Students will engage in developing an understanding of how sound interacts with various materials and objects.

Student Science Performance

Grade or course: Fourth Grade	**Title:**
Topic: Light and Sound	Do you see what I see? Can you hear me now?

Performance Expectation for GSE:

S4P1. Obtain, evaluate, and communicate information about the nature of light and how light interacts with objects.

a. Plan and carry out investigations to observe and record how light interacts with various materials to classify them as opaque, transparent, or translucent.
b. Plan and carry out investigations to describe the path light travels from a light source to a mirror and how it is reflected by the mirror using different angles.
c. Plan and carry out an investigation utilizing everyday materials to explore examples of when light is refracted.
(*Clarification statement:* Everyday materials could include prisms, eyeglasses, and a glass of water.)

S4P2. Obtain, evaluate, and communicate information about how sound is produced and changed and how sound and/or light can be used to communicate.

a. Plan and carry out an investigation utilizing everyday objects to produce sound and predict the effects of changing the strength or speed of vibrations.
b. Design and construct a device to communicate across a distance using light and/or sound.

Performance Expectations for Instruction:

Students will

- Use the words transparent, translucent, and opaque as they work with dissolving candies, investigate other examples, and learn about cloud formations.
- Investigate and share instances of refraction and reflection.
- Become aware that all visible things are seen because of reflected light.
- Use mirrors to investigate reflection and how changing the angle of reflection can change what is seen.
- Investigate how sound changes if the vibrations are faster or slower-- pitch.
- Investigate how sound changes if the vibrations are more or less forceful-- amplitude.
- Make a string telephone using common materials.
- Design a way to communicate across a noisy playground or cafeteria.

Additional notes on student supports

Materials

Gumballs: candy such as gumballs that dissolve in water, water, clear bowls or cups, printed page
Refraction of Light: clear cups, liquid such as water, coin, preform bottle or cylinder jar such as an olive jar with tight fitting lid, pencil
Mirrors: mirrors, tape, small objects such as teddy bear counters
String telephone: various size and type of cups, various size cans and/or containers, various types of string, paper clips, tape

Students will continuously obtain, evaluate, and communicate information. This is not a linear process. Students will communicate through writing and discussions to allow for formative assessment. This benefits the teacher, student, and whole group to guide instruction to clarify misconceptions or extend content.

Engaging Learners	**Phenomenon:** Gazing at Earth's Light Show Video of light shows like these always have astronauts gazing back down at Earth. Time-lapse imagery captured on June 25, 2017, by Expedition 52. Show the picture Light Language. Have students discuss if they can find examples of the terms listed at the bottom of the page. This can serve as a formative assessment to see what the students already understand. Explain that this segment will use language such as this in the study of light and that it is okay if they don't know the words yet.
Exploring	*Obtaining* Gumballs is an activity to give students an example of transparent, translucent, and opaque in liquid. Have them ask questions about what would change the results of the experiment such as temperature of water, other liquids, other candies, size of container, time for water to evaporate, etc. Allow them to plan and carry out an investigation collecting and analyzing their findings to share the results with the class. Have students work in groups to find other materials that they can investigate to show the qualities of transparent, translucent, and/or opaque.
Explaining	Link their understanding of the terms to cloud formations. Water vapor is sometimes so fine that we can see through the tiny droplets clearly. Fog or steam is translucent. Some clouds block light completely and are opaque.
Elaborating	When light is bent as it goes through liquids and such, we call it refraction. Refraction is explained and explored in the Stars, Moon, and Planets Instructional segment (Refraction of Light) and includes some ideas students can use to investigate refraction. Have students research to find other ways of bending light by using prisms, investigating rainbows, etc. Have them present their investigations to the class to show ways that bending of light can trick the eye.
Exploring	Explain that when light does not go through a material, it reflects back to your eye so you can see it. If there is no light to reflect off the object, you cannot see it. Give them a list of common materials and ask them if they reflect light to see if they understand this concept. Tell them that some materials reflect light differently than others. Shiny smooth surfaces, such as mirrors reflect images clearly, but we can see the gray moon shining in the night sky because it is reflecting light. Mirrors are good reflectors of light. Have students work with mirrors to discover how the image is reflected. ● Let them find words or numbers that look the same in the mirror as they do on the printed page. ● See if they can find symmetry in letters by putting the mirror in the middle of a large block printed letter horizontally, diagonally, and vertically.

	Hinged mirrors: Tape one edge of two mirrors together while leaving a small space between for manipulating the mirror to make a hinged mirror. Have students plan and conduct investigations using the hinged mirrors to see how the angle of reflection changes the number of images they see. (*Set a small object in view of the hinged mirrors and see what happens to the reflection as the angle changes.*) How many objects do they see reflected in the mirrors at different angles?
Evaluating	Show the picture Light Language. Have students note how their understanding of this language has changed. Ask them to look around the room to point out examples of these words and write about what they now know.
Engaging Learners	**Phenomenon** Connecting to the year-long theme: ● Eerie Sounds from Space Eerie Sounds from Space Why do sounds seem different in space than on earth? ● HAM It Up Radio How do astronauts communicate in space? Lesson plans for making a communication device: Using two cups, a string, and two paper clips, students produce a device in which they can communicate across the room.
	Obtaining Students will discover that they can communicate with a "string telephone" using materials listed above. Allow ample time for students to determine a way to communicate. It is strongly encouraged to NOT tell the students they are making a string telephone; students should discover this for themselves.
	Evaluating How does the string telephone work? Students will attempt to explain how they can hear through the strings by making a model of how the system works. At this point, there may be discrepancies in their ability to explain, so only formative assessments are made by teacher to inform classroom experiences.
	Communicating Students will share initial models of how the string telephone works. Teacher will lead a discussion of similarities and differences of models; however, a "correct" model is identified at this time as students will do more exploring.
Exploring	*Obtaining* ● What factors affect how the string telephone works? How so? Students will design and conduct an experiment related to string telephones. They will determine a factor to investigate; plan the procedure and data collection method and investigate in cooperative groups. Investigating with String Telephones ● Provide several sound experiences in a station format for students to investigate. Examples may include, but not limited to: tuning forks struck and placed in water, rice on top of plastic wrap placed over a bowl and a speaker with music placed nearby, rulers placed at various lengths over edge of table and struck with a force, hand over throat while speaking)

	Communicating ● Using the "Scientific Poster Layout" outlined on the investigation page, students will visually record and verbally present their findings. ● Recording in student journal or lab recording page for each station. Questions such as: What made the sound? What did it sound like? What did you see the object doing? will be asked at each station.
	Evaluating ● Evaluate students on multiple components recorded on the scientific poster and during the process. Teachers will collect observational data regarding the practices students are engaging in during the process, as well as the final presentation of findings. ● Have students complete probing questions and discussion of learning.
	Formative Assessment of Student Learning
Explaining Finalizing Model	*Obtaining* Provide multiple readings, videos, and resources about sound over several days to connect experiences in the explore phase with the scientific explanation. The resources should connect the experiences to the core content desired: speed of vibrations and sound changes.
	Evaluating Are students beginning to connect their experiences to the content? Provide time for students to revise and explain their initial models of how the string telephone works. Give students another opportunity to explain sound by explaining another experience regarding sound production.
	Communicating Teacher will lead a discussion on updated student models. Students will share their models and discuss similarities and differences of models. Challenges: Can you devise a way to make a "party line" where more than two people can hear the conversation? Are some materials (composition of cup, type of string, etc.) better than others? How far does your device work?
Elaborating Applying Model to Solve a Problems	**Phenomenon** How do astronauts communicate in space? Do they communicate differently in the space station or shuttle than they do on space walks? How does this differ from our communication on earth? How can we improve communication?
	Obtaining Students use various sources to investigate space communication. Communicating in Space Students will use information gained in their research to develop a way to improve communication in space. Refer back to HAM it up radio. AND/OR Students will design a device or system to communicate using light or sound across a noisy playground or cafeteria. These designs can include sketches or actual prototypes based on knowledge.
	Evaluating Student completion of design using accurate sound and light information.
	Communicating Students will share their designs and receive feedback from peers.

Evaluation	***Assessment of Student Learning***
	Student instructions: Your task is to develop and use a conceptual model to explain how sound can move from one end of the "telephone" to the other and then provide a written explanation for how energy is "moved" within the system. Follow the criteria below. Using all of the evidence obtained from a variety of sources (e.g., investigations, readings, class discussions) develop a model to explain how sound travels, students will: • draw and label the model components (parts), interactions among components in the string telephone system (how the parts work together), and mechanisms in the model (how energy is used for sound to "move"), • write a causal explanation for the phenomena (why does the string telephone work?), using the model as supporting evidence.
SEP, CCC, DCI	**Science Essentials**
Science and Engineering Practices	• Planning and carrying out investigations • Designing solutions • Obtaining, evaluating, and communicating information
Crosscutting Concepts	• Energy and Matter
Disciplinary Core Ideas	From *A Framework for K-12 Science Education:* • PS3.B: CONSERVATION OF ENERGY AND ENERGY TRANSFER • PS4.B: ELECTROMAGNETIC RADIATION • ETS1.B: DEVELOPING POSSIBLE SOLUTIONS

Additional Supports for struggling learners:

The following supports are suggestions for this lesson and are not the only options to support students in the classroom. These supports target students that struggle with science material, this lesson or a previous lesson. These are generalized supports and do not take the place of IEP accommodations as required by each student's Individualized Education Program.

General supports for the following categories:

Reading:	Writing:	Math:
1. The teacher can have students match letters prior to reading to remind them of the alphabet. 2. The teacher can have students identify words that they know in the text as the class reads. 3. The teacher should remind students to use strategies when they are reading.	1. The teacher can provide practice for students in the area of writing both in context and practicing just letters. 2. The teacher can provide a sentence starter for the students. 3. The teacher should continually give encouragement to the students. 4. The teacher can provide constructive positive feedback during the writing process to help students understand the expectations.	1. Provide students with opportunities to interact with numbers. 2. The teacher can provide manipulatives to allow the students to count and interact with materials.

Supports for this specific lesson if needed:

Performance expectations for instruction:

1. The teacher should provide information to students in various formats to reach as many students as possible.
2. The students should be given adequate time to complete each part of the lesson.
3. The students should be allowed to express their knowledge in various formats.
4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material.

Engage:

1. The teacher should consider showing the video more than once to allow students to make observations of the light shows.
2. The teacher should consider providing students with the image to make observations quietly at first and then discuss as a group.

3. The teacher should emphasize that students may not know the answers yet but that they should at least be making observations of things that they are seeing in the image.

Exploring:

1. The teacher should be prepared to repeat directions as needed.
2. The teacher should use intentional and flexible grouping to group students. Best practice is to use data to drive student groupings.
3. The teacher should consider providing students with an organizer to plan and carry out their investigation.
4. The teacher should consider using guiding questions to assist students in determining what the students can investigate.

Explaining:

1. The teacher should consider having students observe liquids that are opaque and liquids that are translucent.

Elaborating:

1. The teacher should consider providing students with sources to find information about bending light using prisms.
2. The teacher should consider using guiding questions to assist students with finding information about light bending.

Exploring:

1. The teacher should consider a formative assessment. This should help the teacher identify students that need review, re-teaching or enriching.
2. The teacher should have clear and consistent guidelines for working with mirrors. These guidelines are should assist students in feeling confident in using the mirrors and promote safety for all students in the class.

Evaluating:

1. Students may need additional time to complete their assignment.
2. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include labeling images, drawing pictures, writing or verbally explaining.

Engaging:

1. The teacher should consider having students listen to the recording more than once as needed to make observations.
2. The teacher should consider assisting students in accessing the material in the article by facilitating a read aloud, utilizing text-to-speech or showing a video.
3. The teacher should be prepared to repeat directions as needed.
4. The teacher should use intentional and flexible grouping to group students. Best practice is to use data to drive student groupings.
5. The teacher should consider showing students the materials that they may use to build their phones prior to students beginning to plan.
6. The teacher should consider providing students with sentence starters to help students start writing assignments.
7. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include labeling images, drawing pictures, writing or verbally explaining.

8. The teacher should provide students with multiple formats to share their work. These formats could include using technology, gallery walks or presentations.
9. Students may need additional time to complete the assignments.

Exploring:

1. The teacher should use intentional and flexible grouping to group students. Best practice is to use data to drive student groupings.
2. The teacher should ensure that students have ample time at each station.
3. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include labeling images, drawing pictures, writing or verbally explaining.
4. The teacher should provide students with multiple formats to share their work. These formats could include using technology, gallery walks or presentations.
5. The teacher should consider a formative assessment that can determine which students need reviewing, re-teaching or enriching.

Explaining:

1. Give students a few options of sounds for them to choose from as options for their explanation.
2. Students may need additional time to complete their explanation.
3. The teacher should provide students with multiple formats to share their work. These formats could include using technology, gallery walks or presentations.
4. The teacher should consider using the challenge as an enrichment for students that complete the first task early.

Elaborating:

1. The teacher should consider providing sources for students to use in their research.
2. The teacher should assist students in accessing the material in the article by facilitating a read aloud, utilizing text-to-speech or showing a video.
3. The teacher should consider providing students with an organizer to record their research.
4. The teacher should have clear and consistent guidelines for students to provide feedback to one another. These guidelines should assist students in providing respectful, constructive and useful feedback.
5. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include labeling images, drawing pictures, writing or verbally explaining.
6. The teacher should provide students with multiple formats to share their work. These formats could include using technology, gallery walks or presentations.

Evaluating:

1. Students may need additional time to complete their assignment.
2. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. This could include labeling images, drawing pictures, writing or verbally explaining.

Light Language

See if you can find examples of these words in this picture: light, opaque, translucent, transparent, reflection, refraction.

Return to Instructional Segment

Gumballs

Put the clear container of water over a piece of paper with print on it.

Put a gumball in the water.

No matter what color the water is, if you can read the print, it is transparent water!

Let it sit until the print becomes blurred or fuzzy. If you cannot see the print clearly, the water is becoming translucent because the gumball is dissolving.

Eventually the dissolved particles will block the print and the water becomes opaque.

Return to Instructional Segment

Refraction of Light

Light rays usually travel in straight lines, but when they pass from one material to another they can be forced to bend (change direction and continue on a new straight path). The bending is called refraction. It happens because light travels at different speeds in different materials. If light rays travel through air and enter a denser material, such as water, they slow down and bend into the denser material. Light rays moving into a less dense material, such as from water to air, speed up and bend outwards. Light rays bend or refract if they enter a glass block at an angle. When they pass from air into glass, they bend inwards and slow down. They travel in a straight line through the glass at an angle to their original direction. As they pass out from the glass into air, they bend outwards and speed up again.

Disappearing Coin Trick

In this experiment we will make a coin disappear. For this simple trick you will need two transparent glasses and two coins. First place a coin on the table and place the first glass on its top. Place the other coin inside the second glass. Now start pouring water in the first glass and you'll see the coin actually disappears. Now pour water in the second glass with the coin sitting. In the second case you will still be able to see the coin. In both cases you have to observe from the sides of the glass and not from its top. Why does the coin in the first glass disappear? This is because of refraction of light. In the first case when the coin is under the glass, the light has to go from air to the glass and then inside the water because the coin is under the glass. Because of the refractive index of air is much less than that of glass, the light completely bends around the coin and so you cannot see it. In the second case the light does not bend so much and you are able to see the coin. This is the science behind this disappearing coin trick.

Magnify with a bubble in a tube of water.

Use a small thin jar (such as a preform bottle or an olive jar) with a tight-fitting lid. Fill the jar almost full of water leaving a small space of air at the top. Put the lid on tightly so there are no leaks. Turn the bottle on its side and put it over a sheet of printed paper. When you look through the water portion at a printed page, the words appear larger. If you look through the air bubble portion of the jar, the words appear smaller. The different shapes the light travels through cause the differences in how we see the words.

Pencil in a Glass

Pour water into a clear cup. Place a pencil in the water and look through the side of the cup. The pencil looks bent because the light travels through the liquid differently than through the air above the water. Try other liquids to see the difference.

Return to Instructional Segment

Can you hear me now?

Exploring Sound Through String Telephones

To improve our model of how the string telephone works, we need to understand the factors that affect how sound travels. Before we plan and carry out our own investigation, you need to know what materials are available.

Materials:

- Various types and sizes of cups, cans, containers
- Various string, light rope, yarn, and fishing line
- Paper clips
- Tape

Planning Your Investigation:

- Which factor do you think is most important in sound production? What does the string do? What do the cups do?

  _____

- If you were going to design an experiment around how sound is produced, what materials would you need from our list of classroom materials? Are there other materials you need?

  _____

  _____

- Using your selected materials, what will you change in order to see if and how it affects the type or quality of sound produced?

  _____

  _____

- What will you observe or measure to explain if changing one element of the string telephone affects how the device works?

  _____

  _____

- Hypothesis:
  If we _____,

  then we will observe _____,
  because _____.

Data Collection & Analysis:

Before you begin your investigation:

1. Think about what you are changing in your experiment.
    - How many times will you change that factor?
    - How will you measure or explain what happens?
    - In what order will you test the changes?
    - How will you record those changes?
2. Determine a way to collect your data. Will you create a table? Draw a sketch here.

3. Record your plan below or in your journal and review it with your group.

4. Get your plan approved by your teacher.

During your investigation:

1. Record your observations on paper using the format you created during planning.
2. As you make observations, you may develop more questions about sound. Record those in your science journal to be investigated later. Stick with your current investigation plan!

After your investigation:

1. Discuss with your group, what did you learn from your investigation?

2. Review your hypothesis. Does your data support your hypothesis? How do you know?

3. Do you now have other questions about how sound travels?

4. How could you plan and carry out another investigation?

Presenting Your Findings:

You will create a scientific poster to share your procedure and the findings from your investigation. Follow the poster layout below, and be sure to:

- Identify which factor you are investigating in your question,
- Present your hypothesis in the proper format,
- Attach your completed data sheet to your poster,
- Write in or attach your data analysis,
- Write your conclusion following the Claim, Evidence, Reasoning format.
- List any new questions your group has after completing your investigation.

Be prepared to share your poster with other members of the class.

<table>
<tr><td colspan="3">Question: How does _____ affect sound through a string telephone?</td></tr>
<tr><td>Hypothesis:
If _____,
then _____,
because _____.</td><td>Observations:
(attach data sheet here)
(format will vary from group to group)</td><td>Analysis:
What did you discover?
(if you have an analysis chart attach it here)</td></tr>
<tr><td colspan="2">Conclusion:
Claim: Hypothesis supported or not? If not, what is your new explanation?

Evidence:(What happened? Summarize your evidence and analysis.)

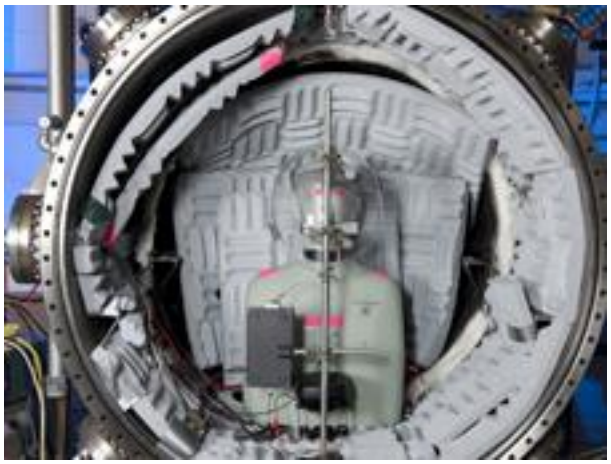
Reasoning: (How does your evidence support your explanation (claim)?</td><td>New Questions:</td></tr>
</table>

Return to Instructional Segment

Communicating in Space

When astronauts venture outside of a spaceship or the International Space Station, they must wear protective space suits to keep them safe from the harsh environment of space. While inside these pressurized suits, it's essential that they remain in constant communication with the rest of the crew in space as well as Mission Control Center on Earth.

While wearing the current space suits, astronauts wear a Communications Carrier Assembly (CCA), or "Snoopy Cap" — a fabric hat fitted with microphones in the ear area for listening and boom microphones in front of the mouth for speaking. These caps are worn under the helmet and visor that surround an astronaut's head.



A new Integrated Audio system, which enables astronauts to communicate in space, is being tested at NASA's Glenn Research Center in Cleveland in a test rig. NASA is in the process of completely redesigning their space suits, with the goal of creating a brand-new space suit to be used starting in 2020. Redesigned and reinvented communications equipment will be an important facet of the new suit. When astronauts venture outside of a spaceship or the International Space Station, they must wear protective space suits to keep them safe from the harsh environment of space. While inside these pressurized suits, it's essential that they remain in constant communication with the rest of the crew in space as well as Mission Control Center on Earth.

Tori Woods, SGT Inc.

NASA's Glenn Research Center

Return to Instructional Segment