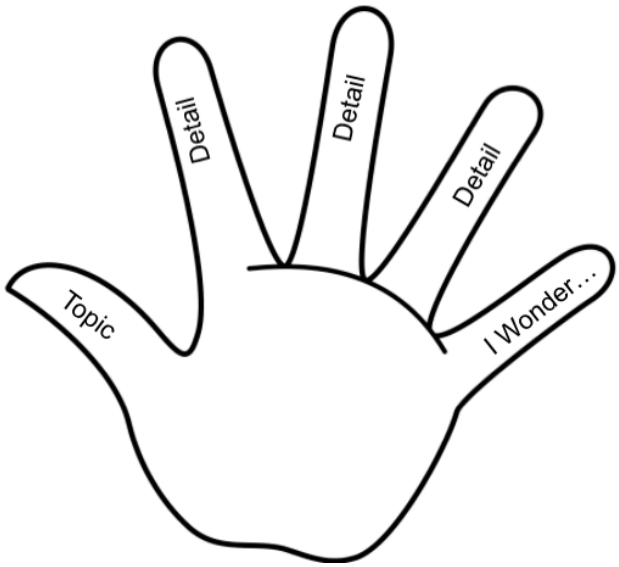
Teacher Scoring Key for Evaluate

1. Instruments should make sound.
2. Instruments should be able to be played in at least two pitches.
3. Students should be able to explain why they chose the materials they did.
4. Students should be able to explain the reasons why their instruments can make sound and why they can play in at least two pitches

REFLECTION

Students will reflect on their learning by completing the Five Finger Summary. Print off the Five Finger Summary Resource, cut them up, and distribute one to each student. Alternatively, students may trace their hand on a piece of paper or in their science journal.

Students will fill in each finger as shown below:



SOUND TEST

Sounds fill our lives. How often do we think about how we hear sound or why some sounds are louder or higher than others? The demonstrations described below can help you learn the science behind sound! Follow the directions for each demonstration and answer the questions that follow.

Sound Test & Materials	Directions	Observe & Record Record the sounds you hear in each sound test. Use sound words like loud, soft, high, low, and pitch when describing what you hear. Share any conclusions you have about the sounds from this demonstration below.
Sound Test 1 Wire hanger, ruler	One group member holds the wire hanger. Another group member taps it with the ruler. Listen.	
Sound Test 2 Several pieces of string, wire hanger, ruler	Each group member wraps a few inches of string around a finger on each hand. Place the string-wrapped fingers gently into each ear. Have another group member tap the hanger with the ruler.	Compare the sound to the last test. Was it louder or softer when the hanger was held by hand and the sound passed through the air?
Sound Test 3 Several pieces of yarn, wire hanger, ruler	Repeat the steps in Sound Test 2 using yarn instead of string.	Take a moment to compare the sound. Was it louder or softer than the string?

Sound Test 4 Several pieces of wire, wire hanger, ruler	Repeat the steps in Sound Test 2 using wire instead of yarn.	Take a moment to compare the sound. Was it louder or softer than the string and yarn?
Which of the mediums above (air, string, yarn, or write) helped you hear the sound of the wire being tapped best?		
Sound Test 4 Several empty glass bottles of the same size, water, pencil	Observe the sound demonstration with glass bottles in class. Record your observations.	Make sure to include what bottle sounded the loudest? Softest? Highest? Lowest? In your observations.

DESIGN A MUSICAL INSTRUMENT

Throughout this lesson you have learned about the principles of sound, how sound waves move through various mediums, and how frequency, tone and pitch play a role. Now it's time to use what you have learned to design a musical instrument that will play in at least two different pitches!

Step 1: Decide what type of instrument you would like to create. Draw a sketch of it below.

Step 2: Determine what materials you will need to make your instrument. Think about how you can adapt or change materials to change pitch through length, mass, volume, etc. Use materials from home such as cans, cups, tubes, paper, plastic, metal, rubberbands, tape, combs, balloons, hangers, yarn, string, floss, bottles, dowel rods, rulers, boxes, straws, etc. Write the materials you will use below.

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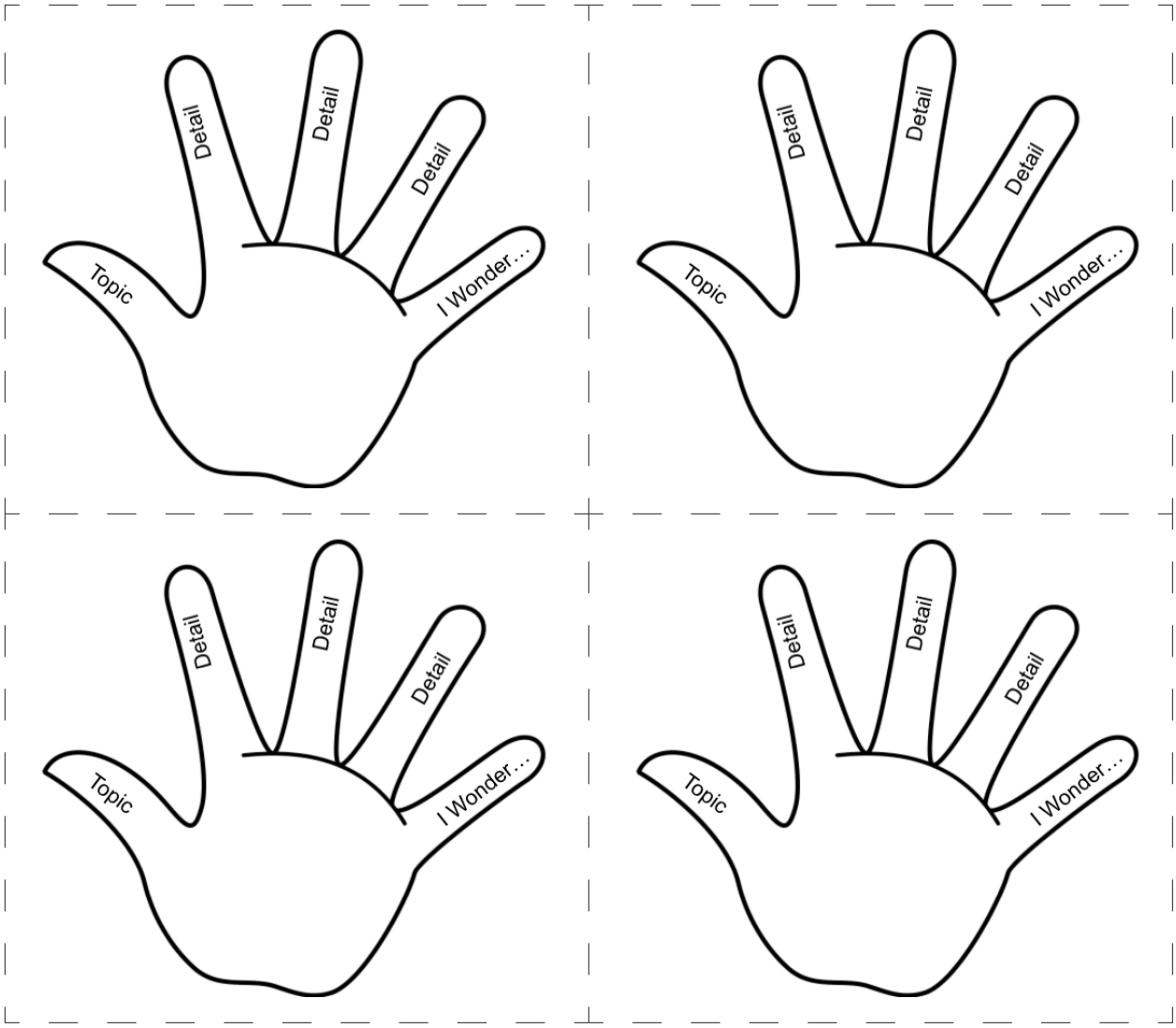
FIVE FINGER SUMMARY



HOME CONNECTIONS

Parent/Guardian Background Information:

The basis for an understanding of sound, music, and hearing is the physics of waves. Sound travels as waves of vibration. The vibrations bump into tiny air molecules that bump into more tiny air molecules close by continuing a wave traveling to the eardrum, which also vibrates! The sound produced is different depending on how big the wave is, how fast the vibration is moving and the medium it is traveling through. Shhhh, shorter waves, have less energy and create a softer sound. BOOM! Big waves have more energy and create louder sounds. When we hear a high pitched squeak or squeal, the vibrations are fast. Low pitched sounds like the sound that comes out of a bass have slower moving vibrations. This week, young scientists have been experimenting with the everyday science of sound. They learned how sound travels, what causes the changes in pitch and they designed their own musical instrument! Select one of the following tasks to complete together with your child to help reinforce and apply their understanding of science concepts:

- Ask your young scientist about the instrument they created in class today. How did they design it? What other instruments can we build as a family to create our own family band? Design and build one or more instruments to add to the one that was created in class. Make music or sound with the instruments and ask your young scientist to explain how you are able to hear sounds. Discuss the pitch. How can we make the sound higher or lower? How can we make the sound louder or softer?
- Next time you go to the doctor, ask about the stethoscope. Stethoscopes work by enhancing the sounds made within the human body and transmitting those sounds to the listener's ear. Research how the stethoscope works and how it is helpful to hear the sounds made in your body. Maybe your doctor will let you listen to your own heartbeat!

HOME CONNECTIONS