

Standard

CT – 5.1a – Sound and light are forms of energy.

MA – Physical Sciences Gr.3-5, #4 & #11

Ride the Wave

Connecticut

Science

Center



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Updated September 2010



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CT Science Standard 5.1a- Sound

Sound and light are forms of energy.

Summary

This program provides you and your students with pre visit, visit and post visit materials related to the topic of sound. During your visit, your students will enjoy opportunities to make observations, raise questions, and learn more about sound energy in one of our Discovery Center classrooms.

In addition, your students will explore the Sight and Sound Experience Gallery. For their gallery visit, your students will be provided with Trail Guides that will help them make observations, predictions, and raise further questions about specific exhibits within the galleries that are related to sound energy.

Also included in this program are lessons that provide interdisciplinary connections, as well as additional resources such as websites, literature links, career information, home and school connections, and related videos.

This unit has been developed to complement some of the core themes, content standards and expected performances of the CT Core Science Frameworks, as well as the National Science Education Standards. It is a supplemental series of "hands-on" investigations that are inquiry-based and designed to engage students as well as to enhance and build upon their prior content knowledge. It may be integrated with other subjects or it may be taught in its entirety within the science classroom.

The complete CT Core Science Curriculum Frameworks is available at the website http://www.sde.ct.gov/sde/lib/sde/pdf/curriculum/science/PK8_sciencecurriculumstandards2009.pdf. See also: American Association for the Advancement of Science, *Atlas of Science Literacy*, Project 2061. In addition, Grade Level Content Standards were released in June, 2007, to "unpack" the science content for grades K-5. Content standard 5.1 has been broken into discrete concepts for light and for sound. This packet will focus exclusively on sound. The original science frameworks were designed to give teachers an idea of what students *should know*. Grade Level Expectations were added in July, 2008, to further "unpack" the science concepts to give an idea of what students *should be able to do*. This gives teachers an idea of what sorts of activities are appropriate to do with students, and even some ideas as to what sorts of questions can reasonably be expected to appear on the CMT.

Following are the specific sections from the CT Core Science Curriculum Framework that are addressed in this unit. The B INQ information reflects the process skills intended for grades 3-5 specifically representing the content standards of scientific inquiry, literacy, and numeracy.

Inquiry Standards

Grades 3-5 Core Scientific Inquiry, Literacy and Numeracy	
Content Standards	Expected Performances
<p>SCIENTIFIC INQUIRY</p> <ul style="list-style-type: none"> ◆ Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena. <p>SCIENTIFIC LITERACY</p> <ul style="list-style-type: none"> ◆ Scientific literacy includes speaking, listening, presenting, interpreting, reading and writing about science. <p>SCIENTIFIC NUMERACY</p> <ul style="list-style-type: none"> ◆ Mathematics provides useful tools for the description, analysis and presentation of scientific data and ideas. 	<p>B INQ.1 Make observations and ask questions about objects, organisms and the environment.</p> <p>B INQ.2 Seek relevant information in books, magazines and electronic media.</p> <p>B INQ.3 Design and conduct simple investigations.</p> <p>B INQ.4 Employ simple equipment and measuring tools to gather data and extend the senses.</p> <p>B INQ.5 Use data to construct reasonable explanations.</p> <p>B INQ.6 Analyze, critique and communicate investigations using words, graphs and drawings.</p> <p>B INQ.7 Read and write a variety of science-related fiction and nonfiction texts.</p> <p>B INQ.8 Search the Web and locate relevant science information.</p> <p>B INQ.9 Use measurement tools and standard units (e.g., centimeters, meters, grams, kilograms) to describe objects and materials.</p> <p>B INQ.10 Use mathematics to analyze, interpret and present data.</p>

CT Science Standards, Grade Level Concepts & Expectations, & CMT Correlation

<i>Energy Transfer and Transformations -What is the role of energy in our world?</i>			
GRADE 5			
5.1 — Sound and light are forms of energy.			
Core Science Curriculum Framework	Underlying Concepts <i>Students should understand that...</i>	Grade-Level Expectations <i>Students should be able to...</i>	CMT Expected Performances
<p>5.1.a. Sound is a form of energy that is produced by the vibration of objects and is transmitted by the vibration of air and objects.</p>	<p>GRADE-LEVEL CONCEPT 5.1.a.</p> <ol style="list-style-type: none"> 1. There are a variety of sounds in our environment. Sounds have characteristics, such as loudness, pitch and quality (or “timbre”), that allow them to be identified. 2. For sound to occur, there must be a vibrating object, a material through which the vibrations are transferred (for example, air or water), and a receiver (for example, an ear) to perceive the sound. 3. Objects can be caused to vibrate by actions such as striking, strumming, bowing, plucking or blowing. 4. Sounds can vary in loudness (“volume”). Volume is affected by the strength of the force causing the vibration. For example, striking a drum forcefully or gently produces sounds with different volumes. 5. Sounds can have a high or low tone (“pitch”). The pitch of a sound depends on the speed of the vibration. Objects that vibrate quickly have a high pitch, while those that vibrate slowly have a low pitch. 6. Pitch is affected by characteristics such as the shape, length, tension or thickness of the vibrating material (for example, the vibrating material may be a string, a glass, a wire or a drum). 7. Sound travels (is “transmitted”) through materials by causing them to vibrate. Sound is not transmitted if there are no materials to vibrate. Solids, liquids and gases (air) transmit sound differently. 8. Sounds can be reflected or absorbed, depending on the properties of the material it hits. Sound tends to bounce off smooth, hard surfaces, producing an echo; sound tends to be absorbed by soft, porous surfaces, producing a muffled sound. 	<ol style="list-style-type: none"> 1. Generalize that vibrating objects produce sound if the vibrations are transferred from the object through another material (e.g., air, a solid, or a liquid). 2. Demonstrate how the loudness, pitch and quality/timbre of sound can be varied. 3. Design and conduct investigations to determine factors that affect pitch. 4. Describe the properties of materials that reflect or absorb sound. 5. Analyze properties of materials that cause sound to be reflected or absorbed, then apply findings to design a device that reflects or absorbs sound. 6. Construct simple musical instruments (e.g., rubber band guitars, drums, etc.) that produce sounds with various pitches, volume and timbres. 7. Provide evidence that light travels in straight lines away from a source in all directions. 8. Investigate how light is refracted as it passes through a lens or through one transparent material to another. 9. Demonstrate that white light is composed of many colors. 10. Explain that all visible 	<p>B17. Describe the factors that affect the pitch and loudness of sound produced by vibrating objects.</p> <p>B18. Describe how sound is transmitted, reflected and/or absorbed by different materials.</p> <p>B19. Describe how light is absorbed and/or reflected by different surfaces.</p>
<p>5.1.b. Light is a form of energy that travels in a straight line and can be reflected by a mirror, refracted by a lens, or absorbed by objects.</p>	<p>GRADE-LEVEL CONCEPT 5.1.b.</p> <ol style="list-style-type: none"> 1. Light travels in straight paths away from a source of illumination in all directions until it hits an object. Some sources of illumination produce their own light (for example, the sun, fire, light bulb); other sources of illumination reflect light produced by something else (for example, the moon or a mirror). 2. Light interacts with objects in various ways; it can be reflected off the object, absorbed by the object, or refracted through the object. 3. Materials can be classified based on how much light passes through them. Transparent materials allow most light to pass through them. Translucent materials allow some light to pass through them. Opaque materials do not allow any light to pass through them. 	<ol style="list-style-type: none"> 7. Provide evidence that light travels in straight lines away from a source in all directions. 8. Investigate how light is refracted as it passes through a lens or through one transparent material to another. 9. Demonstrate that white light is composed of many colors. 10. Explain that all visible 	

CT Science Standard 5.1a- Sound

Sound and light are forms of energy.

	<p>4. Objects that have flat, smooth surfaces reflect light and produce a mirror-like image. Objects that have curved or uneven surfaces scatter the reflected light and produce distorted or blurry images.</p> <p>5. Light always reflects away from a mirror at the same angle that it hits the mirror. The angle of incoming light equals the angle of reflected light.</p> <p>6. Objects that block light traveling from a source produce shadows. The shape, length, direction and clarity of a shadow depend on the shape and position of the object.</p> <p>7. Light changes direction (“refracts”) as it passes from one transparent material to another (for example, as it passes from air to water or through lenses).</p> <p>SCIENTIFIC LITERACY TERMINOLOGY: reflect, absorb, refract, transparent, translucent, opaque, angle, vibration, transfer, volume, pitch, transmit, reflect, absorb</p>	<p>objects are reflecting some light to the human eye.</p> <p>11. Contrast the way light is reflected by a smooth, shiny object (e.g., mirror or pool of water) and how light is reflected by other objects.</p> <p>12. Measure angles to predict the path of light reflected by a mirror.</p> <p>13. Determine whether a material is opaque, transparent or translucent based on how light passes through it.</p> <p>14. Design and conduct light absorption experiments that vary the size, length, direction and clarity of a shadow by changing the position of the light-blocking object or the light source.</p>	
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Massachusetts Learning Standards

Physical Sciences

Grades 3-5

4. Identify the basic forms of energy (light, sound, heat, electrical, and magnetic). Recognize that energy is the ability to cause motion or create change.

11. Recognize that sound is produced by vibrating objects and requires a medium through which to travel. Relate the rate of vibration to the pitch of the sound.

Safety Standards:

- Review expectations for appropriate behavior, handling of materials, and cooperative group procedures to be sure those activities are accessible and safe for all students prior to beginning these investigations.
- Make any necessary student modifications.
- Monitor students to be sure they are acting appropriately, handling materials accordingly, and working cooperatively especially when working with the glass bottles and striking objects to make sounds
- For more comprehensive information on science safety, consult the following guidelines from the Council of State Science Supervisors: http://www.csss-science.org/downloads/scisaf_cal.pdf or http://www.sde.ct.gov/sde/lib/sde/pdf/curriculum/science/safety/scisaf_cal.pdf

Misconceptions and Facts

Misconceptions	Facts
Some students believe that loudness and pitch of sounds are the same thing.	Pitch is different from loudness; pitch refers to frequency while loudness refers to amplitude.
Some students think you can see and hear a distant event at the same moment.	Light travels faster than sound. Light travels at 3×10^8 m/s (186,000 mi/sec) while sound travels at ~ 330 m/s (1,000 ft/sec) in air at a temperature of 25°C.
Hitting an object harder changes its pitch.	Hitting an object harder changes its loudness. A chime struck softly plays the same note as a chime struck harder (which merely rings louder).
In a telephone, actual sounds are carried through the wire (much like the tin can and string version of "telephone").	Sounds are converted to electrical signals in the mouthpiece of a phone and back to sounds by the speaker in the earpiece of a phone.
Sound moves faster in air than in solids (air is "thinner" and forms less of a barrier).	Sound moves faster in solids because atoms and molecules are closer together to quickly pass along a vibration. Likewise, sound travels faster in a liquid than in a gas (air).
Sound moves <i>between</i> particles of matter (in empty space) rather than by collisions of adjacent particles of matter.	Sound requires a medium for it to be transmitted. There are no sounds in empty space (or in outer space). However, radio waves can be transmitted through space without a medium.
In wind instruments, the instrument itself vibrates not the internal air column.	The instrument itself may vibrate, but the majority of sound produced by a musical instrument comes from vibrating air. In wind instruments, it would be the internal air column. In string instruments, it is the air inside the cavity.
As waves move, matter moves along with them.	A wave transmits energy only. Matter (particles) vibrate back and forth but do not move along in one direction.
The pitch of whistles or sirens on moving vehicles is changed by the driver as the vehicle passes (or ambulances have different sirens facing forward and backward).	The Doppler effect describes sound waves in a source moving toward an observer as "bunching up" and thus sounding as if they're at a higher frequency. Likewise sound waves coming from a source moving away from an observer will "spread apart" and thus sound as if they're at a lower frequency.
The pitch of a tuning fork will change as it "slows down", (i.e. "runs" out of energy)	The tuning fork is so named because it provides just one pitch or vibrational frequency. The length of the fork tines determines the frequency of vibration. The amplitude (loudness) will change as the tuning fork "runs out" of energy.

Source of list of misconceptions: <http://amasci.com/miscon/opphys.html> in conjunction with Operation Physics American Institute of Physics 1825 Connecticut Ave. NW, Suite 213 Washington, DC 20009 (202) 232-6688 <http://www.aip.org>

Additional research about misconceptions was found at:
<http://www.project2061.org/publications/bsl/online/ch15/findings.htm#Ch5>

Pre-Visit Activity

The visit to the CT Science Center begins in your classroom with the pre-visit activities. Please consider these activities as a prerequisite to prepare your students for the actual visit. We encourage all teachers who bring their students to the CT Science Center to do these pre and post activities and plan to provide follow up assessments and activities which integrate your visit into a meaningful unit of study.

INTRODUCTION

Students explore the production and transmission of sound. Working in groups, the students will explore materials following the directions on the task card at each of two stations. The students will record what they notice and wonder after exploring each station. After exploring, the students will share their discoveries.

PURPOSE

- Students will identify sound as a form of energy.
- Students will observe the characteristics of sound (loudness, pitch, quality/ timbre).
- Students will categorize sounds by how they are produced (striking, strumming, bowing, plucking or blowing).

SCIENCE CONCEPTS

- Sound is a form of energy.
- Sound is created by vibrations.
- For sound to occur, there must be a vibrating object, a material through which the vibrations are transferred (air, water, wood, metal, etc.) and a receiver (ear, etc.) to perceive the sound.

PRE-ASSESSMENT

Have the children write a response to the following prompts:

1. What is sound?
2. How are different sounds created?
3. What are the characteristics of sound?

**Following your pre-visit activities, classroom activities, and post-visit activities, have the students answer the same prompt to assess their learning.

CT Science Standard 5.1a- Sound
Sound and light are forms of energy.

The following highlighted GLCs and GLEs are covered in this section:

<i>Energy Transfer and Transformations -What is the role of energy in our world?</i>			
GRADE 5			
5.1 — Sound and light are forms of energy.			
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<p>5.1.b. Light is a form of energy that travels in a straight line and can be reflected by a mirror, refracted by a lens, or absorbed by objects.</p>	<p>GRADE-LEVEL CONCEPT 5.1.b.</p> <ol style="list-style-type: none"> Light travels in straight paths away from a source of illumination in all directions until it hits an object. Some sources of illumination produce their own light (for example, the sun, fire, light bulb); other sources of illumination reflect light produced by something else (for example, the moon or a mirror). Light interacts with objects in various ways; it can be reflected off the object, absorbed by the object, or refracted through the object. Materials can be classified based on how much light passes through them. Transparent materials allow most light to pass through them. Translucent materials allow some light to pass 	<ol style="list-style-type: none"> Investigate how light is refracted as it passes through a lens or through one transparent material to another. Demonstrate that white light is composed of many colors. Explain that all visible objects are reflecting some light to the human 	

CT Science Standard 5.1a- Sound

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	<p>through them. Opaque materials do not allow any light to pass through them.</p> <p>4. Objects that have flat, smooth surfaces reflect light and produce a mirror-like image. Objects that have curved or uneven surfaces scatter the reflected light and produce distorted or blurry images.</p> <p>5. Light always reflects away from a mirror at the same angle that it hits the mirror. The angle of incoming light equals the angle of reflected light.</p> <p>6. Objects that block light traveling from a source produce shadows. The shape, length, direction and clarity of a shadow depend on the shape and position of the object.</p> <p>7. Light changes direction (“refracts”) as it passes from one transparent material to another (for example, as it passes from air to water or through lenses).</p> <p>SCIENTIFIC LITERACY TERMINOLOGY: reflect, absorb, refract, transparent, translucent, opaque, angle, vibration, transfer, volume, pitch, transmit, reflect, absorb</p>	<p>eye.</p> <p>11. Contrast the way light is reflected by a smooth, shiny object (e.g., mirror or pool of water) and how light is reflected by other objects.</p> <p>12. Measure angles to predict the path of light reflected by a mirror.</p> <p>13. Determine whether a material is opaque, transparent or translucent based on how light passes through it.</p> <p>14. Design and conduct light absorption experiments that vary the size, length, direction and clarity of a shadow by changing the position of the light-blocking object or the light source.</p>	
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Drumming in the concept of sound

ACTIVITY SUMMARY

Students explore the characteristics of sound. Working in groups, the students will explore materials following the directions on the task card at three different stations. The students will record what they notice and wonder after exploring each station. After exploring, the students will share their discoveries.

If the students have already completed their study of Science Content Standard 5.1a/GLE 1, this activity will review some of the concepts they studied. If the students have not yet studied 5.1a/GLE 1, then this pre-visit activity will provide an overview of some of the concepts.

ACTIVITY PREPARATION

1. Determine the grouping of students (4 per station in pairs) based on a class of 24. If the class is larger than 24, you might want to set up additional materials at each station to accommodate additional teams of 2, or you may want some students to work in groups of 3.
2. Gather the materials.
3. Print four Task Cards for each station and a tent card with the station letter on it.
4. Prepare two of the "Station A" set-ups in one area of the classroom, two of the "Station B" set-ups in another area, and finally "Station C" in the other part of the room.

MATERIALS

Station A

(6) 100 ml graduated cylinders containing different amounts of colored water
1 pencil for each team of 2
Task Card A



Station B

Set of 8 Tuning Forks
Task Card B



Station C

6 Rubber bands (stretched to different lengths on the nails)
Peg board with nails



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ENGAGING ACTIVITY

1. Assign pairs of students to start at Station A, B or C.
2. Students should bring their science notebooks from station to station.
3. Instruct students to read the Task Card at each station before exploring the materials.
4. Students will be given 5 minutes to explore at each station.
5. When the 5 minutes are up, the students will be assigned a Quick Write at each station. Students will be given 2 minutes to write in their science notebooks what they noticed and wondered at each station.
6. When the 2 minute Quick Write is over, students will move as a team to the next station.
7. After each team of students has visited all stations (approximately 21 minutes), students will meet as a whole group to discuss their noticing and wonderings from each station.
8. Before beginning the discussion, ask students to reread their noticing and wonderings and select the ones they wish to share.
9. The teacher should chart the students' noticing and help the students to make meaning of their discoveries.

Below are examples of possible student noticings that might be charted. They are not the only noticings the students might have listed.

Station A

When you blow across the cylinders, the one with the lower water level makes a lower pitch and the one with the higher water level makes a higher pitch sound.

When you tap the cylinders with a pencil, the one with the lower water level makes a higher pitch sound than the one with more water.

When you tap the cylinder harder with the pencil, the sound is louder.

Possible Teacher Synthesis: From your observations, how can sounds be produced? (Objects can be caused to vibrate by actions such as striking or blowing.)

Station B

Different tuning forks of different sizes make different sounds. The pitch (high or low tone) that a particular tuning fork creates depends on the length of the two prongs. The shorter the tuning fork, the higher the pitch. The different tuning forks made a range of sounds.

Possible Teacher Synthesis: What factors affected the pitch of the sound?

Sounds can have a high or low pitch. The pitch of a sound depends on the speed of the vibration. Objects that vibrate quickly have a high pitch while those that vibrate slowly have a low pitch.

PRE-VISIT ACTIVITY CONCLUSION

Now that your students have completed the activity, give each student a 5x7" index cards or pieces of paper. Student will be asked to illustrate on one card or piece of paper one wondering about sound as a result of their exploration that they would like to see explored in future experiments. These cards could be displayed on a bulletin board and could be sorted into the following categories:

- Ways to produce sound
- Factors that affect loudness
- Factors that affect pitch

Task Card Station A

Use the measuring cup fill each of the cylinders with colored water.

- Try striking the top of each of the cylinders using a pencil.

What do you notice and wonder?

- Now try striking the side of the cylinders using the pencil.

What do you notice and wonder?

When you are done with your experiments, pour the water from the cylinders back into the measuring cup.

- Task Card
Station B

- Strike one of the tuning forks with a rubber mallet.
What do you notice and wonder?

- Now test the rest of the tuning forks by striking them
with the rubber mallet.

What do you notice and wonder?

Task Card Station C

- Choose a rubber band and place on the peg board. Strum the rubber band.

What do you notice and wonder?

- Choose a different size rubber band and place on the peg board. What happens when you strum this rubber band?

Record your observations.

- Are the sounds you hear different or similar? What factors affect the sounds of the rubber bands?

What do you notice and wonder?

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Connecticut Science Center Activity

The following highlighted GLCs and GLEs are covered in this section:

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Sound and light are forms of energy.

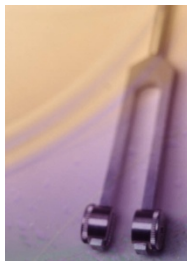
	<p>3. Materials can be classified based on how much light passes through them. Transparent materials allow most light to pass through them. Translucent materials allow some light to pass through them. Opaque materials do not allow any light to pass through them.</p> <p>4. Objects that have flat, smooth surfaces reflect light and produce a mirror-like image. Objects that have curved or uneven surfaces scatter the reflected light and produce distorted or blurry images.</p> <p>5. Light always reflects away from a mirror at the same angle that it hits the mirror. The angle of incoming light equals the angle of reflected light.</p> <p>6. Objects that block light traveling from a source produce shadows. The shape, length, direction and clarity of a shadow depend on the shape and position of the object.</p> <p>7. Light changes direction (“refracts”) as it passes from one transparent material to another (for example, as it passes from air to water or through lenses).</p> <p>SCIENTIFIC LITERACY TERMINOLOGY: reflect, absorb, refract, transparent, translucent, opaque, angle, vibration, transfer, volume, pitch, transmit, reflect, absorb</p>	<p>6. Measure angles to predict the path of light reflected by a mirror.</p> <p>7. Determine whether a material is opaque, transparent or translucent based on how light passes through it.</p> <p>8. Design and conduct light absorption experiments that vary the size, length, direction and clarity of a shadow by changing the position of the light-blocking object or the light source.</p>	
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The Science of Sound

Intro: (10 min) What is sound? How are you able to hear me speaking to you right now? How can I make things sound louder or softer? Write down your own definition of sound.

Student demo: As students finishing writing their definitions we call some to the front of the class to be part of a demonstration. Each student is handed a tuning fork. Students make a line in front of the class each holding various size tuning forks (in order of their decreasing frequencies). We show the students how tuning forks should be held and how they should be hit with a mallet. The teacher then hits all the tuning forks in the line in order and then goes back and hits them in reverse order. All the students in the class hear each frequency as it is hit. Ask them what they noticed and discuss why there are differences in the sound.

Today we will explore sound. We will visit different stations that will help you discover the different factors that affect sound. We will explore sound as a form of energy, work with vibration, learn how sound is produced, investigate pitch, and create a musical instrument that will help us understand sound.



Materials needed:

Station A- Tuning Forks In Water - tuning fork, mallet, cup of water, and an empty soup can (use tuning forks at 480 or 512) and a pencil

Station B- Motion in Air- Tuning fork, mallet, ring stand (with protractor hanging behind it), and ping-pong ball on string

Station C- Groovy Guitars-1 skinny rubber band, 1 fat rubber band (rubber bands, skinny and fat need to be same length), 2 pencils, 1 milk carton (or you could use a shoebox, Tupperware container, etc.)

Station D- It's All About You - vocal cords, straws, and kazoo pipe.

CT Science Standard 5.1a- Sound

Sound and light are forms of energy.

Activities:

Students are working in groups of 3 moving through 4 stations at 5 minute intervals. (Three sets of each station are set up to accommodate 30 students total per class)

Station A- Tuning Forks In Water

Materials: tuning fork, mallet, plastic container of water, pencil, and empty soup can

1. Strike a tuning fork. What do you feel? Strike it again. While it is still humming put it into a cup of water.

What happened to the water? Why did the water react the way it did when you put the tuning fork in the cup?

2. Strike the tuning fork with the mallet. Place the handle against the soup can. What happens? Why? Try it in different positions. What happened? Why?

3. Hit the side of the plastic container with a pencil. Now strike the side of the tin can. What do you notice? Are there different sounds created?

Teacher's Notes: a tuning fork with frequency 341 Hertz works best

Station B- Motion in Air

Materials: Tuning forks, mallet, ring stand (with protractor hanging behind it) and a ping -pong ball on a string

1. Strike a tuning fork with the mallet. Listen. What do you hear? What do you see? What do you feel?

Imagine the ping pong ball is an air molecule

2. Strike a tuning fork gently with a mallet. Touch the vibrating tuning fork to a suspended ping - pong ball while the fork sounds softly. (One student should hold the ping-pong ball on the string above the desk while the other touches the tuning fork to it, tie it to the top of a ringstand)

3. Strike the tuning fork harder with the mallet. Touch the ping - pong ball to it when it is loud. What is the difference between the two events?

4. Try this a few times. Use the different size tuning forks. Do you see the same results?

5. What questions do you have?

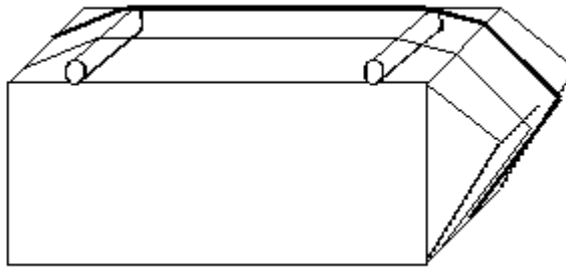
Station C- GROOVY GUITARS

Materials:

- 1 skinny rubber band (rubber bands, skinny and fat need to be same length)
- 1 fat rubber band
- 2 pencils
- 1 milk carton (open container) (or you could use a shoebox, Tupperware container, etc.)

Directions:

1. Put the rubber bands around the milk carton the long way.
2. Put one pencil under the rubber bands near each end of the carton.



3. Pluck the skinny rubber band and listen.
4. Now pluck the fat rubber band and listen. Does the skinny rubber band have a higher or lower pitch than the fat one?
5. Pluck the rubber bands again and watch them vibrate. Does the whole rubber band vibrate or just the part between the pencils?
6. Lets try making the length between the pencils shorter. First, pluck the skinny rubber band again and remember its sound. Move one of the pencils to the middle of the carton. Pluck the skinny rubber band again. Is the new sound higher or lower in pitch?

Teacher's notes: A sound with higher pitch is caused by vibrations that are fast. A sound with lower pitch is caused by vibrations that are slow. The size of an object and tension of the string or rubber band determines if it will vibrate fast or slow and therefore its pitch.

Station D- It's All About You

Materials: vocal cords, straws, and kazoo pipe

1. Try this test. Put your index and middle finger on the center of your neck. Say the word "Aah" as loudly as you can. Then try it as softly as you can. You not only hear a sound, but you can feel a movement inside your throat.

What is happening when you say "Aah"? What would happen if you said another word? or said "Aah" at a higher pitch or a lower pitch? In your group, experiment with many different words and different pitches. What do you notice? What questions do you have?

Teacher's notes: When you say, "Aah", your vocal cords vibrate. That means they move quickly back and forth. As your vocal cords vibrate they produce sound.

2. Use Your Breath-

Take a straw and put it into the hole on the Kazoo pipe. Blow into the straw. What do you hear? Blow hard into the straw and blow softly. Do you hear any differences?

CT Science Standard 5.1a- Sound

Sound and light are forms of energy.

Wrap-Up

Ask them to write a definition of sound now that they have completed all the class activities. Ask if their definition of sound they wrote at the beginning of the class has changed and how it has changed.

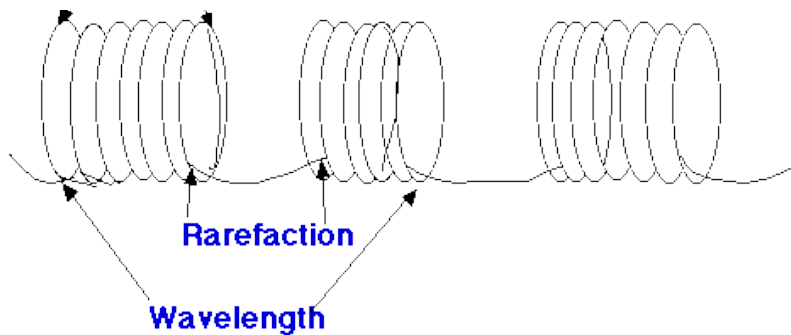
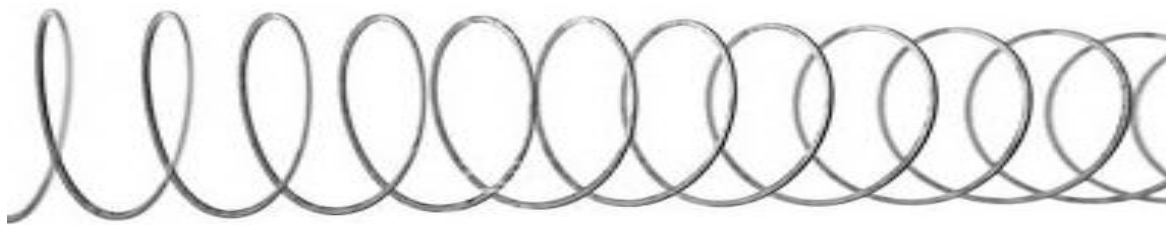
Review each station with the class. Discuss what happened at each station and why.

Teacher's notes: Sound is a form of energy caused by vibrations (they experienced vibrations at Station A). Those vibrations cause movement of air particles (they bump into each other) (they worked with air particles at Station B). That movement is called a sound wave. Introduce sound waves by doing a demo with a slinky. (As seen below) If your ear is within the range of vibrations you hear a sound. An irregular repeating sound is noise but a regular repeating sound is pleasant as in musical notes. Show a melody harp and let the students listen to its different notes. You can show different types of musical instruments and their different pitches using the website: <http://www.datadragon.com/education/instruments> Show the students the different sounds of the woodwind instruments and the string instruments. (Woodwinds can be represented in Station D with our kazoo pipe and strings can be represented in Station C with our groovy guitars)

Demo with a Slinky:

Directions:

1. Use a toy slinky. Stretch it out on the length of the table between two students.
2. Teacher's notes: It is best to do this on a 6ft long table but it could be done on the floor. If it is done on the floor make sure it is done on a tile floor as this activity will not work on a floor with carpet.
3. One student should grab several coils on the slinky. Then let go.
4. You will see the group of coils go across to the other student. Then come back to the starting student.
5. Make sure you notice how the coils stay together. This is what sound waves do.



Post-visit extension:

Where else could you see waves like you see in the slinky? With what other items you might play with could you create these types of waves? Look at the labels in the diagram. Write down what you think these words mean by your observations of the picture and your experiences at this station

Teacher's notes: Sound is a series of compression waves that moves through air or other materials. These sound waves are created by the vibration of some object, like a radio loudspeaker.

The back-and-forth vibration of an object creates the compression waves of sound. The motions of a loudspeaker cone, drumhead and guitar string are good examples of vibration that cause compression waves. This is different than the up and down or transverse motion of a water wave

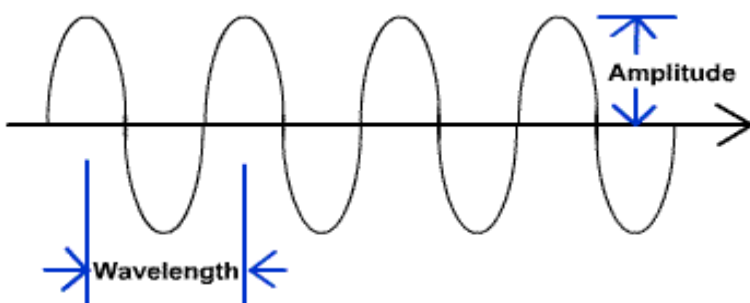
Sound waves can also be referred to as longitudinal waves. **Longitudinal waves** are waves that have same direction of oscillations or vibrations along or parallel to their direction of travel, which means that the oscillations of the medium (particle) is in the same direction or opposite direction as the motion of the wave. Mechanical longitudinal waves have been also referred to as **compressional waves** or **compression waves**.

Rarefaction is the reduction of a medium's density, or the opposite of **compression**. Half of a sound wave is made up of the compression of the medium and the other half is the decompression or rarefaction of the medium.

A sound wave has characteristics just like any other type of wave, including **amplitude**, **wavelength**, **velocity** and **frequency**.

The **amplitude** of a sound wave is the same thing as its loudness. Since sound is a compression wave, its loudness or amplitude would correspond to how much the wave is compressed. It is sometimes called pressure amplitude.

Wavelength is the distance from one crest to another of a wave. Since sound is a compression wave, the wavelength is the distance between maximum compressions.



Pitch- This is how high or low a sound seems. The sound of a bird is high and the sound of a lion is low.

High-frequency Sound Wave



Low-Frequency Sound Waves



Loud



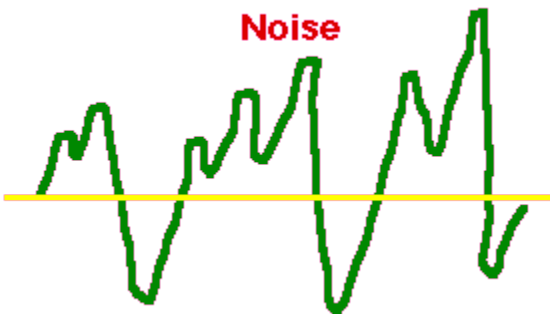
Soft



Pleasant Sound



Noise



Loud or Soft- The more energy a sound wave has the louder it seems. The amplitude or height of a sound wave is a measure of the amount of energy it has. So, the greater the intensity of a sound the greater the amplitude.

A pleasant sound has a regular wave pattern. The pattern is repeated over and over. But the waves of noise are irregular. They do not have a repeated pattern.

The speed or **velocity** of sound in air is approximately 344 meters/second, 1130 feet/sec. or 770 miles per hour at room temperature of 20°C (70°F). The speed varies with the temperature of air, such that sound travels slower at higher altitudes or on cold days.

CT Science Standard 5.1a- Sound

Sound and light are forms of energy.

Note: The difference between **speed** and **velocity** is that velocity usually includes direction of travel. We'll interchange them here, but in some cases the distinction is important.

The relationship between velocity, wavelength and frequency is:

$$\text{Velocity} = \text{wavelength} \times \text{frequency}$$

Since the velocity of sound is approximately the same for all wavelengths, frequency is often used to better describe the effects of the different wavelengths.

The **frequency** of sound is the rate at which the waves pass a given point. It is also the rate at which a guitar string or a loud speaker vibrates. Frequency is also called the pitch of a sound. It is called the note in musical sounds.



Task Card Station A- Tuning Forks In Water

Materials: tuning fork, mallet, plastic container of water, empty soup can, and pencil

A.

1. Strike a tuning fork with the rubber mallet. *What do you feel?*
2. Strike it again. While it is still humming put it slowly into a cup of water. *What happened to the water?*
3. *Why did the water react the way it did when you put the tuning fork in the cup?*
4. Do the same thing with another tuning fork. *What happens?*
5. *Write what you notice and wonder?*

B.

1. Strike a tuning fork with the mallet. Place the handle against the soup can. *What happens? Why do you think?*
2. Try it in different positions. *What happens? Why do you think?*
3. *What do you notice and wonder?*

C. Hit the side of the plastic container with a pencil. Now strike the side of the tin can. *What do you notice? Are there different sounds created?*

Task Card Station B- Motion in Air

Materials: Tuning fork, mallet, and a ping -pong ball on a string

1. Strike a tuning fork with the mallet. *Listen. What do you hear? What do you see? What do you feel?*

Imagine the ping pong ball is an air molecule.

2. Strike a tuning fork gently with a mallet. Touch the vibrating tuning fork to a suspended ping - pong ball while the fork sounds softly. (Make sure the ping-pong ball on the string is stationary before touching the tuning fork to it)

3. Strike the tuning fork harder with the mallet. Touch the ping - pong ball to it when it is loud. *What is the difference between the two events?*

4. Try this a few times. *Do you see the same results?*

5. Repeat Step 2 and 3 with the different tuning forks. *Are the results the same or different?*

6. *What do you notice and wonder?*

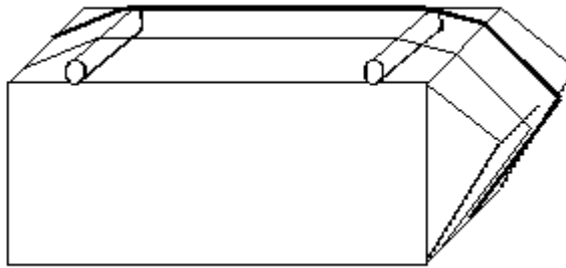
Station C- GROOVY GUITARS

Materials: 1 skinny rubber band, 1 milk carton, 1 fat rubber band, and 2 pencils

Directions:

1. Put the rubber bands around the milk carton the long way. (make sure the rubber bands are not twisted)

2. Put one pencil under the rubber bands near each end of the carton.



3. Strum the skinny rubber band and listen.

4. Now strum the large rubber band and listen. *Does the skinny rubber band have a higher or lower pitch than the large one?*

5. Strum the rubber bands again and watch them vibrate. *Does the whole rubber band vibrate or just the part between the pencils?*

6. Let's try making the length between the pencils shorter. First, strum the skinny rubber band again and remember its sound. Move one of the pencils to the middle of the carton. Strum the skinny rubber band again. *Is the new sound higher or lower in pitch?*

Station D- It's All About You

Materials: your own vocal cords, straws, and a kazoo pipe

1. Use Your Voice-

Try this test. Put your index and middle finger on the center of your neck. Say the word "Aah" or simply talk to your friend as loudly as you can. Then try it as softly as you can. You not only hear a sound, but you can feel a movement inside your throat.

What is happening when you say something?

What would happen if you said another word? Or said "Aah" at a higher pitch or a lower pitch?

In your group, experiment with many different words and different pitches.

What do you notice and wonder?

2. Use Your Air-

Take a straw and put it into the hole on the Kazoo pipe. Blow into the straw. *What do you hear?* Blow hard into the straw and blow softly. *Do you hear any differences? Try the different Kazoo pipes. Do they all sound the same?*

What do you notice and wonder?

Trail Guides

We have created a set of “Trail Guides” for use by you and your students. The first section consists of the trail guides with teacher notes; the second section has the exact same Trail Guides without the teacher notes. You may copy these directly as handouts.

The following highlighted GLE’s and GLC’s are covered in this section:

Energy Transfer and Transformations -What is the role of energy in our world?			
GRADE 5			
5.1 — Sound and light are forms of energy.			
Core Science Curriculum Framework	Underlying Concepts <i>Students should understand that...</i>	Grade-Level Expectations <i>Students should be able to...</i>	CMT Expected Performances
<p>5.1.a. Sound is a form of energy that is produced by the vibration of objects and is transmitted by the vibration of air and objects.</p> <p>5.1.b. Light is a form of energy that travels in a straight line and can be reflected by a mirror, refracted by a lens, or absorbed</p>	<p>GRADE-LEVEL CONCEPT 5.1.a.</p> <ol style="list-style-type: none"> There are a variety of sounds in our environment. Sounds have characteristics, such as loudness, pitch and quality (or “timbre”), that allow them to be identified. For sound to occur, there must be a vibrating object, a material through which the vibrations are transferred (for example, air or water), and a receiver (for example, an ear) to perceive the sound. Objects can be caused to vibrate by actions such as striking, strumming, bowing, plucking or blowing. Sounds can vary in loudness (“volume”). Volume is affected by the strength of the force causing the vibration. For example, striking a drum forcefully or gently produces sounds with different volumes. Sounds can have a high or low tone (“pitch”). The pitch of a sound depends on the speed of the vibration. Objects that vibrate quickly have a high pitch, while those that vibrate slowly have a low pitch. Pitch is affected by characteristics such as the shape, length, tension or thickness of the vibrating material (for example, the vibrating material may be a string, a glass, a wire or a drum). Sound travels (is “transmitted”) through materials by causing them to vibrate. Sound is not transmitted if there are no materials to vibrate. Solids, liquids and gases (air) transmit sound differently. Sounds can be reflected or absorbed, depending on the properties of the material it hits. Sound tends to bounce off smooth, hard surfaces, producing an echo; sound tends to be absorbed by soft, porous surfaces, producing a muffled sound. <p>GRADE-LEVEL CONCEPT 5.1.b.</p> <ol style="list-style-type: none"> Light travels in straight paths away from a source of illumination in all directions until it hits an object. Some sources of illumination produce their own light (for example, the sun, fire, light bulb); other sources of illumination reflect light produced by something else (for example, the moon or a mirror). Light interacts with objects in various ways; it can be reflected off the 	<ol style="list-style-type: none"> Generalize that vibrating objects produce sound if the vibrations are transferred from the object through another material (e.g., air, a solid, or a liquid). Demonstrate how the loudness, pitch and quality/timbre of sound can be varied. Design and conduct investigations to determine factors that affect pitch. Describe the properties of materials that reflect or absorb sound. Analyze properties of materials that cause sound to be reflected or absorbed, then apply findings to design a device that reflects or absorbs sound. Construct simple musical instruments (e.g., rubber band guitars, drums, etc.) that produce sounds with various pitches, volume and timbres. Provide evidence that light travels in straight lines away from a source in all directions. Investigate how light is refracted as it passes through a lens or through one transparent material to another. Demonstrate that white light is composed of many colors. Explain that all visible objects are reflecting some light to the 	<p>B17. Describe the factors that affect the pitch and loudness of sound produced by vibrating objects.</p> <p>B18. Describe how sound is transmitted, reflected and/or absorbed by different materials.</p> <p>B19. Describe how light is absorbed and/or reflected by different surfaces.</p>

CT Science Standard 5.1a- Sound

Sound and light are forms of energy.

<p>by objects.</p>	<p>object, absorbed by the object, or refracted through the object.</p> <ol style="list-style-type: none"> 3. Materials can be classified based on how much light passes through them. Transparent materials allow most light to pass through them. Translucent materials allow some light to pass through them. Opaque materials do not allow any light to pass through them. 4. Objects that have flat, smooth surfaces reflect light and produce a mirror-like image. Objects that have curved or uneven surfaces scatter the reflected light and produce distorted or blurry images. 5. Light always reflects away from a mirror at the same angle that it hits the mirror. The angle of incoming light equals the angle of reflected light. 6. Objects that block light traveling from a source produce shadows. The shape, length, direction and clarity of a shadow depend on the shape and position of the object. 7. Light changes direction (“refracts”) as it passes from one transparent material to another (for example, as it passes from air to water or through lenses). <p>SCIENTIFIC LITERACY TERMINOLOGY: reflect, absorb, refract, transparent, translucent, opaque, angle, vibration, transfer, volume, pitch, transmit, reflect, absorb</p>	<p>human eye.</p> <ol style="list-style-type: none"> 11. Contrast the way light is reflected by a smooth, shiny object (e.g., mirror or pool of water) and how light is reflected by other objects. 12. Measure angles to predict the path of light reflected by a mirror. 13. Determine whether a material is opaque, transparent or translucent based on how light passes through it. 14. Design and conduct light absorption experiments that vary the size, length, direction and clarity of a shadow by changing the position of the light-blocking object or the light source. 	
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Teacher Trail Guides

Trail Guide for *All Galleries*: 5.1a Sound

As you move through the science center be thinking about these questions:

How do sound and noise impact visitors in the gallery?

Do you think the designers purposefully design floor, wall, and ceiling treatments to affect the echoes and transmission of sound from one room to another?

Be on the lookout for an area in the Science Center that seems very quiet. Notice what is on the floors, walls, and ceilings in this area. Do you notice an area in the Science Center where sounds (like clapping) are easily reflected?

Write your ideas down in your science notebook as they come to you as you move through the different exhibits. Talk with a partner to see how your thoughts compare.

Teacher Notes:

Carpets and special acoustic ceiling tiles are used to minimize reflected sound and echoes so that visitors are not overwhelmed by too much sound or noise in one place. Auditoriums and galleries have walls that act as sound baffles and curtains to absorb sound rather than reflecting it. If sounds reflect off of multiple surfaces and arrive at your location out of synch, it can be chaotic and confusing. Usually there is carpeting in a library for this same purpose. Classrooms also use acoustic ceiling tiles so that sounds do not travel to adjacent spaces.

Standard 5.1a GLC #8 GLE #4

Trail Guide *Apollo Mission Space Suit:* 5.1a Sound

Visit the Exploring Space Gallery - 5th Floor North

Apollo Mission Space Suit

What would you hear if another astronaut beat a drum while both of you were standing on the moon?

Assume that you had a sensitive microphone outside of your space suit. What would you hear as you shuffled your feet on the surface?

If you think you will hear something, what pathway will the sound energy take to get to your ears? Draw a sketch of what you think in your science notebook.

You and a friend are Astronauts on the moon and you have lost all radio contact with each other. How could you still have a conversation with them?

Talk with a partner about your ideas.

Teacher Notes:

Sound is vibrations passed through a medium as waves. Sound require a medium (such as air) in order to be transmitted. If someone else is beating a drum, you will not be able to hear it. If you strike the drum yourself, some sound may be transmitted through the suit and your skeleton to your head such that your ear can pick something up. If you shuffle your feet, it will not produce a sound since the moon has no atmosphere, but again it may be transmitted through your shoes and you may feel the vibrations. One way to talk to each other is to touch helmets, the sound will travel through the air in your suit, vibrate the glass, vibrate the glass of your friend's helmet and then travel through the air and you should be able to hear them. You might have to yell to give the waves enough energy to do this.

Standard 5.1a GLC #2, 7 GLE #1

Trail Guide *Different Vibrations Create Distinct Patterns: 5.1a Sound*

Visit the Sight and Sound Experience Gallery - 4th Floor North

Different Vibrations Create Distinct Patterns

Sprinkle sand on the violin plate. Turn the dial to a low frequency, 59Hz. What happens when sound waves cause the metal plate to vibrate? Draw the pattern that you see in your science notebook.

Sprinkle some more sand on the violin. This time turn the frequency to 167Hz. Sketch the pattern you see in your science notebook.

Again sprinkle some sand on the violin. Turn the frequency to 676 Hz and sketch the pattern that emerges.

Compare the patterns you saw for the high, medium and low frequency you just tested. Why do the patterns differ, are there any similarities?

Talk with a partner about your ideas.

Teacher Notes:

Sound energy makes different patterns at different frequencies. The shape of the plate and the frequency of the sound affect the sand patterns. Sand tends to jump away from the vibrating places and settle at the still spots.

If you anchor one end of a slinky and shake the other end back and forth so that a "standing wave" is formed, you will notice nodes (quiet areas where the slinky barely moves) and antinodes (areas of maximum disturbance where the slinky travels farthest upward and downward from the center line.) Consider this for the sand formations on the vibrating plates.

Patterns occur on the plates because vibrations move outward from the mounting post and bounce off the edges of the plate and interfere with each other. Lower frequency waves make simpler patterns because their sound waves are longer and there are fewer of them that 'fit' on the plate.

If you would like to research more about this on the Internet, conduct a search on "Chladni plates".
Standard 5.1a GLC #1, 2, 5, 6, 7 GLE #1

Trail Guide *Different Vibrations Create Distinct Patterns*: 5.1a Sound

Visit the Sight and Sound Experience Gallery - 4th Floor North

Different Vibrations Create Distinct Patterns

Sprinkle sand on the square plate. Turn the dial to a low frequency, 150Hz. What happens when sound waves cause the metal plate to vibrate? Draw the pattern that you see in your science notebook.

Sprinkle some more sand on the square plate. This time turn the frequency to 322Hz. Sketch the pattern you see in your science notebook.

Again sprinkle some sand on the square plate. Turn the frequency to 480 Hz and sketch the pattern that emerges.

Compare the patterns you saw for the frequencies you just tested. Why do the patterns differ? Are there any similarities?

What do you notice about the sand formations with respect to the different shaped plates?

Talk with a partner about your ideas.

Teacher Notes:

Only one group can use the Patterns exhibit (plate and violin) at a time.

Patterns occur on the plates because vibrations move outward from the mounting post and bounce off the edges of the plate and interfere with each other. Lower frequency waves make simpler patterns because their sound waves are longer and there are fewer of them that 'fit' on the plate.

Standard 5.1a GLC #1, 2, 5, 6, 7 GLE #1

Trail Guide *Rube Goldberg Machines:* 5.1a Sound

Visit the Invention Dimension Gallery - 5th Floor North

Rube Goldberg Machines.

Listen to all the sounds you hear these machines make as the ball rolls to the goal. What kind of sounds do the different materials make? Are some louder than others? Write down your observations in your science notebooks.

Talk with a partner and write your thoughts into your science notebooks.

Teacher Notes:

Students will hear high sounds, low sounds, sounds with good quality (timbre), and low quality (timbre). They will also hear how the same object sounds differently depending on if it is allowed to freely vibrate or not.

Standard 5.1a GLE #2 GLC #3, 4, 5

Student Trail Guides

Trail Guide for *All Galleries*: 5.1a Sound

As you move through the science center be thinking about these questions:

How do sound and noise impact visitors in the gallery?

Do you think the designers purposefully design floor, wall, and ceiling treatments to affect the echoes and transmission of sound from one room to another?

Be on the lookout for an area in the Science Center that seems very quiet. Notice what is on the floors, walls, and ceilings in this area. Do you notice an area in the Science Center where sounds (like clapping) are easily reflected?

Write your ideas down in your science notebook as they come to you as you move through the different exhibits. Talk with a partner to see how your thoughts compare.

Trail Guide *Apollo Mission Space Suit*. 5.1a Sound

Visit the Exploring Space Gallery - 5th Floor North

Apollo Mission Space Suit

What would you hear if another astronaut beat a drum while both of you were standing on the moon?

Assume that you had a sensitive microphone outside of your space suit. What would you hear as you shuffled your feet on the surface?

If you think you will hear something, what pathway will the sound energy take to get to your ears? Draw a sketch of what you think in your science notebook.

You and a friend are Astronauts on the moon and you have lost all radio contact with each other. How could you still have a conversation with them?

Talk with a partner about your ideas.

CT Science Standard 5.1a- Sound
Sound and light are forms of energy.



Trail Guide *Different Vibrations Create Distinct Patterns: 5.1a Sound*

Visit the Sight and Sound Experience Gallery - 4th Floor North

Different Vibrations Create Distinct Patterns

Sprinkle sand on the violin plate. Turn the dial to a low frequency, 59Hz. What happens when sound waves cause the metal plate to vibrate? Draw the pattern that you see in your science notebook.

Sprinkle some more sand on the violin. This time turn the frequency to 167Hz. Sketch the pattern you see in your science notebook.

Again sprinkle some sand on the violin. Turn the frequency to 676 Hz and sketch the pattern that emerges.

Compare the patterns you saw for the high, medium and low frequency you just tested. Why do the patterns differ, are there any similarities?

Talk with a partner about your ideas.

Trail Guide Different *Vibrations Create Distinct Patterns*: 5.1a Sound

Visit the Sight and Sound Experience Gallery - 4th Floor North

Different Vibrations Create Distinct Patterns

Sprinkle sand on the square plate. Turn the dial to a low frequency, 150Hz. What happens when sound waves cause the metal plate to vibrate? Draw the pattern that you see in your science notebook.

Sprinkle some more sand on the square plate. This time turn the frequency to 322Hz. Sketch the pattern you see in your science notebook.

Again sprinkle some sand on the square plate. Turn the frequency to 480 Hz and sketch the pattern that emerges.

Compare the patterns you saw for the frequencies you just tested. Why do the patterns differ? Are there any similarities?

What do you notice about the sand formations with respect to the different shaped plates?

Talk with a partner about your ideas.

Trail Guide *Rube Goldberg Machines:* 5.1a Sound

Visit the Invention Dimension Gallery - 5th Floor North

Rube Goldberg Machines.

Listen to all the sounds you hear these machines make as the ball rolls to the goal. What kind of sounds do the different materials make? Are some louder than others? Write down your observations in your science notebooks.

Talk with a partner and write your thoughts into your science notebooks.

Post-Visit Activity Creating Musical Instruments

The following highlighted GLCs and GLEs are covered in this section:

<i>Energy Transfer and Transformations -What is the role of energy in our world?</i>			
GRADE 5			
5.1 — Sound and light are forms of energy.			
Core Science Curriculum Framework	Underlying Concepts <i>Students should understand that...</i>	Grade-Level Expectations <i>Students should be able to...</i>	CMT Expected Performances
<p>5.1.a. Sound is a form of energy that is produced by the vibration of objects and is transmitted by the vibration of air and objects.</p>	<p>GRADE-LEVEL CONCEPT 5.1.a.</p> <ol style="list-style-type: none"> There are a variety of sounds in our environment. Sounds have characteristics, such as loudness, pitch and quality (or “timbre”), that allow them to be identified. For sound to occur, there must be a vibrating object, a material through which the vibrations are transferred (for example, air or water), and a receiver (for example, an ear) to perceive the sound. Objects can be caused to vibrate by actions such as striking, strumming, bowing, plucking or blowing. Sounds can vary in loudness (“volume”). Volume is affected by the strength of the force causing the vibration. For example, striking a drum forcefully or gently produces sounds with different volumes. Sounds can have a high or low tone (“pitch”). The pitch of a sound depends on the speed of the vibration. Objects that vibrate quickly have a high pitch, while those that vibrate slowly have a low pitch. Pitch is affected by characteristics such as the shape, length, tension or thickness of the vibrating material (for example, the vibrating material may be a string, a glass, a wire or a drum). Sound travels (is “transmitted”) through materials by causing them to vibrate. Sound is not transmitted if there are no materials to vibrate. Solids, liquids and gases (air) transmit sound differently. Sounds can be reflected or absorbed, depending on the properties of the material it hits. Sound tends to bounce off smooth, hard surfaces, producing an echo; sound tends to be absorbed by soft, porous surfaces, producing a muffled sound. 	<ol style="list-style-type: none"> Generalize that vibrating objects produce sound if the vibrations are transferred from the object through another material (e.g., air, a solid, or a liquid). Demonstrate how the loudness, pitch and quality/timbre of sound can be varied. Design and conduct investigations to determine factors that affect pitch. Describe the properties of materials that reflect or absorb sound. Analyze properties of materials that cause sound to be reflected or absorbed, then apply findings to design a device that reflects or absorbs sound. Construct simple musical instruments (e.g., rubber band guitars, drums, etc.) that produce sounds with various pitches, volume and timbres. Provide evidence that light travels in straight lines away from a source in all directions. Investigate how light is refracted as it passes through a lens or through one transparent material to another. Demonstrate that white light is composed of many 	<p>B17. Describe the factors that affect the pitch and loudness of sound produced by vibrating objects.</p> <p>B18. Describe how sound is transmitted, reflected and/or absorbed by different materials.</p> <p>B19. Describe how light is absorbed and/or reflected by different surfaces.</p>
<p>5.1.b. Light is a form of energy that travels in a straight line and can be reflected by a mirror, refracted by a lens, or absorbed by objects.</p>	<p>GRADE-LEVEL CONCEPT 5.1.b.</p> <ol style="list-style-type: none"> Light travels in straight paths away from a source of illumination in all directions until it hits an object. Some sources of illumination produce their own light (for example, the sun, fire, light bulb); other sources of illumination reflect light produced by something else (for example, the moon or a mirror). Light interacts with objects in various ways; it can be reflected off the object, absorbed by the object, or refracted through the object. Materials can be classified based on how much light passes 	<ol style="list-style-type: none"> Provide evidence that light travels in straight lines away from a source in all directions. Investigate how light is refracted as it passes through a lens or through one transparent material to another. Demonstrate that white light is composed of many 	

CT Science Standard 5.1a- Sound

Sound and light are forms of energy.

	<p>through them. Transparent materials allow most light to pass through them. Translucent materials allow some light to pass through them. Opaque materials do not allow any light to pass through them.</p> <ol style="list-style-type: none">Objects that have flat, smooth surfaces reflect light and produce a mirror-like image. Objects that have curved or uneven surfaces scatter the reflected light and produce distorted or blurry images.Light always reflects away from a mirror at the same angle that it hits the mirror. The angle of incoming light equals the angle of reflected light.Objects that block light traveling from a source produce shadows. The shape, length, direction and clarity of a shadow depend on the shape and position of the object.Light changes direction ("refracts") as it passes from one transparent material to another (for example, as it passes from air to water or through lenses). <p>SCIENTIFIC LITERACY TERMINOLOGY: reflect, absorb, refract, transparent, translucent, opaque, angle, vibration, transfer, volume, pitch, transmit, reflect, absorb</p>	<p>colors.</p> <ol style="list-style-type: none">Explain that all visible objects are reflecting some light to the human eye.Contrast the way light is reflected by a smooth, shiny object (e.g., mirror or pool of water) and how light is reflected by other objects.Measure angles to predict the path of light reflected by a mirror.Determine whether a material is opaque, transparent or translucent based on how light passes through it.Design and conduct light absorption experiments that vary the size, length, direction and clarity of a shadow by changing the position of the light-blocking object or the light source.	
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Activity Summary

**** Safety Concern: Be Aware of any students with Latex Allergies if using balloons.**

For your post-visit activity students can create their own musical instrument. Place various recycled materials of your choosing on a table in the classroom.

Introduction (2 min)

Students will be asked to create a musical instrument and focus on three different things about Sound- Volume, Pitch and Timbre. They will be instructed that they need to present their instrument at the end of class. During their 3 minute presentation they will play the instrument for the class and discuss how the instrument demonstrates those three parts of Sound- volume, pitch and timbre. Each student in the group should focus on one of those things while working on the design of the instrument.

Design (5 min)

Students will be given 5 minutes to design and plan their instruments. One representative of the group may go to the materials table to view the different types of materials.

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Choosing Materials (2 min)

Students will have one representative of their group come up to the materials table to choose their materials.

Creating Instrument (15 min)

Students will have 15 minutes to create the instrument.

Practice Shareout (5 min)

Students will be given 5 minutes to practice their presentation to the class.

Play Instrument and Shareout (for 10 groups this can take up to 30 min)

Students will be given 3 minutes to play their instrument and shareout with the class. How does each instrument demonstrate volume, pitch and timbre?

Performance Task

“Name that Pitch”

It is suggested that this task be introduced toward the end of the sound unit. The students can then refer to their prior learning when completing the task.

Task

You and your partner have entered a song writing contest. The rules of the contest are very specific. Your song may have only 10 notes. Five of the notes must have a high pitch and five of the notes must have a low pitch. The notes may be played in the order that you and your partner choose. During the play offs one partner will “play” the note while the other partner indicates whether the note is high or low.

Safety Notes:

- Review expectations for appropriate behavior
- Glass bottles will be used and proper use of the bottles must be addressed
- A pencil will be used as the striking instrument. Appropriate modeling of how to safely use the pencil will be necessary.
- Students may also blow over the top of the bottles to make sounds. This might be seen as a health risk if any of the students have colds. The method used would be at the teacher’s discretion.

Materials Needed:

science notebooks for recording plans and wonderings
six glass bottles per team
supply of water
food coloring (optional)
unsharpened pencil

Procedure

1. Students will be divided into teams of two.
2. The available materials will be introduced to the students. The pencil will be used as the striking instrument. Be certain to emphasize that gentle striking is appropriate.
3. Students will explore to find out whether more or less water impacts the pitch.
4. Students will discuss their findings.
5. Students will record their findings.
6. Students will decide on the amount of water to be poured into each bottle.
7. Students will explore how sounds of various pitches can be combined.
8. Students will prepare to share their “song”

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9. Students will decide which team member will “play” the song and which team member will indicate the pitch of each note.

The Play Offs

1. The students will share their songs with their classmates.
2. During each team’s share students in the audience will keep a tally of how many high notes and how many low notes they heard. This procedure will help to make certain that the rules of the contest were followed. Prior to the sharing, the teacher should present a mini lesson on data collection.

Synthesis

Following the Play Offs, a class discussion focusing on the unpacked content standards will take place. The standards could be on a transparency and shown to the students one at a time or a copy could be provided for each student. This would be an appropriate time for students to refer to their science notebooks and find evidence for each of the unpacked content standards. A class discussion will lead to further clarification and connections.

◆ Sound is a form of energy that is produced by the vibration of objects and is transmitted by the vibration of air and objects.

GRADE-LEVEL CONCEPTS:

- There are a variety of sounds in our environment. Sounds have characteristics, such as loudness, pitch and quality (or “timbre”), that allow them to be identified.
- For sound to occur, there must be a vibrating object, a material through which the vibrations are transferred (for example, air or water), and a receiver (for example, an ear) to perceive the sound.
- Objects can be caused to vibrate by actions such as striking, strumming, bowing, plucking or blowing.
- Sounds can vary in loudness (“volume”). Volume is affected by the strength of the force causing the vibration. For example, striking a drum forcefully or gently produces sounds with different volumes.
- Sounds can have a high or low tone (“pitch”). The pitch of a sound depends on the speed of the vibration. Objects that vibrate quickly have a high pitch, while those that vibrate slowly have a low pitch.
- Pitch is affected by characteristics such as the shape, length, tension or thickness of the vibrating material (for example, the vibrating material may be a string, a glass, a wire or a drum).
- Sound travels (is “transmitted”) through materials by causing them to vibrate. Sound is not transmitted if there are no materials to vibrate. Solids, liquids and gases (air) transmit sound differently.

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- Sounds can be reflected or absorbed, depending on the properties of the material it hits. Sound tends to bounce off smooth, hard surfaces, producing an echo; sound tends to be absorbed by soft, porous surfaces, producing a muffled sound.

Closure

The teacher becomes the orchestra conductor and holds up cards, ex. #1, #2, - 10, indicating the note to be played. All of the teams will play in the final orchestra presentation.

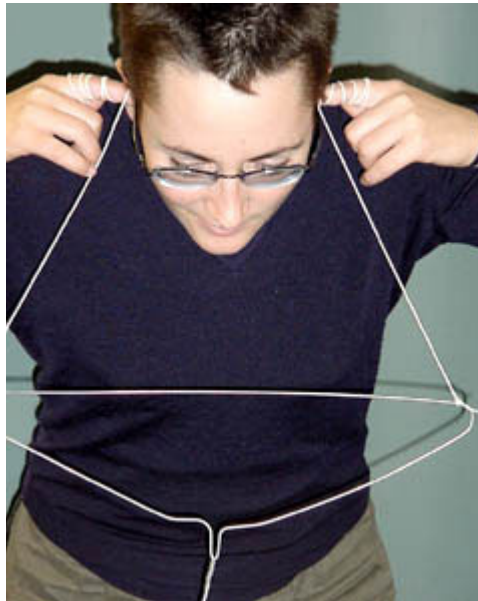
Participation certificates may be awarded to the participants.

Further Extensions

- Teachers might wish to use the original lesson as an Inquiry starter.
- Once students have raised questions; new materials, such as sand, Styrofoam cups, plastic cups etc. might be introduced.
- Students could write a song using their water bottles as instruments.
- The classroom teacher could work in conjunction with the music teacher to enable students to explore musical instruments that have a high or a low pitch.

Guided Investigation Sound

Content Standard 5.1



www.questacon.edu.au

Connecticut State Department of Education
Bureau of Curriculum and Instruction

Do You Hear What I Hear? A Guided Exploration of Sound

Teacher Materials

Authored by Eloise Farmer
Connecticut Science Center

CT Science Standard 5.1a- Sound
Sound and light are forms of energy.

Content Standards	Expected Performances
<p>SCIENTIFIC INQUIRY</p> <ul style="list-style-type: none"> Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena. <p>SCIENTIFIC LITERACY</p> <ul style="list-style-type: none"> Scientific literacy includes speaking, listening, presenting, interpreting, reading and writing about science. <p>SCIENTIFIC NUMERACY</p> <ul style="list-style-type: none"> Mathematics provides useful tools for the description, analysis and presentation of scientific data and ideas. 	<p>B INQ.1 Make observations and ask questions about objects, organisms and the environment.</p> <p>B INQ.2 Seek relevant information in books, magazines and electronic media.</p> <p>B INQ.3 Design and conduct simple investigations.</p> <p>B INQ.4 Employ simple equipment and measuring tools to gather data and extend the senses.</p> <p>B INQ.5 Use data to construct reasonable explanations.</p> <p>B INQ.6 Analyze, critique and communicate investigations using words, graphs and drawings.</p> <p>B INQ.9 Use measurement tools and standard units (e.g., centimeters, meters, grams, kilograms) to describe objects and materials.</p>
	<p>B INQ.7 B.2 Describe how sound is transmitted, reflected and/or absorbed by different materials.</p>

Grade 5 Core Themes, Content Standards and Expected Performances	
Content Standards	Expected Performances
<p><i>Energy Transfer and Transformations – What is the role of energy in our world?</i></p> <p>5.1 - Sound and light are forms of energy.</p> <ul style="list-style-type: none"> Sound is a form of energy that is produced by the vibration of objects and is transmitted by the vibration of air and objects. 	

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SCIENCE CONTENT STANDARD 5.1		
<p>CONCEPTUAL THEME:</p> <p><i>Energy Transfer and Transformations - What is the role of energy in our world?</i></p> <p>CONTENT STANDARD:</p> <p>5.1 – Sound and light are forms of energy.</p>	<p>GRADE-LEVEL CONCEPT 1: ♦ Sound is a form of energy that is produced by the vibration of objects and is transmitted by the vibration of air and objects.</p> <p>GRADE-LEVEL EXPECTATIONS:</p> <ol style="list-style-type: none"> 2. For sound to occur, there must be a vibrating object, a material through which the vibrations are transferred (for example, air or water), and a receiver (for example, an ear) to perceive the sound. 3. Objects can be caused to vibrate by actions such as striking, strumming, bowing, plucking or blowing. 5. Sound travels (is “transmitted”) through materials by causing them to vibrate. Sound is not transmitted if there are no materials to vibrate. Solids, liquids and gases (air) transmit sound differently. 6. Sounds can be reflected or absorbed, depending on the properties of the material it hits. Sound tends to bounce off smooth, hard surfaces, producing an echo; sound tends to be absorbed by soft, porous surfaces, producing a muffled sound. 	<p>CMT EXPECTED PERFORMANCES</p> <p>B.2 Describe how sound is transmitted, reflected and/or absorbed by different materials.</p>

SUMMARY for TEACHER

<p><i>Fact: A wave transmits energy only. Particles move back and forth but do not travel with the wave. Individual waves move past the particles.</i></p>	<p><i>Student Misconception: As waves move, particles travel with the wave from where the wave starts and the particles end up somewhere else.</i></p>
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The main purpose of this activity is to change the student misconception about how sound travels, and how longitudinal waves travel. Students also will use the process skills of observation, communication, and making inferences. They will also be using Mathematics Frameworks Standards

CT Science Standard 5.1a- Sound

Sound and light are forms of energy.

3.1A, 3.2 A and B, and 4.2A for Grade 5. Literacy Comprehension Competencies, pages 19 and 20 of SDE document on Literacy.

CT Science Standard 5.1a- Sound

Sound and light are forms of energy.

Background Information for the Teacher:

Definition of a Wave:

Webster's dictionary defines a wave as "a disturbance or variation that transfers energy progressively from point to point in a medium and that may take the form of an elastic deformation or of a variation of pressure, electric or magnetic intensity, electric potential, or temperature."

The most important part of this definition is that a wave is a disturbance or variation which travels through a medium. The medium through which the wave travels may experience some local oscillations as the wave passes, but the particles in the medium do NOT travel with the wave. The disturbance may take any of a number of shapes, from a finite width pulse to an infinitely long sine wave. Illustrations you can use with your class can be found at:

<http://www.kettering.edu/~drussell/Demos/waves-intro/waves-intro.html>, and you could use the activities pictured on this site to demonstrate waves.

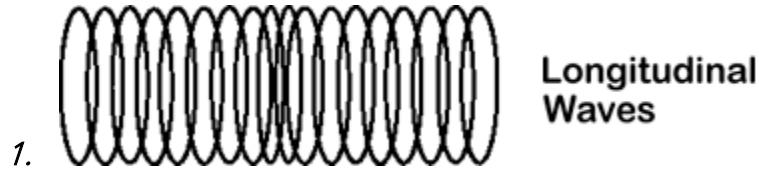
Sound waves are vibrating particles, so if there are no particles, there's nothing to bump into, so sounds can't travel. In outer space, there are no particles to bump into, so sounds can't travel. No particles means no vibrations, and no vibrations means no sound waves, which means no sounds. In movies and on TV, you'll sometimes see and hear things exploding in outer space -- alien spacecraft and things like that. The explosions can make the story more exciting, but in real life, you wouldn't be able to hear an explosion in outer space. {You might be able to find a physics teacher in your local high school who will set up a vacuum pump, a bell jar, and a ringing alarm clock for your students. As the vacuum pump removes the air from the jar, the sound will fade, since there will be no particles of air to vibrate, there will be no sound}.

A longitudinal wave vibrates parallel to (in the same direction of) wave travel (sound waves are a good example). A transverse wave vibrates perpendicular (at right angles) to the wave travel (water waves are a good example of a transverse wave, so water waves are not a good analogy for sound).

To demonstrate the sound (longitudinal) waves:

Have two students each take one end of a Slinky and stretch it out along the floor (the waves will be more apparent this way).

Longitudinal Waves. Have one student grasp and draw toward himself or herself several coils of a stretched metal Slinky and then release the coils. The other student must hold his or her end of the Slinky so that it will not move. A longitudinal wave pulse will be generated and travels down the length of the Slinky, and the coils will remain and vibrate in the same place. You could have the students read the following paragraphs as a way of engaging them, or have them begin the activity directly. If you do not have a slinky available, you could ask the students to stand in a line and put their hands on the shoulders of the one in front of them. Then ask the student on the end to take a step forward, and then back, and tell them they are molecules vibrating in response to the energy of the sound wave.



The first short activity you conduct with the soup cans and the saran wrap will show students that sound waves are transmitted through air, and the energy from them can be transferred to solid particles from the source through the air to the destination. As the sound waves hit the plastic wrap, the vibrations will cause the salt particles to “jump”. Making the plastic cup amplifiers is very easy. You can use any kind of string, and even provide different kinds of string to see if the sounds made are different. If you have resin available to coat the string, the sounds will be even louder. Violinists use resin on their bows, and baseball players may put some in a glove.

Relationship between sound and waves

Objectives

- Students will use observation skills to draw conclusions and make predictions.
- Students will be able to see the results of sound waves.

ENGAGE: PRE-ASSESSMENT (Completion time to write answers and discuss: 1/2 hour)

What can travel without being seen? What allows you to feel a loud noise? What sort of a wave looks more like a slinky than an ocean? *Ask the children to discuss these questions in groups and write the answers.*

At the end of the activity, have the students answer the same prompts to assess their learning.

Discuss the group answers to the questions provided above.

SOUND WAVES! Let’s make an amplifier for our sound. (Completion time to make amplifier and drum and do the activity will take about 1 hour)

First, ask the students to make a plastic cup amplifier. Ask them if they know what an amplifier will do.

Materials: Plastic cup, 1 meter piece of string, paper clip or toothpick. Punch a small hole in the bottom of the plastic cup with a pencil point, thread the string through it and tie a knot to the paper clip on top of the cup at the end of the string large enough so the string will not pull through the cup. Using a paper towel, pull along the string. Record your results on your O.W.L. paper.



Then, help students to overcome their misconception by performing the following activity (they will see that the salt does not travel through the air):

Explore: Now let's use our amplifier to find out some things about sound.

MATERIALS at Your Table

- 1 metal can with both ends cut off
- 1 sheet of plastic wrap
- Fine sand or table salt
- 1 plastic cup amplifier
- 1 rubber band



WHAT TO DO

1. Make a drum by stretching a piece of plastic wrap over a large round tin, a coffee can with both ends cut out, or a soup can with both ends removed.
2. Stretch the rubber band around the tin to hold the plastic very taut.
3. Sprinkle a small amount of salt or sand on to the top of the plastic drumskin.
4. Take your plastic cup amplifier, pull your fingers covered with the paper towel along the string sharply to make a loud sound and hold it near the plastic drum skin. *Students will see the salt dance on the surface of the plastic drum skin. They should observe that energy from the sound wave caused the drum skin to vibrate.*

QUESTIONS (BINQ3)

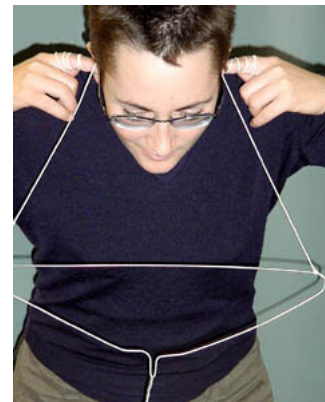
2. What did you observe? Write your observations in the "I notice" column in your notebook
3. What do you think caused the results that you noticed? *At this point, student groups could share their ideas about how the sound waves got from the sources to the plastic "drum" They could also extend this part of the investigation using different kinds of string and different sizes of cups.*
4. What questions do you now have? Write your questions in the "I wonder" column in your notebook.

The next part of the task is designed so that students can explore the different materials that can transmit sound. They can change the kind of string, or the thickness or material of the hanger, or different objects like spoons, with different lengths of string, and they can bang the object against different materials.

HAVE STUDENTS MAKE THE COAT HANGER CHIME...The "Hanger Clanger" (Time to make the clanger is only about 10 minutes, and exploration time after that is up to the teacher.)

Let's Make a "Hanger Clanger"!

What to Do Next: Your teacher will give each group a metal coat hanger and 2 pieces of string or yarn. Tie each piece of string to one of the bends in the coat hanger. Swing the coat hanger so it hits the side of your desk or table. Now wrap the ends of each string around the index finger of each hand, put each finger into your ear (just a little way in) and swing the coat hanger the same way you did before and hit the side of the table. You have made a "hanger clanger"!



QUESTIONS

1. What did you observe? Write your observations in the "I notice" column in your notebook
2. What questions do you now have? Write your questions in the "I wonder" column in your notebook.

A class discussion could be carried out at this point, and students could hypothesize as to the cause of the increased sound when they put the string near their ears.

ELABORATE:

Investigating Further: *Estimated time will depend on how long the teacher allows the discussion to continue. 30 minutes is a possible time frame to allow students to choose investigable questions. Another 30 minutes could be allowed to investigate and record results.*

1. Investigation #2- You will be using materials from investigation #1. Write down one investigable question from your "Wonder" column that you will share with the class. Your teacher will display the questions from the whole class. You will see that some of them could easily be investigated, while others cannot. *If you post the questions around the room, you would have divided them into investigable questions and those that could be held for future work, or as not investigable with available materials and time.*
2. Take a gallery walk to view all the investigable questions. You and your group members will then choose a question that you will pursue. *Students could divide into groups according to questions that they would like to pursue, or their group would have to agree on which question most interests them.*
3. Write the question you have chosen: *Students may ask how whether sound travels better through a solid, or a liquid, rather than air, whether types of string, length of string or thickness of coat hanger will make a different sound, or if string tied to other materials would make different sounds, etc. They may want to bang the hanger clanger against different materials, like cloth, wood, cinder block walls, metal doors, or Styrofoam. They must be sure to have only one dependent variable, and should try to make sure the "clanger" is swung the exact same distance each time. Or they could try swinging it against the same material, but swing it at different arcs each time. Use the term "Fair Test" frequently. Emphasize that only one thing can be changed when comparing sounds.*

CT Science Standard 5.1a- Sound
Sound and light are forms of energy.



CT Science Standard 5.1a- Sound

Sound and light are forms of energy.

- *Choose the question*

Grouping:

Teacher Selected

Student- put their number on a card 1st 2nd and 3rd for which category you want and the teacher placed the Post-Its on the categories which allows teachers to have some control over the process and also breaks up groups that may have been peer influenced.

1. Prediction/ Hypothesis
2. Plan (you may want to let the students know that they will communicate their investigation because it may influence some materials they request. Teacher approval of the plan must include a check on how they will capture data- maybe a self assessment for the plan (checklist)
 - a. Possible pair-share for each other to check over their plans. (make it easier for teacher)
 - b. Student can generate the rubric or checklist

Step Three: Complete the investigation

Step Four: Communicate the concepts that they learned. Purpose is the underlying concepts. This is the heart of the content.

Possible Strategies:

1. Share in group
2. Share with class
3. What would you do differently next time?
4. Be alert to possible misconception beforehand and have a plan

Step Five: Synthesis. ****Very important step**

Teacher ties back to the underlying concept so that everyone processes the ideas. Summarizing evidence that each group put forward that supports the concepts

Possible Strategies-

Chart paper with outcomes and as the students present the teacher

Plan the steps you will use, write them down, and check with your teacher before you begin. Students should have a do-able experiment written completely before beginning work. Make sure your activity is written so that someone who has not done this activity would be able to repeat it. Your teacher will let you know what choices you have in the way you will present what you learned to the class. It could be a data table, a graph, a poster, or a PowerPoint presentation. This could be decided by the teacher before students begin work, or choices could be offered. The results need to be measurable, so students will need to set up some kind of loudness scale for comparison. If they decide to do so, they might be able to use the distance from the "drum" membrane that will cause it to vibrate as a quantitative number. (BINQ4)

Analyze your data. Is the data reasonable? Do you need to repeat trials? Was it a fair test with only one variable? *Care must be taken to have only one dependent variable. This is a key*

CT Science Standard 5.1a- Sound
Sound and light are forms of energy.

question to ask. Much of what they do would be subjective, so they will have to think hard to come up with data they can report. (BINQ4)

Interpret your data. What conclusions can be made based on your data?

Share your procedures and conclusions with others in your class. (This aspect of the unit can take as long as the teacher wishes to give for class reports)

Now you will be applying what you learned to solve a new problem:

Performance-Based Assessment: (1 hour of time to prepare and build apparatus, another hour for discussion and reports of results.

You want to block sound waves from coming into your ears when you are trying to read a book in a noisy room. What materials might be useful? Choose from the following materials to use in planning and conducting your experiment: Styrofoam peanut pieces, sponge, cotton balls, fabric pieces, toilet tissues, paper towels, saran wrap, sandwich size plastic baggies, coat hanger, duct tape, a cloth scarf, water, bubble wrap, or think of some other materials that might work and ask your teacher if you can use them. Use two plastic sandwich bags and your hanger clanger along with materials provided to design something to cover your ears that will help to solve your problem. (B2)

How will you measure your information? *Students might try using the hanger clanger and rate the sound on a numerical scale as they hear it. They might try having someone make a sound at different distances behind them to see when they can hear it and measure the distance, or they might try using a buzzer or an alarm clock as a standard noise. Sometimes they might feel the vibration but be unable to hear the sound through the air.*

Be prepared to report your results back to the class and to explain why your particular idea was or was not successful. (BINQ9)

Post Assessment: Ask the same questions that were asked at the beginning of the unit. Return both papers to students and allow them to assess their own progress, deciding what process skills and what concepts were learned. A valuable discussion could ensue when certain concepts were not learned or completely understood.

Some web resources you might use:

<http://www.philtulga.com/MSSActivities.html>

<http://www.kettering.edu/~drussell/Demos/waves/wavemotion.html>

Acoustics Animations

@acoustics Animations.e

Kettering University Applied Physics

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Sound and light are forms of energy.

The Teacher could use the following reading segment anywhere in the lesson where it would seem appropriate.

When you think about waves, you might think first about water. You have seen waves in a lake or in the ocean as they move across the surface of the water. Did you know that there are lots of waves all around you that you cannot see? There are other kinds of waves that invisibly moving in the matter all around you right at this very moment! Some of these are sound waves which carry sound to your ears. Sound waves need to use water, air, or a variety of solids to travel from one place to another. You cannot see sound waves in the air, but you can feel their effects. When you strike a metal object, the metal continues to vibrate for a fraction of a second afterward. As it vibrates, the air around is also vibrating. These little vibrations in the air (sound waves) quickly move through the air in all directions.

When you speak or shout, your vocal chords **vibrate**. These vibrations create air movement which goes out in all directions through the air as waves. When these waves reach our ears, they make our eardrums vibrate so we can hear the words. The vibrating object, like your vocal chords, bumps the air particles next to it. They then bump the particles next to them, and so on. To get to our ears, **sound waves** need to travel through matter, like air, that can vibrate. Air is made up of particles, and these are what move to make the sound waves.

Most of the sounds we hear travel through the air, but sound waves can also move through other materials as well. Are other materials better carriers of sound waves than air? How do we know they are waves when we cannot see them?

Guided Investigation Sound

TEACHER RESOURCE INFORMATION

Underlying Science Concepts (Key Ideas)

- Sound and Light are forms of energy
- Light travels in straight lines and can be reflected off of smooth surfaces
- Light can be bent (refracted) when traveling through different media (through water, through glass, through a diamond, etc.)
- Light can be absorbed
- Opaque objects block light and cast shadows
- Translucent objects allow light through with a sharp image (looking through frosted glass)
- Transparent objects allow light through with a clear image (looking through a lens or clear glass)
- Sounds are created by striking, blowing, plucking, or blowing
- Different tensions make different frequency notes
- Striking an object harder makes a louder sound

Teacher Resources

Safety Disclaimer:

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Background for the Teacher

What is sound?

Sound is a form of energy that requires a medium (such as air). Most musical instruments create sound by striking, strumming, blowing, or plucking a string or an object. This causes either the object (a string or a drum head) to vibrate or for a cavity of air to vibrate (such as the air inside a guitar or violin body). Similarly to light, sound can also be absorbed or reflected. When it is reflected (such as an echo), there is generally a reinforcement or constructive interference which increases the volume.

Professional Development

Field Trip Professional Development Workshop

Come be a student for a day. Prior to bringing your class to the CT Science Center, you are encouraged to spend time at the Center and explore the exhibits and programs available to you and your students by participating in our two day Field Trip Professional Development Workshop.

During these two days, you will have an opportunity to explore the Art, Music, & Culture Gallery, the Planet Earth Gallery, and the Earth Science Gallery and other relevant galleries using our

standards based Trail Guides. These guides will lead you and your students on the pathway toward enjoying the museum while maintaining focus on your grade level or content standard.

You will also have the opportunity to participate as a learner in the pre visit, visit and post visit activities provided by the CT Science Center. In addition, you will participate in a Guided Investigation aligned with content standard 5.1. Afterward, you will process the various activities and discuss their applications in your classroom and in your students' learning.



5.1 Sound Content Workshop

Energy Transfer and Transformation

This is a five day content workshop focused specifically on standard 5.1 which focuses on the concept that light and sound are forms of energy. Through participating in this inquiry-based workshop, you will deepen your understanding of this standard and more importantly, be better prepared to guide your students to an in depth understanding of this concept as well.

During this workshop, you will have the opportunity to experience multiple inquiries that will guide you to a deeper understanding of the science concept, as well as the opportunity to then process the inquiries as a teacher and discuss their applications in your classroom and in your students' learning. You will also experience the integration of language arts and science through vocabulary, nonfiction texts and science notebooking.

Come for the week and collaborate with other Grade 5 teachers across the state as you design and develop your own inquiry-based lesson to be used in your classroom with your students.

Interdisciplinary Extensions:

Language Arts

Are you fascinated by dolphins or bats?

Be a researcher and find the connections between dolphins and sound or bats and sound. Prepare a short presentation with a visual and share your findings with the class.

Compare Light and Sound.

Create a folded book, Dinah Zike style (www.dinah.com).
Section suggestions 1. What is energy? 2. Characteristics of light; 3. Characteristics of sound; 4. Illustration of how sound travels; 5. Illustration of how light travels; 6. Illustrate or use words to show the relationship between light and transparent materials, translucent materials and opaque materials; 7. Choose a musical instrument and explain the part that vibration plays in determining the pitch.

Have fun with words – onomatopoeia

Listen carefully. "Splash," is that sound being made by water? Words that sound like the sound are called onomatopoeic words. Make a mini book of onomatopoeic words. Be sure to write the word on the page and illustrate it.

Expository Writing

Your school principal has made a new rule. This year's school band or orchestra will be made up of only one instrument instead of several. Write a letter to your principal respectfully explaining why you do not feel that this is a good idea. Be sure to include facts about what you have learned about vibration, pitch and the transmission of sound.

Art

Design an echo free gym.

Become a building designer and design a school with an echo free gym. Is it possible? What will your gym look like? Will it have windows? Will the walls be made of metal? Find a small box and turn it into an echo free gym.

Hint: You may use materials in the classroom craft box.

Technology

Are you interested in participating in a Webquest?

Log in to "Sounding it out . . .

http://www.mcteach.net/student/science/sound/webquest/sound_webquest.htm

To Ring or not to Ring!

Sometimes a cell phone "rings" at an inappropriate time. You are waiting for a very important call. The silent mode on your phone is not working. You must rely on one of the "ring" modes. Which of the modes will be the least disturbing? Listen to each ring and compare/contrast the "rings" according to pitch. Present your compare/contrast chart to the class and, if you have parental and teacher permission, bring in the phone and let us hear the ring you have selected due to the least disturbing pitch.

Teacher Websites

How Stuff Works

<http://science.howstuffworks.com/sound.html>

"How Stuff Works" provides a wonderful background on sound energy. You can get lots of information about sound at the following website

<http://hyperphysics.phy-astr.gsu.edu/hbase/HFrame.html>

HyperPhysics is a wonderful site that not only gives understandable explanations of the range of Physics topics, but shows how those different areas are connected and related to each other.

Online Projects

<http://webquest.org> This site has a collection of web quests organized by grade level and subject area. "Good Vibrations Sound Solution" is a WebQuest is designed for fifth grade. The Sound Police are considering placing a ban on sound at Good Vibrations Academy. It is your job to find a creative solution.

Literature Links Energy

Title	Author	ISBN	Publisher	How resource has been used in unit
<u>Energy</u>	Block, Arlene	0-328-13793-6	Pearson Scott Foresman	This book explores energy and the kinds of energy. Photographs of everyday situations help students to grasp the concepts. This book would be appropriate for students who need a lower reading level. (2.9)

Literature Links Sound

Title	Author	ISBN	Publisher	How resource has been used in unit
<u>Science Alive Sound</u>		0-7787-0608-7	Crabtree	Studying sound is fascinating. This book describes how we hear sounds and presents some interesting investigations.
<u>All about Sound</u>	Anderson, Kristen	0-328-13800-2	Pearson	Colorful photographs provide a visual representation of concepts for struggling readers.
<u>How Can I Experiment with Sound?</u>	Dalton, Cindy	1-58952-042-4	Rourke Publishing	Colorful photographs combined with captions that address a sound concept make this an appropriate book for a student at any reading level.

CT Science Standard 5.1a- Sound*Sound and light are forms of energy.*

<u>How Sound Travels</u>	Borland, Kim	0-328-13801-0	Pearson	Sound waves, pitch, echoes and the speed of sound are just a few of the concepts discussed in this book. Students reading on a fifth grade level would be especially interested in the explanation of echolocation.
<u>Sound</u>	Sandow, Timothy	0-328-13847-9	Pearson	All students, especially those enrolled in instrumental music programs, will benefit from reading the sections on musical instruments.
<u>Sound</u>	Trumbauer, Lisa	1-56784-342-5	Newbridge	This big book would provide a fantastic introduction to the study of sound.
<u>Sound</u>	Walker, Sally	0-8225-2840-1	Lerner	Adults and students will enjoy the chapter, "Sounds We Can't Hear."
<u>How Sound Works</u>	Weiss, Wendy	0-328-13848-7	Pearson	What is sound; how do we hear sounds; how is sound made – are just a few of the topics addressed in this book.

Teacher Resources

Title	Author	ISBN	Publisher	
<u>Stop Faking It Sound! Finally Understanding Science So You Can Teach It</u>	Robertson, William		NSTA Press	Excellent resources for teachers who would like a refresher in the physics of light and sound. You will have opportunities to laugh while learning.

CT Science Standard 5.1a- Sound
Sound and light are forms of energy.

Videos

The Way Things Work – Sound

Based on book by David Macaulay 2003, Schlessinger Media

The Way Things Work – Musical Instruments

Based on book by David Macaulay 2003, Schlessinger Media

http://www.nidcd.nih.gov/health/education/video/sound_vid.htm

Sound and Deafness

http://www.metacafe.com/watch/27875/breaking_the_sound_barrier/

Breaking the sound barrier



CT Science Standard 5.1a- Sound
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Classroom Kits

Physics of Sound

Delta

www.delta-education.com

Sound

Insights

Kendall/Hunt Publishing Company

www.insightsK-6.com

Sound

Science and Technology for Children

<http://www.carolina.com>

Posters for Classroom Use

Investigating Sound www.neosci.com

CT Science Standard 5.1a- Sound
Sound and light are forms of energy.

Software

The websites that have been listed above provide interactive learning activities (for free). Students are able to engage with these resources, and no additional software is required.

CT Science Standard 5.1a- Sound

Sound and light are forms of energy.

Home/School/Community Connection

- You could invite parents to come and watch their child's Performance Task presentation.
- Students write newsletters home describing their experience at the CT Science Center and what they've learned about sound and light.
- Ask for parent volunteers to come in and assist you with the pre- and post- activities.
- Ask the high school music department coordinator to demonstrate different musical instruments (invite students to come along).

Careers in Sound

Audiologist - assesses and treats persons with hearing and related disorders, also counsels in strategies to improve speech or hearing impairment and ways to protect our hearing.

Composer - writes music using musical notation so others can perform what is written.

Conductors - use visual gestures to lead a group of musicians.

Instrumentalists - play musical instruments, examples - drummer, flautist, guitarist, harpist, pianist, and trumpeter.

Medical Ultrasonographer - uses a medical imaging technique based on high frequency sound to visualize internal organs, muscles etc.

Musical Instrument Repairers - repair musical instruments such as, guitar (electric and acoustic), bass, mandolin, banjo, fiddle, violin, viola, cello, double bass, and ukulele.

Sound Engineers - operate machines and equipment to record, synchronize, mix or reproduce music, voices or sound effects in sports arenas, theater productions, recording studios or movie productions.

Vocalists - individuals who use their voice as an instrument; examples are a singer or rapper.



Student Resources

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Student Websites

www.exploratorium.edu This site offers links to hundreds of topics related to sound. Listen: Making Sense of Sound is devoted to attentive listening - one of the links affords the opportunity to tune into nature's subtle clues; or you can link to a hydraulic model of the cochlea, listening to Aretha Franklin's "Respect."

www.bbc.co.uk/schools/ks2bitesize/science/ This site has interesting links to: Changing Sounds- you can change the pitch of the guitar

www.wonderville.ca/vl/activities/hearing_sound.html Click on "How We Hear" and students will have an opportunity to observe a sound wave and listen to the sounds of various animals and objects, such as cymbals.

www.fearofphysics.com/sound/sounds.html This site introduces sound and makes connections between sound waves and how we hear. Students are able to listen to sounds between 300 hertz and 1000 hertz

CT Science Standard 5.1a- Sound
Sound and light are forms of energy.

