Project CONN-CEPT Science Units

Astronomy: Sun, Moon, and Stars (K-2)
The World of Matter (1)
Living Things: Changes, Stages and Cycles (2-3)
Eurekas and Ecosystems (4-5)
Light: A Rainbow of Explorations (4-5)
Sound's Story: H-Ear the Pitch (4-5)
Structure and Function: What's Their Junction? (6)
Weather: The Never-Ending Story (6)
Cells: The Story of Life (7)
Reactions and Interactions (7-8)

Project CONN-CEPT Social Studies Units

Time Change and Continuity in History (K)
Local Government (3)
What Makes a Region? An Investigation of the Northeast (4)
Goods, Services, Resources, Scarcity and Systems: An Exploration of State Economics (4-5)
Concepts and Tools of the Geographer (6)
With Liberty and Justice for All: A Study of the U.S. Constitution (6-8)

Units in Preparation

Junior Economist: People, Resources, Trade (1-2)
A Habitat is a Home for Plants and Animals: Needs, Resources, Adaptation and Systems (1-2)
May the Force Be with You: Forces, Motion and Simple Machines (2-3)
Comparing Cultures: Tradition, Dwellings, Language, and Cultural Evolution (2-3)
Peopling of the Americas (4-5)
Going to the Source: Using Primary Resources in United States History (6-8)
Exploring the World's Oceans: Chemistry, Geology and Biology (7)
Reactions and Interactions: Chemical Reactions (7-8)

Research for this grant was supported under the Javits Act Program (Grant No. S206A020086) as administered by the Institute of Educational Sciences, U.S. Department of Education. The opinions expressed in this report do not reflect the position or policies of the Institute of Education Sciences or the U.S. Department of Education.

A Shared Story

The exhibit hall was huge, and publishers' banners, suspended from the ceiling, waved back and forth in the air conditioned room. Hundreds of conference participants filled the aisles. Vendors of curriculum materials, eager to share their colorful and glossy wares with passing teachers and administrators, stood at the edge of their displays offering warm smiles, prizes, and publishers' catalogues.

Charlene and Andrew had carefully planned their tour through the aisles and divided up so that they could see all the materials. They looked forward to their time in the vendor area because they needed curriculum materials in social studies and science for their upper elementary and middle school students. They hoped they would find something good. They wanted coherent, comprehensive units that addressed their state and national standards, had good assessments, required students to think their way through content, provided teachers with teaching strategies, and some guidance regarding how to differentiate the curriculum for students with varied learning needs.

They looked at many cleverly designed curriculum packages and kits. Most materials were collections of episodic learning activities. Some contained coherent learning activities for students, but did not teach to the critical concepts and principles embedded in state and national standards. Other materials, claiming to be comprehensive, did not contain aligned pre- and post-assessments, user-friendly teacher information, suggestions for teaching, or techniques for differentiating. Several kits attended to concepts and principles, but none was comprehensive enough to address all the standards for a particular grade level. At least two kits would be required to cover the prerequisite standards. Worse, the cost for the two kits would not include the price for the consumables that would have to be purchased each year to keep the kits adequately stocked. They could hardly pay for the cost of one kit!

Charlene and Andrew met at the back of the hall and compared notes. They were disappointed because they realized that the high-quality, standards-based curriculum materials they wanted were not in the racks. Now what? Were there other vendors? If so, who were they and how could they be contacted? If there were no vendors with the materials they needed, could they write the needed curriculum themselves? Who could help them? Did the district have money to pay stipends for curriculum development? How could they possibly write all the curricula that was required to address the state assessments?

We dedicate this curriculum unit, as well as others written under this Javits grant, to all the teachers who have had experiences like Charlene and Andrew. We hope the unit presented here will meet the needs of educators who live in real classrooms, contend with real time constraints, prepare students adequately for high-stakes assessments, seek high-quality curriculum materials, and strive to meet the varied learning needs of all their students.

Deborah E. Burns
Jeanne H. Purcell

PREFACE

In 2002, the Connecticut State Department of Education was awarded a Javits grant from the U.S. Department of Education called Project CONN-CEPT. The major focus of grant activities was the creation of standards-based curriculum units, K-8, in science and social studies. These rigorous curriculum units have been created for all students because every child must have access to the highest quality curriculum. At the same time, the units also have a particular focus on the needs of advanced learners—those who know more, learn more rapidly, think more deeply, or who are more innovative in a particular area of study. It was our goal to embed learning opportunities for advanced learners that were tightly aligned with the concepts and principles that guided the unit.

The Parallel Curriculum Model

This standards-based curriculum unit has been designed using the *Parallel Curriculum Model* (PCM) (Tomlinson, Kaplan, Renzulli, Purcell, Leppien, & Burns, 2002). The *Parallel Curriculum Model* is a set of four interrelated designs that can be used singly, or in combination, to create or revise existing curriculum units, lessons, or tasks. Each of the four parallels offers a unique approach for organizing content, teaching, and learning that is closely aligned to the special purpose of each parallel. The four parallels include: the Core Curriculum Parallel, the Curriculum of Practice, the Curriculum of Connections, and the Curriculum of Identity.

The *Core Curriculum* addresses the core concepts, principles, and skills of a discipline. It is designed to help students understand essential, discipline-based content through the use of representative topics, inductive teaching, and analytic learning activities. The *Curriculum of Connections* builds upon the Core Curriculum. It is a plan that includes a set of guidelines and procedures to help curriculum developers connect overarching concepts, principles, and skills within and across disciplines, time periods, cultures, places, and/or events. This parallel is designed to help students understand overarching concepts, such as change, conflict, cause and effect, and patterns, as they relate to new content and content areas. The *Curriculum of Practice* is a plan that includes a set of guidelines and procedures to help students understand, use, generalize, and transfer essential knowledge, understandings, and skills in a field to authentic questions, practices, and problems. This parallel is designed to help students function with increasing skill and competency as a researcher, creator, producer, problem solver, or practitioner in a field. The *Curriculum of Identity* is a plan that includes a set of guidelines and procedures to assist students in reflecting upon the relationship between the skills and ideas in a discipline and their own lives, personal growth, and development. This parallel is designed to help students explore and participate in a discipline or field as it relates to their own interests, goals, and strengths, both now and in the future.

The *Parallel Curriculum Model* also contains a new concept called Ascending Intellectual Demand (AID). Ascending Intellectual Demand offers practitioners a way to think about a discipline and each student's steady, progressive movement from novice to expert within that discipline. As students are ready, teachers ask students for increasing levels of cognition, affect, and application. As such, AID is a framework teachers use to increase the challenge level for students by asking them to behave and act in expert-like ways. (Tomlinson, Kaplan, Purcell, Leppien, Burns, & Strickland, 2006).

This unit has been designed using the Core Curriculum Parallel. Core Curriculum addresses the essential concepts, principles, generalizations, and skills of a subject area. It is designed to help students understand essential, discipline-based content through the use of representative topics, inductive teaching, and analytic learning activities. Although the majority of lessons in this unit have been designed using the Core Curriculum Parallel, it also contains several lessons that provide students with opportunities to explore other parallels that are closely connected to the subject matter.

Our Invitation…

We invite you to peruse and implement this curriculum unit. We believe the use of this unit will be enhanced to the extent that you:

- **Study PCM**. Read the original book, as well as other companion volumes, including *The Parallel Curriculum in the Classroom: Units for Application Across the Content Areas, K-12* and *The Parallel Curriculum in the Classroom: Essays for Application Across the Content Areas, K-12*. By studying the model in depth, teachers and administrators will have a clear sense of its goals and purposes.
- **Join us on our continuing journey to refine these curriculum units.** We know better than to suggest that these units are scripts for total success in the classroom. They are, at best, our most thoughtful thinking to date. They are solid evidence that we need to persevere. In small collaborative and reflective teams of practitioners, we invite you to field test these units and make your own refinements.
- **Raise questions about curriculum materials.** Provocative, compelling and pioneering questions about the quality of curriculum material—and their incumbent learning opportunities—are absolutely essential. Persistent and thoughtful questioning will lead us to the development of strenuous learning opportunities that will contribute to our students' life-long success in the 21st century.
- **Compare the units with material developed using other curriculum models.** Through such comparisons, we are better able to make decisions about the use of the model and its related curriculum materials for addressing the unique needs of diverse learners.
- **Examine PCM as one bridge between general and gifted education.** We believe that the rigorousness of PCM has much to offer *all* students, not just those who may already know, do, or understand at very different levels of sophistication.

ACKNOWLEDGEMENTS

We would like to thank our mentors, Carol Tomlinson and Carolyn Callahan. They have been our constant supporters and guides as we moved into uncharted territory related to curriculum development and differentiation.

Over the years we have been guided by the wise counsel of our curriculum writers: Cheryll Adams, Renee Alister, Karen Berk, Fie Budzinsky, Meagan Bulger, Yvette Cain, Lori Cipollini, Leslie Chislett, Megan Coffey, Edie Doherty, Claire Farley, Kurt Haste, Carla Hill, MaryAnn Iadarolla, Caitlin Johnson, Megan Lamontagne, Donna Leake, Lisa Malina, Kay Rasmussen, Martha Rouleau, Cindy Strickland, Mary Grace Stewart, Kim Turret, Ann Marie Wintenberg, and Karen Zaleski. They have worked tirelessly on their curriculum units and provided us with many insights into the curriculum writing process. Although we had a road map at the outset of the writing process, our writers helped us to craft new roads when the old ones no longer worked. We thank them for their integrity, care, innovativeness, and encouragement.

We thank all of the people who featured into the field testing process. These people include teachers in Cheshire, Hartford and Portland Public Schools. We especially want to thank the following building administrators who supported our work: Tory Niles and John Laverty from Hartford; Linda Cahill and Deborah Granier from Portland; and Steve Proffitt, Diane DiPietro, Sharon Weirsman, Russ Hinkley, Beverly Scully, and Mary Karas from Cheshire. The insights from teachers and administrators helped to make our curriculum units stronger and more practical.

Kim Allen, from Project LEARN, provided us with assistance and support in all of our endeavors and made sure that we stayed the course in solid financial standing. Nancy Wight and Gail Heigel, from Cheshire Public Schools, spent untold hours formatting, typing, duplicating, collating, and distributing the experimental units and ordering the numerous student materials and teacher resources that supplement these lessons. They are the masters of due diligence and attention to detail. We also wish to thank Eileen Williams and Patricia Johnson, from the State Department of Education, for formatting, typing, and preparing the pre-assessments and post assessments for the units. They worked tirelessly for many hours after work and on weekends to meet our deadlines and never lost their smiles.

We thank Cheshire Public Schools and the Connecticut State Department of Education for allowing us to take on this tremendous task and allowing us the hours within day (and night) to accomplish all that was required.

Our families and friends deserve special recognition because they offered unwavering support and encouragement. We recognize they made personal sacrifices, and we hope that we have grown as a result.

Most of all, we would like to thank Judy Walsh on whose shoulders these units truly stand. With the greatest of care and unparalleled thoughtfulness and consideration, Judy has edited each manuscript, worked collaboratively with each author to refine each lesson, written lessons when it was necessary, and provided a sense of humor and her wisdom as a teacher. She is selfless and seeks only to advance each author and the project. In every way, she has been our "North Star" on the project.

Format for the Project CONN-CEPT Curriculum Units

Each Project CONN-CEPT curriculum unit is formatted in the same way and contains four components: an overview, the lessons, a content map, and a comprehensive list of resources required in the unit. The *overview* is a chart that includes the lesson principles, concepts and skills, the time allocation, the standards that are explicitly addressed within each lesson, and a brief description of each lesson. The overview provides potential users with a "snap-shot" of the unit, related standards, and classroom activities.

The *lessons* follow the overview and vary in number depending upon the content area and grade level of the unit. Each lesson is comprehensive and addresses 10 curriculum components: content, assessments, introductory and debriefing activities, teaching strategies, learning activities, grouping strategies, products, resources, extensions, and differentiation activities. For the most part, each lesson provides specific information about each of these components. An aligned pre- and post-assessment is included for the entire unit, and aligned formative assessments are provided at critical junctures in the unit. Additionally, each lesson contains all the required black-line masters and materials.

Many lessons contain two features that are unique to Project CONN-CEPT materials: opportunities for Ascending Intellectual Demands (AID) and talent-spotting activities. Ascending Intellectual Demand is a term used to describe learning opportunities that require students to work at increasing levels of discipline-specific expertise (Tomlinson et al). They are appropriate for any student who demonstrates advanced ability or expertise in a discipline. The AID opportunities are labeled using the acronym AID. Additionally, many lessons contain searchlight opportunities. Searchlight opportunities are rich moments during a lesson for teachers to observe students and note those who appear to have heightened interest in the topic under investigation. To support these students' emerging interests, extension ideas are provided.

A *content map* comes after the lessons. Like the overview, the content chart is a snap-shot of the important knowledge in a unit: the major and minor principles, concepts, skills, themes and guiding questions. Teachers who want in-depth information about the knowledge contained in the unit will find this chart useful.

A comprehensive list of *resource materials* concludes each unit. Although the required materials are also listed at the beginning of each lesson, the comprehensive listing provides teachers with a one-page summary of all the materials and it facilitates planning.

Sound's Story: H-Ear the Pitch: Grades 4-5

This unit on sound has been designed using the Core Curriculum parallel. Core Curriculum addresses the core concepts, principles, generalizations, and skills of a subject area. It is designed to help students understand essential, discipline-based content through the use of representative topics, inductive teaching, and analytic learning activities. Although the majority of lessons in this unit have been designed using the Core Curriculum parallel, it also provides several lessons that provide grade 4/5 students with opportunities to connect the material to another discipline (Curriculum of Connections). In addition, there is a lesson that gives students the chance to reflect on themselves (Curriculum of Identity).

The unit contains 11 lessons that are outlined in the chart below. The first column contains the lesson number and the name of the parallel(s) that the lesson addresses. The second column contains a series of numbers. The numbers reflect the national standards—culled from *National Science Education Standards* (National Research Council, 1996) and *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993)—that are addressed in each lesson and that are listed and numbered below. Connecticut's standards are also listed in a similar fashion. For brevity's sake, only one or two standards are listed in each row of the chart and represent the major focus of individual sessions. However, the lessons have been designed to build upon each other, and each session builds iteratively upon many of the standards.

Column three contains the principles that guide the lesson. The principles—which state relationships among essential concepts—reflect what we want students to know and be able to do upon completing the lessons. They are derived from the standards, reflect both declarative and procedural knowledge, and illustrate the careful attention that has been given to "teasing apart" the complexity of ideas contained within standard statements.

Column four includes a brief description of the lesson. It provides an overview of some of the teaching and learning activities that are designed to occur within the classroom.

National Standards

Physical Science

1. Sound is produced by vibrating objects. The pitch of sound can be varied by changing the rate of vibration. (*National Science Education Standards*, K-4)
2. Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways. (NSES*, K-4)
3. Vibrations in materials set up wavelike disturbances that spread away from the source. Sound and earthquake waves are examples. These and other waves move at different speeds in different materials. (*Benchmarks for Science Literacy*, 6-8)

Science as Inquiry

4. Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world. (NSES, K-4)
5. Scientists use different kinds of investigations depending on the question they are trying to answer. Types of investigations include describing objects, events and organisms; classifying them; and doing fair test (experimenting). (NSES, Science as Inquiry, K-4)
6. Simple instruments, such as magnifiers, thermometers, and rulers, provide more information than scientists obtain using only their senses. (NSES, K-4)
7. Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations. (NSES, K-4)
8. Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations. (NSES, 5-8)
9. Science advances through legitimate skepticism. Asking questions and querying other scientists' explanations is part of scientific inquiry. Scientists evaluate the explanations proposed by other scientists by examining evidence, comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations. (NSES, 5-8)

Models

10. Seeing how a models works after changes are made to it may suggest how the real thing would work if the same were done to it. (BSL**, 3-5)

Constancy and Change

11. Some features of things may stay the same even when other features change. Some patterns look the same when they are shifted over, or turned, or reflected, or seen from different directions. (BSL, 3-5)

* National Research Council. (1996). National science education standards. Washington, DC: National Academy Press.

** American Association for the Advancement of Science. (1993). Project 2061: Benchmarks for science literacy. New York: Oxford University Press

Connecticut Related Content Standards
Grades 3-5

I Scientific Inquiry (Expected Performances – B INQ. 1, B INQ. 2, B INQ. 3, B INQ 4)
Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena.

Scientific Literacy (Expected Performances – B INQ. 5, B INQ 8)
Scientific literacy includes speaking, listening, presenting, interpreting, reading and writing about science.

Scientific Numeracy (Expected Performances – B INQ. 9)
Mathematics provides useful tools for the description, analysis and presentation of scientific data and ideas.

Grade 5

5.1 Energy Transfer and Transformations (Expected Performances – B 17, B 18)
What is the role of energy in our world?
Sound and light are forms of energy.

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

5.2 Structure and Function (Expected Performances – B 21)
How are organisms structured to ensure efficiency and survival?
Perceiving and responding to information about the environment is critical to the survival of organisms.

- The sense organs perceive stimuli from the environment and send signals to the brain through the nervous system.

Lesson	Standards	Lesson principles	Lesson description
1 (CORE) 45 minutes			This lesson includes a pre-assessment that questions students' current understandings regarding the nature of sound, its connections to their anatomy, specifically the function of the ear, and its uses in technology applications, such as sonar and ultrasonic devices.
2 (CORE) 1 hour	1, 2, 4, 5 CT Standards: I (Expected Performances – B INQ. 1, 3) 5.1 (B 17)	• Sound is produced when material vibrates. • Sounds are abundant most everywhere and most all the time. • Sound is the invisible transfer of motion from one object or material to another. • Sounds can be amplified.	Students will explore the question as to how sounds are made in this lesson. They will engage in two activities that lead them to understand that sound is formed because of vibrations of matter, including air. In addition, they will explore the concept that sounds can be transferred from one material to another.
3 (CORE/ AID) 50 minutes	2, 3, 5, 7 CT Standard: I (Expected Performances – B INQ. 1, 3, 5) 5.1 (Expected Performances – B 17, B 18)	• Sound travels through solids, liquids and gases. • Sound is the invisible transfer of motion from one object or material to another. • The nature of a substance determines how well sound travels through it (AID).	In this lesson students will continue their exploration of sound by doing three activities that lead them to understand that sound can travel through all types of matter, including air. They continue to explore the concept of transfer of motion and learn about the concept of resonance by discussing such things as why a singer can shatter glass when she sings a certain note. Two AID opportunities for students to explore how sound changes as it travels through different media.
4 (CORE) 55 minutes	1, 4, 6, 9 CT Standards: I (Expected Performances – B INQ. 1, 3, 4, 5, 9) 5.1 (Expected Performances – B 17, B 18)	• Pitch can be changed by altering the characteristics of the vibrating source that produces the sound. • The stronger the vibration of the source (stronger the input) for a sound, the greater its intensity or loudness will be. • Larger volumes of material vibrate more slowly and vice versa. • Different lengths of vibrating air produce different sounds.	Students in this lesson will discover that they can identify different characteristics of sound, such as volume and pitch and even the tone of a musical note. The students start their investigation of the variations in sounds by holding a ruler against a desktop, so that some of the ruler hangs over the edge. Students will vary the amount of ruler that extends, while "plunking" the ruler to hear the resulting sound. Students will thus explore the concept that there are variations in sound from a given object and that those variations seem to be caused by different, specific types of movement of the object.

SOUND'S STORY: H-EAR THE PITCH

Lesson	Standards	Lesson principles	Lesson description
5 (CORE/ AID) 50 minutes	1, 7, 8 (AID), 9 CT Standards: I(Expected Performances- B INQ. 1, 2 (AID), 3, 4, 5, 8 (AID), 9 5.1 (Expected Performance – B 17, B 18)	• Pitch can be changed by altering the characteristics of the vibrating source that produces the sound. • The stronger the vibration of the source (stronger the input) for a sound, the greater the volume or loudness will be.	Students in this lesson will explore what aspect of the change in the vibrating source explains the resulting differences in the sounds of notes. Specifically, students will do activities with bottles and straws that help them understand that sounds are produced and can be varied by vibrating varying lengths of air columns. Two AID activities offer students who need an additional challenge an opportunity to research instruments that use vibrating air or the chance to extend the class activity with bottles and straws.
6 (CONNECTIONS) 1 hour, 30 minutes	1, 4, 7 CT Standards: I (Expected Performances – B INQ. 1, 3) 5.1 (Expected Performances – B 17, B 18)	• Pitch can be changed by altering the characteristics of the vibrating source that produces the sound.	In this lesson students will explore the nature of a musical scale and how different vibrating sources can produce the pitches needed to create a scale. In the activity students will be challenged by a fictitious movie company to create a musical instrument that can play a full, eight-note scale of music. They will name their invention and share with class members its versatility and appropriateness for an animated adventure movie.
7 (CORE/ IDENTITY/ AID) 1 hour, 20 minutes	5, 7, 8 (AID), 9, 10 CT Standard: I (Expected Performance – B INQ. 1, 3) 5.1 (Expected Performance – B 18)	• Sound waves can be absorbed. • Not all materials absorb sound energy in the same manner. • Sound waves can be reflected. • Solid surfaces reflect sound better than porous surfaces. • Echoes are an example of sound reflection.	Students have seen how sound can be transmitted through materials. In this lesson they will explore the absorption and reflection of sound, as it strikes various substances. They will see the similarity between a sponge's ability to absorb water and a porous substance's ability to absorb sound. They also will discuss sound reflection as experienced through echoes and in places (e.g., loud restaurants) where sounds are not absorbed sufficiently. Finally, students will discuss some of the similarities between some of sound's and light's behaviors. An AID activity invites students to investigate the science of acoustics and the fittings architects use to absorb sound.
8 (CONNECTIONS) 50 minutes	5, 7, 10 CT Standards: I (Expected Performance – B INQ. 1, 3) 5.2 (Expected Performance B 21)	• The ear is an organ for hearing and balance. • Air vibrations cause the ear drum to vibrate, which in turn causes other parts of the inner ear to vibrate which is then translated by the brain into sounds.	Students will explore how the human ear is built to detect sound. Specifically, in this lesson students will investigate how they actually hear sound by examining a diagram of an ear. It will be used to help students better understand the connection between the biological structures and functions of the ear's parts.

Lesson	Standards	Lesson principles	Lesson description
9 (CORE/ AID) 1 hour	5, 7, 8 (AID), 11 CT Standards: I (Expected Performances – B INQ. 1, 3, 4, 5) 5.2 (Expected Performances – B 17, B 18)	• The range of sound is broad, and there are many sounds that humans cannot hear. • Some animals can hear sounds that humans cannot.	There is a whole different world to see and hear that humans cannot experience without the help of technology. In this lesson students listen to a conventional whistle and then try to hear a dog whistle. They soon realize that humans cannot hear what some other animals can. Three AID activities are offered for students who need more challenge. They can investigate normal everyday sounds and create a safety poster to show the sounds and their decibel levels. A second activity focuses on fetal ultrasound, and a third investigates oscilloscopes.
10 (CONNECTIONS /AID) 35 minutes	5, 7 CT Standard: I (Expected Performances – B INQ. 1, 3) 5.2 (Expected Performances – B 18)	• Sound can be encoded and used as a means of communication.	In this lesson students will enjoy using sound variations, specifically the Morse code, to communicate with one another. They will make a connection between science and those people who invent things that use scientific concepts. An AID activity gives students the opportunity to get a historical perspective on an inventor by researching Samuel Morse's life, the inventor of the telegraph, and, of course, the Morse code.
11 (CORE) 45 minutes		All principles in the unit	Post assessment

Reference

American Association for the Advancement of Science. (1993). *Project 2061: Benchmarks for science literacy.* New York: Oxford University Press.

Connecticut State Department of Education. (2004). *Core science curriculum framework*. Hartford, CT: Connecticut State Department of Education.

National Research Council. (1996). *National science education standards.* Washington, DC: National Academy Press.

Tomlinson, C. A., Kaplan, S. N., Renzulli, J. S., Purcell, J., Leppien, J., & Burns, D. (2002). *The parallel curriculum: A design to develop high potential and challenge high-ability learners*. Thousand Oaks, CA: Corwin Press.

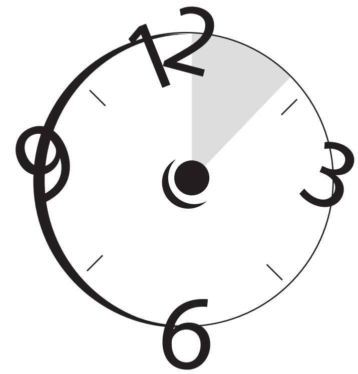
CONTENTS

Sound Right with Sound! and H-ear's the Pitch: Listen Up!

Core

Time Allocation: 45 minutes

Required Materials and Resources on Page 121



Lesson Overview

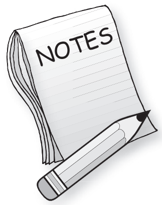
Students in this lesson answer pre-assessment questions that demonstrate their current understandings regarding the nature of sound, its connections to their anatomy, specifically the function of the ear, and its uses in technology applications, such as sonar and ultrasonic devices.

Guiding Questions

- How are sounds made?
- What makes different sounds that come from the same object sound differently?
- Can sound travel through water?
- Can a singer really shatter a glass across a room?
- Can sound travel through empty space?
- Can sound be produced when no one is around to hear it?
- What makes a sound louder?

BIG IDEA

What do I know about sound?



Content Goals

Universal Theme(s)

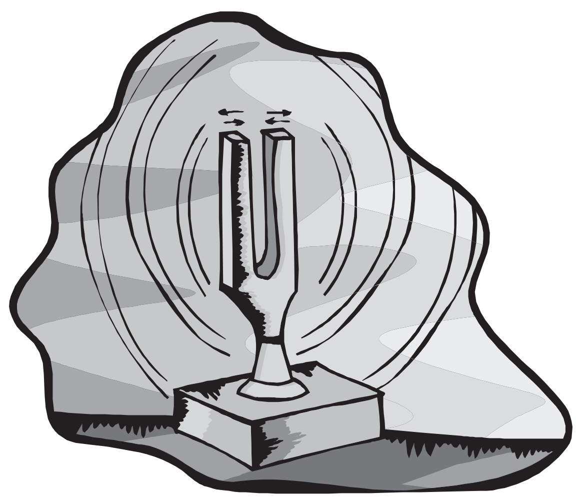
- Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena.
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.
- Form and function are interdependent.

Principles and Generalizations

- Sound is produced when material vibrates.
- Sounds are abundant most everywhere and most all the time.
- Sound is the invisible transfer of motion from one object or material to another.
- Sounds can be amplified.
- Sound travels through solids, liquids and gases.
- The nature of a substance determines how well sound travels through it (AID).

Concepts

- Model
- Sound
- Vibration
- Transfer of sound
- Sound amplification
- Pitch
- Intensity or loudness of sound



Teacher Information

N/A

Skills

- Predict
- Make observations

- Record data
- Interpret data
- Identify characteristics
- Compare and contrast
- Draw conclusions
- See relationships

Materials and Resources
N/A

Preparation Activities
1. Copy the pre-assessment, **Pre-asssessment for the Sound Unit** for each student.
2. Copy the **Possible Answers to the Pre-asssessment for the Sound Unit.**

Introductory Activity
N/A

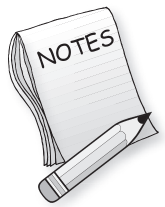
Pre-assessment
Pre-assessment for the **Sound Unit**

Teaching and Learning Activities (50 minutes)
1. Explain to students that the pre-assessment will be used as a tool by you to measure their previous knowledge. Emphasize that they should make their best effort on the assessment but should not worry if they do not know some of the questions.

2. Distribute the **Pre-assessment for the Sound Unit**.

Products and Assignments
Students' assessment results

Extension Activities
N/A



Post Assessment
N/A

Debriefing and Reflection Opportunities
N/A

Name ______________________________ Date______________

Pre-assessment for the Sound Unit

1. Would you be most likely to hear an echo in a room that is:
    a. Empty
    b. Filled with drapes, curtains, carpet, and furniture
    c. Contains one couch
    d. None of the above

2. What medium would sound travel through the most quickly?
    a. Wood
    b. Water
    c. Air
    d. None of the above

3. What object would absorb the most sound?
    a. Wood
    b. Cement
    c. Pillow
    d. None of the above

4. What object would reflect the most sound?
    a. Glass
    b. Blanket
    c. Air
    d. None of the above

5. ______ must occur to produce sound.
    a. Heat
    b. Vibrations
    c. Nuclear
    d. None of the above

6. What does reflection of sound mean?
    a. Sound waves bouncing off an object
    b. Sound waves absorbed by an object
    c. Sound waves travel through matter
    d. None of the above

Name ______________________________ Date_______________

7. What does absorption of sound mean?
    a. Sound waves are taken into the object
    b. Sound waves bounce off the object
    c. Sound waves skip over the object.
    d. None of the above

8. If you held a Ziploc bag by your ear and you wanted to hear someone tapping on it the most clearly, what would you put inside?
    a. Air
    b. Water
    c. Wood
    d. None of the above

For the following questions, answer as completely as you can!

9. Can sound travel through each of the states of matter listed below? If so, **list an example** and **explain**.

Liquids?

Solids?

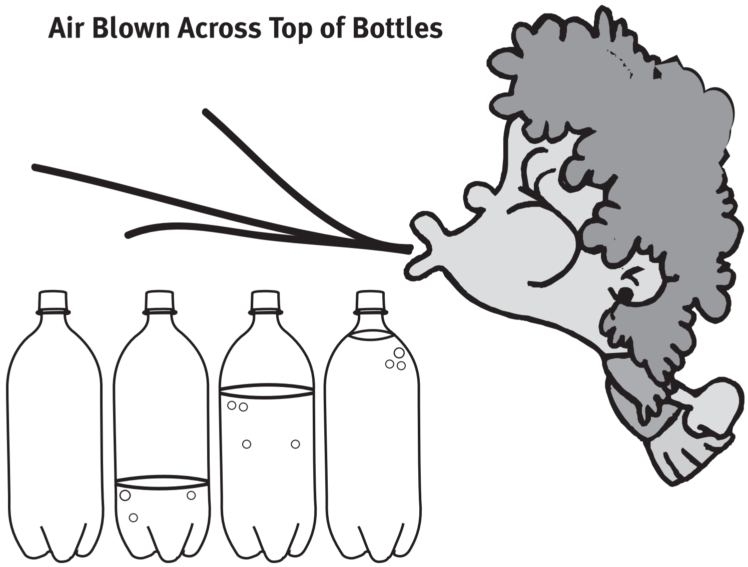
Gases?

10. Can sound travel through a vacuum (empty space)? **Explain** your answer.

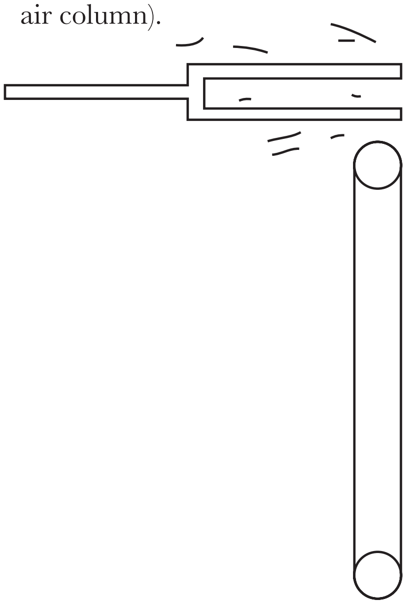
Name ____________________________ Date______________

11. Suppose you have four bottles. One is empty, one is 1/4 full of water, one is about 2/3 full of water, and one is nearly full. Predict what difference, if any, there will be if you blow across the top of each bottle. Give reasons for your predictions.

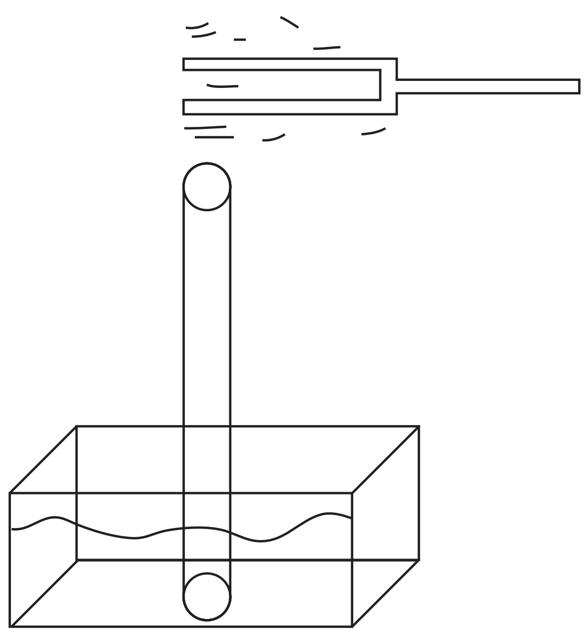
Air Blown Across Top of Bottles



12. If you held a vibrating tuning fork above a cylinder with both ends open, predict how the sound would change as you lowered the cylinder into a container of water (changing the length of the air column).



Hollow Glass Tube Open on Each End



Glass Tube Lowered into Water

Name ______________________________ Date______________

13. Why do you think the outer ear is shaped the way it is?

14. Why can’t humans hear dog whistles? Explain your answer.

15. What technology do you know that uses sound to assist humans? Explain your answer.

Possible Answers to the Pre-assessment for the Sound Unit

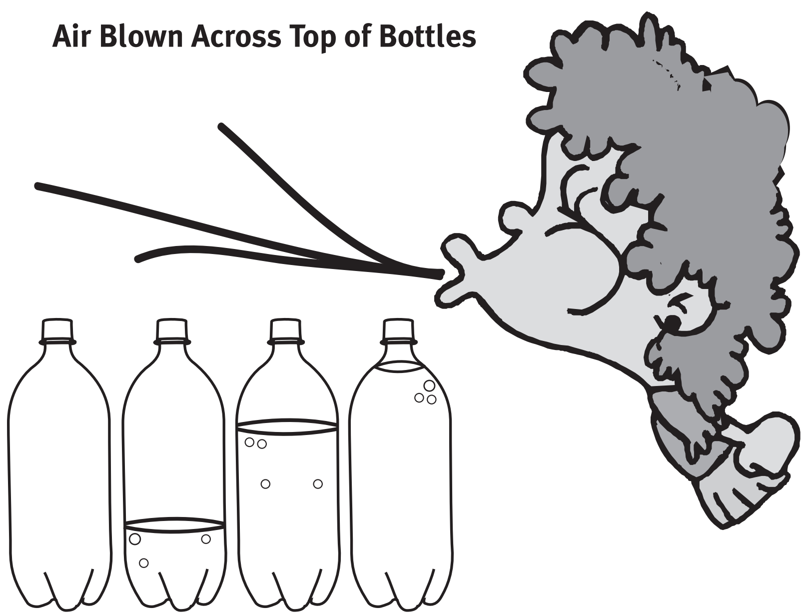
1. A
2. A
3. C
4. A
5. B
6. A
7. A
8. C
9. Can sound travel the states of matter listed below? If so, list an example and explain.

Correct answer: Yes, for all three states of matter
Liquid: Whale or porpoise noises underwater
Solid: When you put your ear to the ground and hear sounds
Gas: When you hear someone speaking across a room
Possible incorrect answer: No or am not sure: Examples could be incorrect

10. Can sound travel through a vacuum (empty space)? **Explain** your answer.

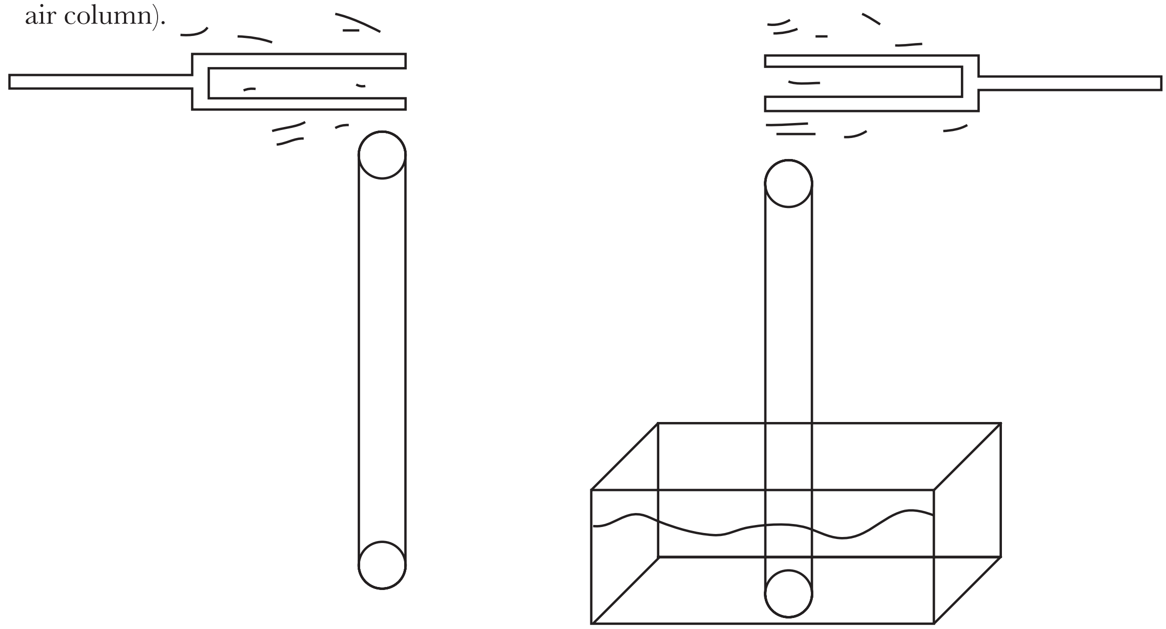
No, because sound needs a vibrating substance to exist and since a vacuum is empty, there is nothing to vibrate, hence no sound.

11. Suppose you have four bottles. One is empty, one is 1/4 full of water, one is about 2/3 full of water, and one is nearly full. Predict what difference, if any, there will be if you blow across the top of each bottle. Give reasons for your predictions.



The sound or pitches will be different for each bottle because the amount of vibrating air (column length varies for each bottle).

12. If you held a vibrating tuning fork above a cylinder with both ends open, predict how the sound would change as you lowered the cylinder into a container of water (changing the length of the air column).



Hollow Glass Tube Open on Each End **Glass Tube Lowered into Water**

The sound would change its pitch (highness or lowness) because the column of air vibrating would be smaller (shorter).

13. Why do you think the outer ear is shaped the way it is?

It funnels or directs the sound, concentrates it so by the time it gets to the inner ear it is amplified and easier to hear.

14. Why can't humans hear dog whistles? Explain your answer.

The sounds are out of their hearing range. Dogs can hear higher sounds than humans can.

15. What technology do you know that uses sound to assist humans? Explain your answer.

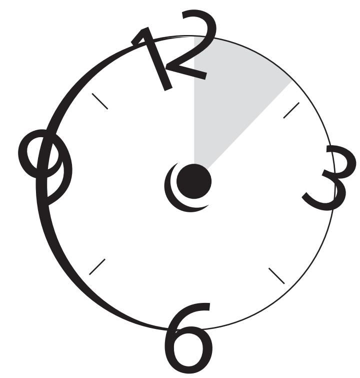
We use sounds to detect things under the water. It is called sonar. We also use sound, ultrasound, to make pictures of fetuses.

Sound Right about Sound!

Core

Time Allocation: 1 hour

Required Materials and Resources on Page 121



Lesson Overview

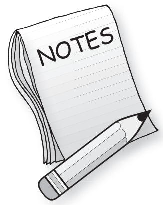
In this lesson students will explore the question as to how sounds are made. They will do two activities that lead them to understand that sound is formed because of vibrations of matter, including air. In addition, they will explore the concept that sounds can be transferred from one material to another.

Guiding Questions

- How are sounds made?

BIG IDEA

How are sounds produced and how can they be transferred?



Content Goals

Universal Theme(s)

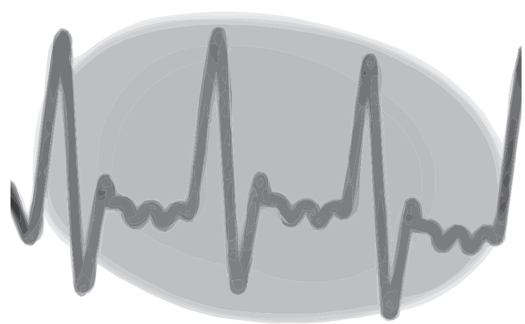
- Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena.
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.
- Form and function are interdependent.

Principles and Generalizations

- Sound is produced when material vibrates.
- Sounds are abundant most everywhere and most all the time.
- Sound is the invisible transfer of motion from one object or material to another.
- Sounds can be amplified.

Concepts

- Model
- Sound
- Vibration
- Transfer of sound
- Sound amplification



Teacher Information

- The dictionary definition of sound is as follows: "mechanical vibrations transmitted by a medium." The vibrations are passed from particle to particle in the medium like a domino effect. For instance, in the rice activity below when the vibrations from banging the tin lid travel to the plastic wrap, the plastic vibrates causing the rice to vibrate or dance. This activity proves sound is produced by vibrating objects, and that it travels through media, such as air and plastic.
- Most sources of sound, whether they are solid, liquid or gas, vibrate in some regular, cyclical manner, although there can be a single motion in some cases, such as clapping hands once, but that in turn leads to an

oscillation in the air, similar to one push of a swing producing a motion that swings (cycles) back to rest. As a result, falling trees do make sounds in the forest even when no one is there to hear them.

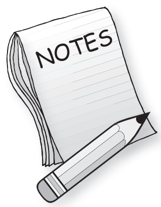
- If the word "energy" comes up in discussion, it is not to be emphasized. The point of the exploration is for students to discover the attributes of sound, one of which is that it is can be converted into other forms, such as motion, as seen in the motion of the rice in the Seeing Sound activity.
- Sound vibrations from objects, such as the opera singer, act like a "pusher" to make a swing go into motion. They are in "sync" or technically speaking the same natural frequency. When they are subject to that frequency, they start to oscillate "in sympathy" with the incoming vibration.

Skills

- Predict
- Make observations
- Compare and contrast
- Identify cause and effect
- Draw conclusions

Materials and Resources

1. Large tin can and lid (e.g., coffee, or large tomato paste can)-- You can get empty ones from a school cafeteria to be used as a teacher demonstration or get one for each student group, depending on their availability.
2. Wooden spoon (1 for the demonstration or 1 for each student group)
3. Rice (10-12 grains for the teacher demonstration or for each student group)
4. Plastic wrap (enough to cover the top of each can)
5. Rubber band (1 for each can used)
6. Masking tape (1 piece per student group)
7. String (1, 12" piece per student group)
8. Ping-pong ball (1 per student group)
9. Balloon (latex, 9") 1 per student or student group
10. Tuning fork (6-8 per class, any note will do)
11. Student journals



Preparation Activities

1. Copy the lab activity, **Playing with Sound!** For each student.
2. Copy **Answers to the Playing with Sound Observations/ Questions** for yourself.

Introductory Activity (10 minutes)

- Tell students that they will be exploring sound in this unit of study. Make the statement: "Almost everything around us at one time or another produces sounds" and have students react to that statement. Ask them if they agree or disagree.
- Ask them if a tree falling in the woods produces sound. Let students share their ideas without giving any answers or explanations.
- Invite students to share their ideas about how they think that objects make sound. Again, let them respond without giving any answers or explanations.
- Instruct students to take out their journals and to describe what they think all objects that make sound have in common.
- Invite students to share their thoughts, remembering to pass no judgment at this time as to the accuracy of their thinking.

Pre-assessment

N/A

Teaching and Learning Activities (40 minutes)

1. Assign lab partners.

2. Distribute a balloon to each group.

3. Tell students to blow up the balloon.

4. After balloons are blown up, tell them each to do the following:
    a. Hold the balloon against your ear.
    b. Ask your partner to press his or her lips against the balloon and speak.

5. Invite students to share their observations. They all should have heard and felt sound vibrations. They can actually feel their own voice through their lips as the balloon's skin vibrates against them.

6. Show the students a tuning fork. Tap the tuning fork with an eraser or against your knee. The tuning fork will vibrate and produced a sound. The students must be very quiet to hear it. Inform the students that the tuning fork is vibrating so fast that it is difficult to see.

7. Invite students to strike the tuning fork themselves so they can feel the vibrations in their hand. Tell them to also bring the tuning fork close to their skin without touching it. Ask, "Do you feel the vibrations?" "What happens when you touch the vibrating tuning fork?" (You stop the vibrations; therefore, you stop the sound.)

8. Since it is difficult for the entire class to hear the tuning fork, amplify the sound. Strike the tuning fork and place it on a tin can. Ask the students if the sound is louder. Invite the students to offer suggestions as to which objects around the room might amplify the sound. Allow them to test their predictions. Classify the objects tested on the board with a chart.

Objects that amplified the sound well	Object that did not amplify the sound well

9. Tell the class that they will be doing a lab activity, **Playing with Sound!**

10. If you do not have enough cans with lids etc., do the activities as teacher demonstrations.

Products and Assignments

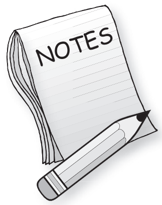
- Students' homework assignment is to answer question #3 from Activity #2 in the lab, **Playing with Sound!**

Extension Activities

N/A

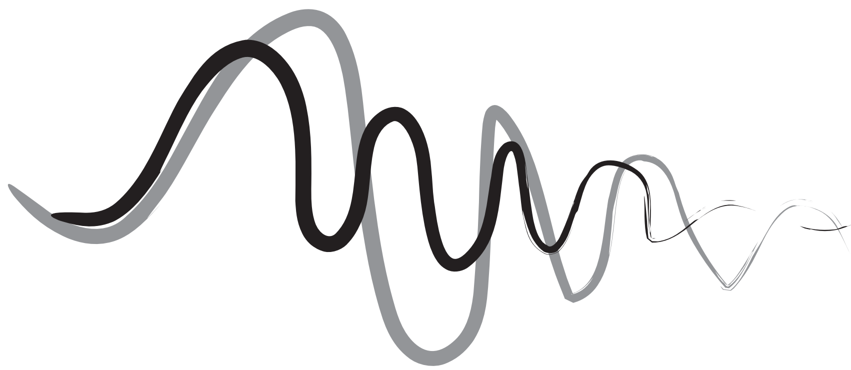
Post Assessment

N/A



Debriefing and Reflection Opportunities (10 minutes)

1. Discuss the observations and questions from Activities 1 and 2 **except for question #3**, which is a homework assignment.
2. Check to see that students are able to conclude that sound is caused by vibrations and that it is able to travel through air and transfer its motion to other objects.
3. Tell students to answer question #3 for homework.



Name ______________________________ Date______________

Playing with Sound!

Activity 1: Seeing Sound

1. Take a can and cover the can with plastic wrap and secure it tightly with a rubber band. Make sure the top surface is flat and as tight as possible.
2. Sprinkle some rice grains on the plastic wrap.
3. Hold a lid (from the can) close to the can but not above it and take the wooden spoon and bang the lid.

Observations/Questions:

1. Describe what happens to the rice grains.

Activity 2: Seeing Sound Again

1. Tape a 12-inch string to a ping-pong ball and hold the string and ping-pong ball system as steady as possible.
2. Strike the tuning fork again and hold it as close as possible to the ping-pong ball without touching the ball.

Observations/Questions:

1. Describe what happens to the ping-pong ball.

2. What does the behavior observed in Activities #1 and #2 above tell you about sound?

3. What do you think is happening when an opera singer "breaks a crystal glass" by singing a high note or when dishes rattle in a cupboard when a certain loud sound is made or a window or other object rattles when certain sounds are played?

Answers to Playing with Sound Observations/Questions!

Activity 1: Seeing Sound

1. Take a can and cover the can with plastic wrap and secure it tightly with a rubber band. Make sure the top surface is flat and as tight as possible.
2. Sprinkle some rice grains on the plastic wrap.
3. Hold a lid (from the can) close to the can but not above it and take the wooden spoon and bang the lid.

Observations/Questions:

1. Describe what happens to the rice grains.

They bounce.

Activity 2: Seeing Sound Again

1. Tape a 12-inch string to a ping-pong ball and hold the string and ping-pong ball system as steady as possible.
2. Strike the tuning fork again and hold it as close as possible to the ping-pong ball without touching it.

Observations/Questions:

1. Describe what happens to the ping-pong ball.

It moves.

2. What does the behavior observed in Activities #1 and #2 above tell you about sound?

Sound can be transferred from one object to another.

3. What do you think is happening when an opera singer "breaks a crystal glass" by singing a high note or when dishes rattle in a cupboard when a certain loud sound is made or a window or other object rattles when certain sounds are played?

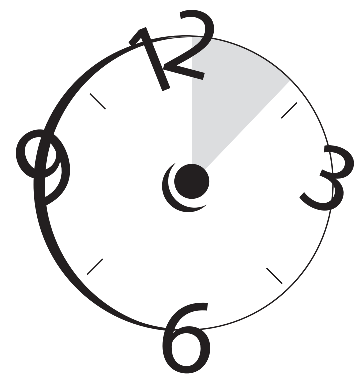
The singer produces sound vibrations that travel through the air and cause the glass to vibrate and eventually break.

Sound Right about Sound!

Core/AID

Time Allocation: 50 minutes

Required Materials and Resources on Page 121



Lesson Overview

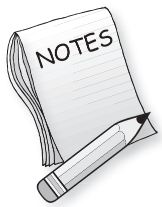
In this lesson students will continue their exploration of sound. They will do three activities that lead them to understand that sound can travel through all types of matter, including air. They continue to explore the concept of transfer of motion and be introduced to the concept of resonance by discussing such things as why a singer can shatter glass when she sings a certain note.

Guiding Questions

- What makes different sounds sound differently?
- Can sound travel through water?
- Can a singer really shatter a glass across a room?

BIG IDEA

Sound can travel through solids, liquids and gases.



Content Goals

Universal Theme(s)

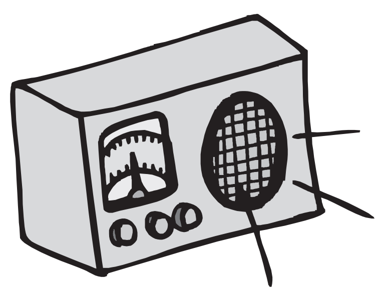
- Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena.
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.
- Form and function are interdependent.

Principles and Generalizations

- Sound travels through solids, liquids and gases.
- Sound is the invisible transfer of motion from one object or material to another.
- The nature of a substance determines how well sound travels through it (AID).

Concepts

- Sound
- Vibration
- Transfer of motion
- Resonance



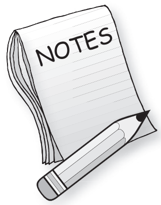
Teacher Information

- Sound vibrations from objects such as the opera singer act like a "pusher" to make a swing go into motion. They are in "sync" or, technically speaking, have the same natural frequency. When they are subject to that frequency, they start to oscillate "in sympathy" or "resonate" with the incoming vibration.
- The sound passing through the sand, sugar or flour is louder than the sound passing through the water. The sound passing through the bag of water should sound louder than the sound passing through the bag of air. The explanation is complicated. Many people including writers of

scientific textbooks think it is because of density. This is a misconception. The following site, http://www.eskimo.com/~billb/miscon/miscon4.html#sound, addresses this misconception and says:

Many elementary textbooks say that sound travels better through solids and liquids than through air, but they are incorrect. In fact, air, solids, and liquids are nearly transparent to sound waves. Some authors use an experiment to convince us differently: place a solid ruler so it touches both a ticking watch and your ear, and the sound becomes louder. Doesn't this prove that wood is better than air at conducting sound? Not really, because sound has an interesting property not usually mentioned in the books: waves of sound traveling inside a solid will bounce off the air outside the solid. The experiment with the ruler merely proves that a wooden rod can act as a sort of "tube," (this is the idea behind a megaphone's ability to "guide sound") and it will guide sounds to your head which would otherwise spread in all directions in the air. A hollow pipe can also be used to guide the ticking sounds to your head, thus illustrating that air is a good conductor after all. Sound in a solid has difficulty getting past a crack in the solid, just as sound in the air has difficulty getting past a wall. Solids, liquids, and air are nearly equal as sound conductors. It's true that the speed of sound differs in each material, but this does not affect how well they conduct. "Faster" doesn't mean "better."

- During Activity #2, **Phone a Friend**, when one student speaks into the cup or can, the movement of the air vibrates the bottom of the cup or can. The cup vibrates the particles in the string, like falling dominoes, until the vibrations reach the listener's cup. The vibrations from the listener's cup vibrate the air inside the cup which in turn vibrates the eardrum of the listener who then hears the vibrations as sound.
- (AID) Tin-can telephones are simply two, topless tin cans with their bottoms tied together with a length of string or wire. When a sound is made into the top of one can, the sound causes the bottom of that can to vibrate "in sympathy" with it – at the same frequencies. That vibration causes the string to become tauter and looser at the same frequency, passing that vibration to the bottom of the second can, the vibration of which causes the air in that can to vibrate "in sympathy" with the bottom,



thus producing the same (or similar) sound for the second person to hear. Think of it as a "domino effect" with vibrations, each component causing the next component to vibrate in a manner similar to the first vibration. If the vibrations change frequency sequentially, as in voice, then the vibrations being passed along the line will vibrate in a similar sequence.

Skills

- Make observations
- Compare and contrast
- Identify cause and effect
- Draw conclusions

Materials and Resources

1. Baggies (3 per student)
2. Sand, sugar or flour (enough to fill a baggie half way)
3. Water (enough to fill a baggie)
4. Coin
5. Paper cups (2 per student group)
6. String (15 feet per student group)
7. Paper clips (2 per student group)
8. Pushpin (1 per student group)
9. (AID) Tin soup cans (2 similar sized cans per student group)
10. (AID) Kite string (5 meters per student group)
11. (AID) Fishing line (5 meters per student group)
12. (AID) Yarn (5 meters per student group)
13. (AID) Picture Wire (5 meters per student group)
14. (AID) Plant wire (5 meters per student group)

Preparation Activities

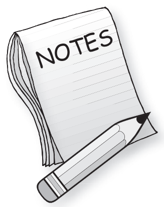
1. Copy the lab activity, **Playing with Sound Again!** for each student.
2. Copy Answers to the **Playing with Sound Again Observations/ Questions** for yourself.
3. (AID) Copy the extension activity, **Extension Activity - Tin-can Telephones** for appropriate students.
4. Copy for **Answers to the Extension activity - Tin-can Telephones** for yourself.

Introductory Activity (10 minutes)

- Collect students' lab activity sheets from yesterday's lab activity.
- Ask students to share their thoughts regarding question #3 from Activity 2. Some students may know that sound waves cause vibrations that can be "picked up" by other objects, such as the glass that breaks. Decide how much of the terminology like the word resonate (see **Teacher Information** above) you want to use. Students should be told that they are not responsible for the terms you use but for the idea that objects that are vibrating can make some other objects vibrate by a transfer of their motion (mechanical energy to be exact).
- Discuss the fact that natural phenomena, such as storms, are prodigious generators of infrasound sounds that can rattle and shatter windows without people hearing anything at the time.
- Ask students if they think animals hear what we hear. Some students probably know that some animals have unusual abilities to hear things we cannot. Discuss the tsunami disaster as an example of animals' ability to escape dangers that we cannot detect. Ask students if they knew that many people noted that after the recent tsunami disaster that not very many wild animals were found dead. Most of those who could fly, run or crawl quickly, left their usual habitats and went to higher ground where the waves couldn't reach them before the tsunami struck. **SEARCHLIGHT**: Be aware of students who show advanced knowledge and interest, as they may be good candidates for the extension activities.
- Query students to see if they know what the early Native American hunters used to do to help them to track a herd of bison. Students might realize that they would put their ears and hands on the ground. Also mention that train robbers in the Old West put their ears and hands on the train tracks to check for approaching trains. Ask, "Why do you think this helped the hunters and robbers?" "Why would they put their ears and hands on the ground or train tracks?"

Pre-assessment

N/A



Teaching and Learning Activities (30 minutes)

1. Assign lab partners.

2. Tell students to do the lab activity, **Playing with Sound Again!** Circulate to provide scaffolding for those students who may need it.

Products and Assignments

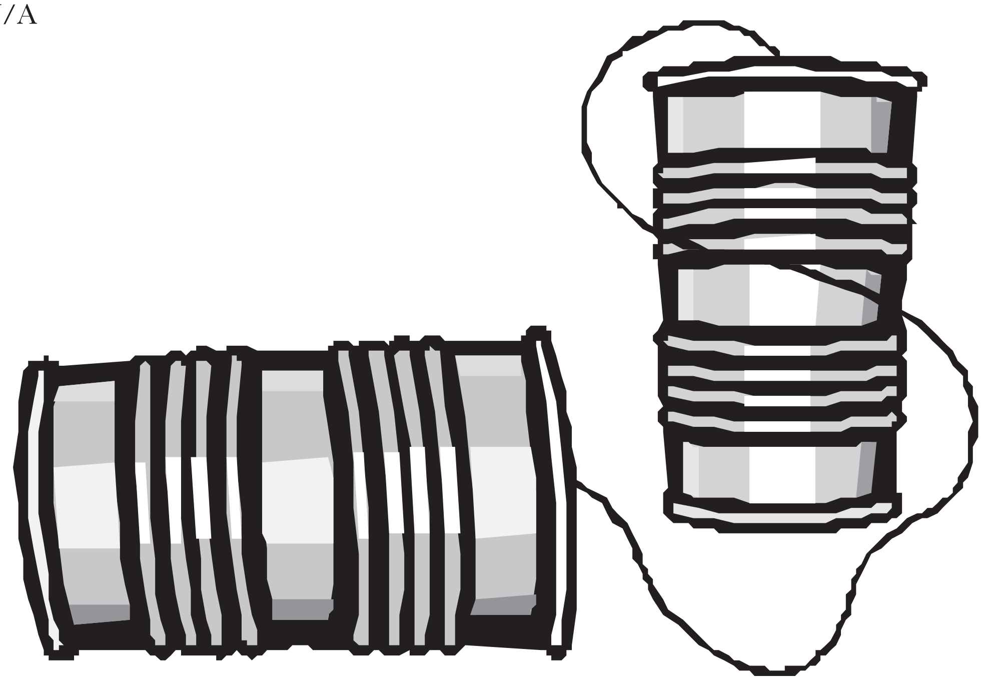
- Homework assignment is to complete question #1 for Activity #2 on the lab sheet, **Playing with Sound Again!**

Extension Activities

1. (AID) Students who were highly interested in the building and using the telephone cups could do some more investigation into how sound changes as it travels through different solid media, kite string, fishing line and plant and picture wire by doing the **Tin-can Telephones (TCT's)** activity.
2. (AID) Tell students that sound travels through lots of different materials, which we will call media. They will be using different string media such as kite string, fishing line, plant or flower arrangement wire and thicker picture wire to explore how well sounds can travel through different solid materials.

Post Assessment

N/A



Debriefing and Reflection Opportunities (10 minutes)

1. Reconvene students at the end of the lab activity and have them share what they learned about sound from Activity #1. Students should conclude that sound does travel through solids, liquids and gases (air), but it travels better through solids than it does through liquids and travels the poorest through gas. Do not discuss why it travels better through solids, as the explanation is too difficult for students of this age (see **Teacher Information**).
2. Ask students to explain for homework how sound got back and forth from their partner to them. Tell them in their answer to describe what substances were vibrating and what the actual path was of the sound.
3. (AID) Focus students on the main intent of this activity, for the students to determine that the way in which sound travels is related to several factors about the material (medium) through which the sound travels, (e.g., the substance of the string, the tautness of the string, etc.). None of the details are very significant, only the concept that movement of the sound is affected by the medium through which it travels.

Name ______________________________ Date______________

Playing with Sound Again!

Activity 1: Listening to Sound through a Solid, Liquid and Gas

1. Fill the first bag halfway with the sand, sugar or flour.
2. Push out the extra air and seal the bag.
3. Fill the second bag halfway with water and push out the air and seal it.
4. Fill the third bag halfway with air and seal it.
5. Place all three bags on the table top.
6. Place your ear on the bag of sand, sugar or flour.
7. Gently tap a coin on the table and listen.
8. Repeat the procedure using the other two bags.
9. Compare the three different sounds.

Observations/Questions:

1. Describe any differences you hear in the sound as you listen to it through each of the bags.

Activity 2: Phone a Friend

1. Use the pushpin to poke a hole in the bottom of each cup.
2. Cut a segment of string about 10-20 feet long.
3. Pass one end of the string through the bottom hole of one cup.
4. Tie the string to the paper clip which is inside the cup.
5. Pull on the string so the paper clip lies flat on the inside of the cup.
6. Repeat the same procedure to attach the other end of the string and paper clip to the inside of the other cup.
7. Move the two cups apart, so the string between them is taut.
8. Have one person speak into one cup while the other person listens with the other cup
9. Reverse the roles.
10. Try to determine what your partner is saying.

Observations/Questions:

What happened? Explain how you think sound got to your partner's ear.

Answers to the Playing with Sound Again Observations/Questions

Activity 1: Listening to Sound through a Solid, Liquid and Gas

1. Fill the first bag halfway with the sand, sugar or flour.
2. Push out the extra air and seal the bag.
3. Fill the second bag halfway with water and push out the air and seal it.
4. Fill the third bag halfway with air and seal it.
5. Place all three bags on the table top.
6. Place your ear on the bag of sand, sugar or flour.
7. Gently tap a coin on the table and listen.
8. Repeat the procedure using the other two bags.
9. Compare the three different sounds

Observations/Questions:

1. Describe any differences you hear in the sound as you listen to it through each of the bags.

The sound is louder through the sand, sugar, flour bag than it is in the water bag. The sound that travels through the water bag is louder than the sound that travels through the air bag.

Activity 2: Phone a Friend

1. Use the pushpin to poke a hole in the bottom of each cup.
2. Cut a segment of string about 10-20 feet long.
3. Pass one end of the string through the bottom hole of one cup.
4. Tie the string to the paper clip which is inside the cup.
5. Pull on the string so the paper clip lies flat on the inside of the cup.
6. Repeat the same procedure to attach the other end of the string and paper clip to the inside of the other cup.
7. Move the two cups apart so the string between them is taut.
8. Have one person speak into one cup while the other person listens with the other cup.
9. Reverse the roles.
10. Try to determine what your partner is saying.

Observations/Questions:

1. What happened? Explain how you think sound got to your partner's ear.

When the person spoke into the cup, the movement of the air vibrated the bottom of the cup. The cup vibrated the particles in the string, like falling dominoes, until they reached the bottom of the listener's cup. The vibrations from the listener's cup vibrated the air inside the cup which in turn vibrated the eardrum of the listener who then heard the vibrations as sound.

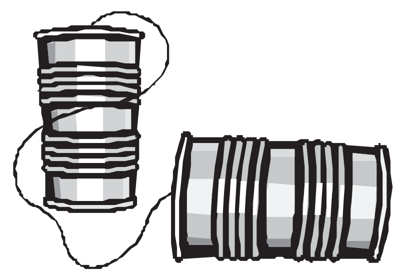
Name ______________________________ Date______________

Extension Activity – Tin-can Telephones (TCT's)

If you have more than two students, tell each group to make a telephone with different connecting media and then exchange phone sets.

1. Take two cans (same material) and one length of one type of string.
2. Each "can" has two small holes in its base. Thread the first type of string through the holes in the bottom of the can and tie one end of the string to the base of that can.
3. Then, in the same way, tie the other end of the string to the base of the other can.
4. If you stretch the string taut, you can hold your can to your ear and when your partner talks into the other can, you can hear what your partner says. Do this and explore what makes the sound louder or clearer, or what prevents the sound from traveling along the string.

Questions:



1. What seems to make the sound NOT TRAVEL along the string?

2. What seems to make the sound louder or clearer through the TCT telephones?

3. Is there a difference between the way high notes and low notes can be heard through the TCT telephones?

4. Trade your TCT with another team and repeat the experiment with the different cans or different string. What differences can you observe?

5. Join together with a different team and listen to sounds coming through two different TCT's at the same time. Do this with each of the different TCT's. Which TCT seems to be the better TCT for sending voice messages to your partner?

Name ______________________________ Date______________

Extension Activity – Tin-can Telephones (TCT's)

6. Explain what you have learned about TCT's and what design aspect of a TCT makes it *better* at carrying sounds between partners? What must you be sure happens to make sure the TCC works?

7. You hear sounds with your ears, but not all sounds are the same. Identify and describe as many different "characteristics" of sound as you and your partner can.

Answers to the Extension Activity – Tin-can Telephones

1. What seems to make the sound NOT TRAVEL along the string?

When the string is not taut, the sound does not travel to the other phone.

2. What seems to make the sound louder or clearer through the TCT telephones?

When the string is stretched more tightly, the sound is louder and clearer.

3. Is there a difference between the way high notes and low notes can be heard through the TCT telephones?

The high notes seem to travel more clearly.

4. Trade your TCT with another team and repeat the experiment with the different cans or different string. What differences can you observe?

When the string is thinner with fewer strands, the sound seems to travel clearer and stronger.

5. Join together with a different team and listen to sounds coming through two different TCT's at the same time. Do this with each of the different TCT's. Which TCT seems to be the better TCT for sending voice messages to your partner?

The wire TCT seems to be the best for sending messages, then the fishing string and the kite string. The yarn does not seem to make a good TCT at all.

6. Explain what you have learned about TCT's and what design aspect of a TCT makes it better at carrying sounds between partners? What must you be sure happens to make sure the TCC works?

TCT's work better at carrying sounds when the string is stretched tighter and when the string has fewer strands. Metal strings (wire) and plastic strings seem to be better than fiber strings. You must be sure to pull tightly on the string and not have it touch anything along the way for it to work well.

7. You hear sounds with your ears, but not all sounds are the same. Identify and describe as many different "characteristics" of sound as you and your partner can.

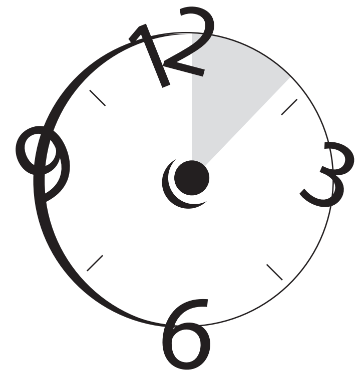
Loudness (amplitude) is how "strong" the sound seems to be.
Pitch describes the note that is sounded, from low (bass) to high (treble).
There are different types of sounds, such as a "sharp" slap or a gentle hum or a musical note or a screech or a clashing sound.
There are sounds that go well together (harmony) or those that don't (cacophony).

Sound Right about Sound!

Core

Time Allocation: 55 minutes

Required Materials and Resources on Page 121



Lesson Overview

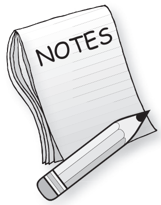
Students in this lesson will discover that they can identify different characteristics of sound, such as volume and pitch and even the tone of a musical note. The students start their investigation of the variations in sounds by holding a ruler against a desktop, so that some of the ruler hangs over the edge. Students will vary the amount of ruler that extends, while "plunking" the ruler to hear the resulting sound. Students will thus explore the concept that there are variations in sound from a given object and that those variations seem to be caused by different, specific types of movement of the object.

Guiding Questions

- Why do you think a doctor thumps on an abdomen during a medical exam?
- What makes different sounds that come from the same object sound differently?
- Can sound travel through empty space?
- Can sound be produced when no one is around to hear it?
- What makes a sound louder?

BIG IDEA

Pitch, Tone, and Volume of Sound



Content Goals

Universal Theme(s)

- Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena.
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.
- Form and function are interdependent.

Principles and Generalizations

- Pitch can be changed by altering the characteristics of the vibrating source that produces the sound.
- The stronger the vibration of the source (stronger the input) for a sound, the greater its intensity or loudness will be.
- Larger volumes of material vibrate more slowly and vice versa.
- Different lengths of vibrating air produce different sounds.

Concepts

- Pitch
- Loudness of sound

Teacher Information

- Space for all intents and purposes is a vacuum, so sound would not travel in space.
- Most sources of sound, whether they are solid, liquid or gas, vibrate in some regular, cyclical manner, although there can be a single motion in some cases, such as clapping your hands once, but that in turn leads to an oscillation in the air, similar to one push of a swing producing a motion that swings (cycles) back to rest.
- Pitch is how high or low a sound is.
- There are several characteristics of sound that the students can identify and explore. These include the volume, or how loud the sound is and

pitch, or the note that is "played." There is another characteristic that students may not recognize which is tone. Tone describes subtle differences between the way the object or the medium vibrates to produce two different sounds of the same note (pitch), such as the trumpet sound versus the clarinet sound, both playing the same note (pitch).

- Varying the length of air columns changes the pitch of the sounds produced.
- The more rapid the number vibrations in a given amount of time (vibrational energy), the higher the resulting sound or pitch.
- The less rapid number vibrations in a given amount of time (vibrational energy), the lower the resulting sound or pitch.
- Be careful to avoid using the term speed to describe how rapidly the ruler or object is vibrating. The correct term is frequency, and the use of the term speed will nurture a misconception for the student when students move on to the concept of how fast (speed) a sound travels, as opposed to its pitch.

Skills

- Predict
- Make observations
- Record data
- Compare and contrast
- Identify cause and effect
- Draw conclusions

Materials and Resources

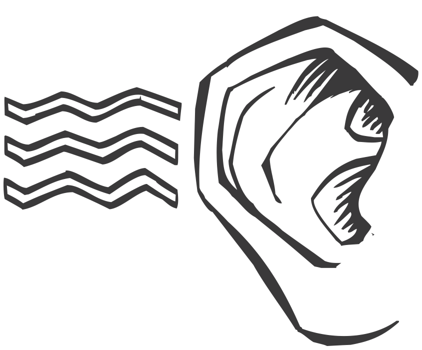
1. Cassette or CD of Beethoven and a player or use an Internet clip of some of his music by going to the site www.shoutcast.com . Select classical under the genre area, search for Beethoven, and you will undoubtedly find a piece of music to play.
2. Ruler (1 per student or student group)

Preparation Activities

1. Copy the lab activity, **What Makes Different Sounds Sound Differently?** for each student.
2. Copy **Answers to the Lab Activity, What Makes Different Sounds Sound Differently?** for yourself.

Introductory Activity (10 minutes)

- Collect students' lab sheet, **Playing with Sound Again!** Review student answers to question #1 from Activity #2. Students should realize that sound vibrations traveled through various media ultimately reaching their partner's ear.
- Tell students that doctors often thump on a person's abdomen during a checkup. Ask students why they think a doctor might do this procedure. Hopefully, students will suggest that a doctor is listening to the resulting sound and that if there were a solid, liquid or even gas in the abdomen, he or she could hear the difference.
- As a way of further addressing the idea that sound needs a medium through which to travel, ask the students in "Think, Pair, Share" format to discuss the question, "Does sound travel in outer space?" (see **Teacher Information**)
- If students mention that there is matter, stars, and planets, tell them we are asking if sound can travel across the vast areas of space where there are no stars, or planets. Inform students that outer space has vast areas of nothingness in between the stars. Students should realize that there is essentially no matter in space and so sound cannot travel in space.
- Ask students the intriguing question for the day, "Can sound be produced when no one is around to hear it? Remind them of the question posed several days ago, "If a tree falls in a forest, is a sound produced?"
- Let students interact with each other without giving the "right" answer. See if students can convince one another that the answer is affirmative because regardless of whether an "ear drum" is present, if an object vibrates, it moves air and produces sound. Reinforce the idea that as long as objects can vibrate, such as a tree falling and the air next to it, then sounds are produced regardless of whether humans are present or not.
- Continue with the review of the concept that sound is caused by vibrations of objects by asking students to place two fingers on the front of their throat and to be perfectly quiet. Ask them, "Did you feel any vibrations?" (No, they would not feel vibrations if they were quiet although they might feel the pulse of their heart rate. Don't confuse the two). Tell them to say a word over ten times and place two fingers on the front of their throat again. Ask them what they feel. (They should feel vibrations.)



- Discuss singing and the fact that sounds are made that vary. Have them sing different notes, feel their necks and see if they can describe how the vibration in their throat changes. Students will comment that they feel an area just above the chest bone that seems to be vibrating when they make a sound. When the note they sing is higher, the vibration should seem faster.
- Play a sample of Beethoven's music and discuss how the variety of instrumental sounds comes together.
- Invite students to imagine how difficult it must be to write the music for all those instruments! Then share with them that toward the end of his life, Ludwig von Beethoven was totally deaf! Tell them that he would clench one end of a wooden stick between his teeth and place the other end against the piano's soundboard. When he hit a note, the vibrations traveled up the stick into his jaw. He used vibrations to create compositions.
- Tell students they will be exploring sound making for the purpose of answering the question, "**What Makes Different Sounds Sound Differently?**"

Pre-assessment

N/A

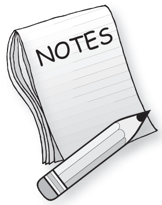
Teaching and Learning Activities (35 minutes)

1. Distribute and review the activity **What Makes Different Sounds Sound Differently?**

2. Before breaking students into lab partners, ask if any of them are "tone deaf." If so, pair them with a student who is not.

3. Inform students before they begin the lab that they should hold the ruler down to the desktop tightly by **pressing down at the very edge of the desk,** so that the ruler does not "rattle" against the desktop when "plucked."

4. Tell students that you will collect the lab tomorrow and that they must finish the questions for homework.



5. Tell students to bring in any small metal object that could be used to build an instrument (e.g., spoon, chain, cheese grater, colander or hubcap).

Products and Assignments

- Students' homework assignment is to finish the questions for the lab activity, **What Makes Different Sounds Sound Differently?**

Extension Activities

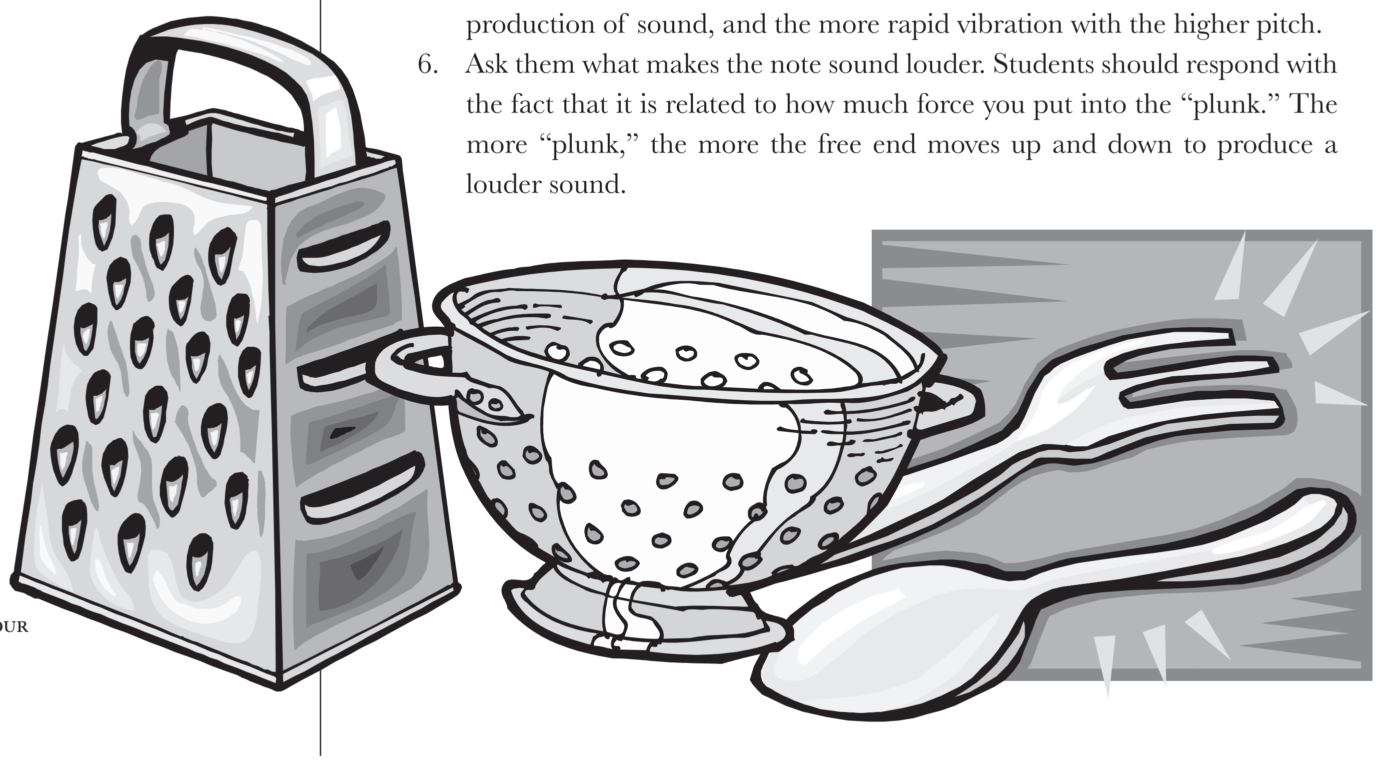
N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (10 minutes)

1. Discuss some of the answers to the questions.
2. Introduce the concept of "pitch."
3. Ask students what happened when more of the ruler was extended over the edge of the table (the more ruler that is hanging over the edge, the lower the note that will be produced).
4. Ask them the converse (the shorter the vibrating part of the ruler, the higher the pitch.)
5. Check to make sure that students connect the vibrating object with the production of sound, and the more rapid vibration with the higher pitch.
6. Ask them what makes the note sound louder. Students should respond with the fact that it is related to how much force you put into the "plunk." The more "plunk," the more the free end moves up and down to produce a louder sound.



Name ______________________________ Date______________

What Makes Different Sounds Sound Differently?

Instructions:

1. With your partner, locate your ruler so that the 15 cm mark is at the edge of your desk with the half of the ruler with the "0" hanging over the edge and the other half solidly on the desk.
2. Press down firmly on the part of the ruler that is on the desk, **(remember to press down at the very edge of the desk)** and then gently "plunk" the ruler with your other hand, so that it vibrates against the desk. We call the back and forth motion *vibration*. Observe the note it makes and watch how quickly it vibrates up and down.
3. Then slide the ruler further out so that the 18 cm mark is on the edge of the desk and "plunk" it again. Observe the new note it makes and how fast it seems to be vibrating compared to the first note.
4. Compare the "rate" at which the ruler vibrates at the two positions. Describe the comparison:

5. Compare the musical note that the ruler makes when it is plunked at the two positions.

6. Now slide the ruler more onto the desk so the 12 cm mark is at the edge of the desk, and again "plunk" the ruler and observe the note and how it vibrates. Compare this new vibration and sound with the previous two positions.

7. See if you can make all the notes of the scale (DO, RE, MI, FA, SO, LA, TI, DO) by sliding the ruler to various positions on the desktop. Record the length of ruler that is vibrating (extended over the side of the desk) for each note. When a vibrating object makes a particular sound that is a note. We call that note its *pitch*. From now on we will refer to the note that is produced as the pitch of the sound.

Pitch	DO	RE	MI	FA	SO	LA	TI	DO
Length								

Name ______________________________ Date______________

8. How does the length of ruler that is vibrating seem to relate to the pitch of the note that is made when it is "plunked"?

9. How does the length of ruler that is vibrating at the lower "DO" pitch compare to the length of ruler that is vibrating at the higher "DO" pitch?

10. What seems to make the sound louder?

Answers to the Lab Activity, What Makes Different Sounds Sound Differently?

Instructions:

1. With your partner, locate your ruler so that the 15 cm mark is at the edge of your desk with the half of the ruler with the "0" hanging over the edge and the other half solidly on the desk.
2. Press down firmly on the part of the ruler that is on the desk, and then gently "plunk" the ruler with your other hand so that it vibrates against the desk. We call the back and forth motion *vibration*. Observe the note it makes and watch how quickly it vibrates up and down.
3. Then slide the ruler further out so that the 18 cm mark is on the edge of the desk and "plunk" it again. Observe the new note it makes and how fast it seems to be vibrating compared to the first note.
4. Compare the "rate" at which the ruler vibrates at the two positions. Describe the comparison:

When there is more ruler extended out from the desktop (at 18 cm), it vibrates less rapidly (frequency – not speed terms), but when there is less ruler extended out from the desktop (at 15 cm), it vibrates more rapidly.

5. Compare the musical note that the ruler makes when it is plunked at the two positions.

When 18 cm of the ruler is extended out from the desktop, it sounds a low note. When only 15 cm of the ruler is extended out from the desktop, it makes a higher note.

6. Now slide the ruler more onto the desk so the 12 cm mark is at the edge of the desk, and again "plunk" the ruler and observe the note and how it vibrates. Compare this new vibration and sound with the previous two positions.

When only 12 cm of the ruler is extended out from the desktop, it vibrates even more rapidly and makes a higher note than it did at the 15 cm mark.

7. See if you can make all the notes of the scale (DO, RE, MI, FA, SO, LA, TI, DO) by sliding the ruler to various positions on the desktop. Record the length of ruler that is vibrating (extended over the side of the desk) for each note. When a vibrating object makes a particular sound that is a note, we call that note its *pitch*. From now on we will refer to the note that is produced as the pitch of the sound.

Pitch	DO	RE	MI	FA	SO	LA	TI	DO
Length								

8. How does the length of ruler that is vibrating seem to relate to the pitch of the note that is made when it is “plunked”?

(NOTE – the actual lengths of ruler that make the notes will vary dependent upon the type of ruler you use, as well as the pitch you determine for “do, re, …”). Overall, as the pitch rises, the length of ruler is less.

9. How does the length of ruler that is vibrating at the lower “DO” pitch compare to the length of ruler that is vibrating at the higher “DO” pitch?

The length of the ruler that makes the lower “DO” should be approximately twice the length of ruler that makes the higher “DO.”

10. What seems to make the sound louder?

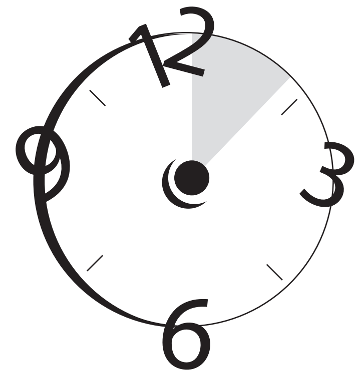
The stronger you “pluck” the ruler, the louder the sounds seem to be. The greater the amplitude of the ruler’s vibration (the greater the actual movement of the ruler’s free end up and down), the louder the sound should be.

Sound Right about Sound!

Core/AID

Time Allocation: 50 minutes

Required Materials and Resources on Page 121



Lesson Overview

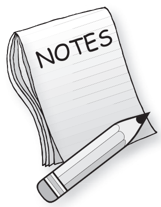
Students in this lesson will explore what aspect of the change in the vibrating source explains the resulting differences in the sounds of notes. Specifically, students will do activities with bottles and straws that help them understand that sounds are produced and can be varied by vibrating varying lengths of air columns.

Guiding Questions

- What makes different sounds that come from the same object sound differently?

BIG IDEA

Sounds can be varied by vibrating varying lengths of air columns.



Content Goals

Universal Theme(s)

- Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena.
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.
- Form and function are interdependent.

Principles and Generalizations

- Pitch can be changed by altering the characteristics of the vibrating source that produces the sound.
- The stronger the vibration of the source (stronger the input) for a sound, the greater the volume or loudness will be.

Concepts

- Pitch
- Volume of sound

Teacher Information

- The straw activity was based on *Awesome Experiments in Light and Sound* (2006) by Michael DiSpezio.
- Pitch can be changed by altering the characteristics of the vibrating source (e.g., length, thickness, density, shape).
- In playing with straws, students will see the longer the distance the air travels, the lower the pitch. If holes are put into the straws to simulate wind instruments like a flute, students will note that when the hole in the straw is left uncovered, the sound wave is shortened causing a higher pitch.
- Pitch is a function of the mass and volume (density) of vibrating air, as well as the size of the resonating chamber in which it is vibrating. Larger volumes or densities of air will absorb more vibrational energy leading to a dampening or lowering of the sound frequency or pitch. Thus, the

larger the volume of air and/or resonating chamber, the lower the pitch; and the smaller the volume of air and/or resonating chamber, the higher the pitch. The bottle with the LEAST amount of water had the LARGEST volume of air and space to vibrate in, and therefore had the LOWEST pitch. Conversely, the bottle with the MOST amount of water had the SMALLEST volume of air and space to vibrate in, and therefore had the HIGHEST pitch.

- In the bottle experiment you want the students to compare the pitch to the length of air column, not the amount of water in the bottle. The pitch will be higher as the length of the air column available to vibrate becomes shorter. It is not a linear, or one for one, relationship. Avoid having the students compare the pitch to the amount of water they put in the bottle, as it will lead to misconceptions later. More water makes the pitch higher, when the water itself is not part of the process – it is the shortening of the air column that causes the sound to have a higher pitch.

Skills

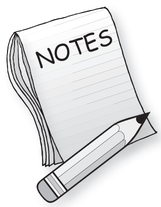
- Predict
- Make observations
- Record data
- Compare and contrast
- Identify cause and effect
- Draw conclusions
- Research (AID)

Materials and Resources

1. 10" Plastic straw (1 per student for *Variation #1* of Activity #2 or 2 per student for *Variation #2*)
2. Scissors (1 per student or student group)
3. Empty plastic, 2-liter bottles (4 per student or student group)
4. Water (3 liters per student or group)
5. Liter bottle for measuring purposes (1 per student or student group)
6. Masking tape

Preparation Activities

1. Copy the lab activity, **This is Music to My Ears!** for each student.



2. Copy **Answers to the Lab Activity, This is Music to My Ears!** for yourself.

Introductory Activity (10 minutes)

- Collect and label students' metal pieces.
- Collect students' lab sheet, **What Makes Different Sounds Sound Differently?**
- As a way of reviewing yesterday's work, ask students to describe what the relationship is between the length of the ruler extended over the edge of the table (longer versus shorter) and the note that is produced (low versus high).
- Ask students what is happening as the ruler goes up and down. Students should recognize that air is being made to move faster when the ruler vibrates faster (less overhang) and that when it vibrates more slowly, so does the air beneath it, thus producing a lower note. **SEARCHLIGHT**: Be on the lookout for students who demonstrate an above average ability with the material. They may be ideal candidates for the extension activities.
- Have students share their observations and answers to the questions assigned for homework.
- Ask them what makes the note sound louder. Students should respond with the fact that it is related to how much force you put into the "plunk." The more "plunk," the more the free end moves up and down and produces a louder sound.
- Tell students they will be further exploring sound making by doing the lab activity, **This is Music to My Ears!**

Pre-assessment

N/A

Teaching and Learning Activities (30 minutes)

1. Assign lab partners making sure that each group has a student that can hear differences in notes.

2. Instruct students to first do **Activity #1** of **This is Music to My Ears!**

3. Circulate amongst the groups making sure that each has made the predictions before they have explored the sounds produced by the bottles.

4. Before doing **Activity #2** reconvene students and assign 1/2 of the class ***Variation #1*** and the other half of the class ***Variation #2*** of the second activity.

5. Tell students to bring in any small metal object that could be used to build an instrument (e.g., spoon, chain, cheese grater, colander or hubcap).

Products and Assignments

- Students' homework assignment is to finish the questions for the lab activity, **This is Music to My Ears!**

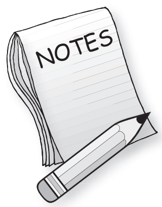
Extension Activities

1. (AID) Students who need an additional challenge can be asked to see if they can get many different notes from the "fluta-straws" by cutting more holes in the straw and covering them in different combinations to produce different pitches.
2. (AID) There are three groups of instruments that use vibrating air to produce a sound. Students who have an interest in musical instruments can research and create a poster of instruments that vibrate air to make a sound.
    a. Have students research instruments, then collect pictures and categorize them into brass instruments, reed instruments and whistle instruments. Finally, have them explain why instruments in each category produce different pitches of sound.

    Sample:

Brass	Reeds	Whistles
Trumpet	Clarinet	Recorder
Trombone	Oboe	Flute
Tuba	Saxophone	Piccolo

    b. Students can display their posters around the room and be given an opportunity to share what they learned about these types of instruments, especially as it relates to the types of notes each group can play and how the instrument changes volumes of air to get its set of notes.



Post Assessment

N/A

Debriefing and Reflection Opportunities (10 minutes)

1. Have representatives from the groups that did ***Variation #1*** and ***Variation #2*** share their findings. Ask the other groups to give input if there are any discrepancies in results.
2. As a way to informally assess students, ask for three volunteers to come to the front of the room. Do not tell then ahead of time what you want them to do. When they get up there, tell them to write a sentence that relates the amount of air vibrating to the high or lowness of the resulting pitch.
3. Tell the other students at their seat to do the same and to use the back of their lab sheets. Students should be able to relate a note's pitch to the amount of substance vibrating, such that they say the more quantity of a substance, such as air, that vibrates the lower the note and vice versa.

Name ______________________________ Date______________

This is Music to My Ears!

Activity 1:
Instructions:

1. Pour 1/2 a liter of water into one bottle.
2. Pour 1 liter of water into a second bottle.
3. Pour 1½ liters into the third bottle
4. Leave one bottle empty.
5. Label each of the bottles using masking tape, as to the amount of water in each one.
6. Predict below which bottle will have the highest pitch and which bottle will have the lowest pitch when you tap each bottle:

7. What vibrates to produce sound when you tap the bottle?

8. Tap each bottle and listen to the sounds produced.
   a. Which bottle had the highest pitch?

   b. Which bottle had the lowest pitch?

9. Predict below which bottle will have the highest pitch and which bottle will have the lowest pitch when you blow across the top of each bottle:

10. What vibrates to produce sound when you blow across the bottle?

11. Blow across each bottle and listen to the sounds produced.
    a. Which bottle had the highest pitch?

    b. Which bottle had the lowest pitch?

12. When material vibrates slowly, it produces a lower sound. In both cases the lower sound was produced by having the __________ (least or most) amount of the vibrating substance?

Name ____________________________ Date______________

Questions:

1. Were your predictions correct? Why do you think your predictions were correct or incorrect?

2. Why do you think the notes coming from a cello sound so different than those coming from a violin? (Hint: Think about the size of the instruments and what is vibrating.)

Activity #2:

1. Press down one end of the straw so it is flat.
2. Using scissors cut away the corners of the flattened end. The snips should produce a triangle.
3. Open the flattened (reed) end.
4. Make 2 snips on top of the straw being careful not cut the straw into 2 pieces. Make the opening about 2 inches from the other end of the straw. This opening will be a short cut for the air to escape from rather than traveling the entire distance of the straw. Make sure you do.
5. Place the reed end of the straw in your mouth and cover up the hole you just cut with your finger. Make sure it doesn't touch your cheek or tongue and blow through the straw.
6. Now uncover the hole and blow into the reed end of the straw.
7. If no sound is produced, be sure the reed end is still open and free to vibrate.

Questions:

1. What is the difference in the sound when the hole is covered versus not covered?

2. What is the only difference between the two situations that produce the two sounds?

3. Which situation, the uncovered or covered hole, had the most air vibrating?

4. Which situation, the uncovered or covered hole, had the lowest pitch?

5. Write a sentence that describes the relationship you discovered between the amount of air (volume of air) that vibrated and the sound that was produced. You can start your sentence with any of the examples below and fill in the missing part or write a sentence that is all your own!

    - The largest amount of air (volume of air) creates a… sound.

    - The smaller the air column, the… the sound is that can be produced.

Activity 3: (Optional)

1. Take a straw and cut in half.
2. Take an ink pen and write the letter "F" on one of the halves.
3. Take the other piece of that straw and cut it in half, thus making two pieces that are 1/4 of the original straw.
4. Label one of those pieces "S" and throw the other piece out.
5. Take a second straw and measure its length. It should be about 30 cm.
6. Measure down 10 cm and cut that piece off.
7. Label that piece T.
8. Take the other, longer piece which is about 20 cm and cut it into half. Cut that half again, thus making a 5 cm piece and label the piece "O".
9. Take the second remaining 10 cm piece and measure 4 cm down and cut it.
10. Label the 4 cm piece "P" and the 6 cm piece "Z."
11. Take your six pieces of straw and blow across the top of each one until you get a note. Put the straws in order of lowest note to highest note. Record the order below and make sure to LABEL WHICH END OF YOUR ORDER IS THE HIGHEST NOTE PRODUCER AND WHICH END IS THE LOWEST NOTE MAKER.

Questions:

1. What happens to the sound as the length of the straw gets longer or in other words the column or amount of air increases?

2. How are these results similar to the bottles filled with air and water activity you explored?

3. Write a sentence that describes the relationship you discovered between the amounts of air (volume of air) that vibrated and the sound that was produced. You can start your sentence with any of the examples below and fill in the missing part or write a sentence that is all your own!

    - The largest amount of air (volume of air) creates a _____sound.

    - The smaller the air column, the ______ the sound is that can be produced.

Answers to the Lab Activity, This is Music to My Ears!

Activity 1:

Instructions:

1. Pour 1/2 a liter of water into one bottle.
2. Pour 1 liter of water into a second bottle.
3. Pour $1\frac{1}{2}$ liters into the third bottle
4. Leave one bottle empty.
5. Label each of the bottles using masking tape, as to the amount of water in each one.
6. Predict below which bottle will have the highest pitch and which bottle will have the lowest pitch when you tap each bottle:

    Student responses may vary.
7. What vibrates to produce sound when you tap the bottle?

    The water vibrates.
8. Tap each bottle and listen to the sounds produced.

    a. Which bottle had the highest pitch?

    The bottle with the least water had the highest pitch.

    b. Which bottle had the lowest pitch?

    The bottle with the most water had the lowest pitch.
9. Predict below which bottle will have the highest pitch and which bottle will have the lowest pitch when you blow across the top of each bottle:

    Student responses may vary.
10. What vibrates to produce sound when you blow across the bottle?

    The air column vibrates.
11. Blow across each bottle and listen to the sounds produced.

    a. Which bottle had the highest pitch?

    The bottle with least amount of air will have the highest pitch.

    b. Which bottle had the lowest pitch?

    The bottle with the most amount of air will have the lowest pitch.
12. When material vibrates slower it produces a lower sound. In both cases the lower sound was produced by having the __________ (least or most) amount of the vibrating substance?

Most

Questions:

1. Were your predictions correct? Write a sentence that describes the relationship between the amount of air that vibrates and the highness or lowness of the note.

    Student responses will vary. The more air there is to vibrate or the more water that vibrates, the lower the note.
2. Why do you think the notes coming from a cello sound so different than those coming from a violin? (Hint: Think about the size of the instruments).

    A cello is much bigger than a violin and therefore, has more air in its body to vibrate when a string is plucked.

Activity #2:

1. Press down one end of the straw so it is flat.
2. Using scissors cut away the corners of the flattened end. The snips should produce a triangle.
3. Open the flattened (reed) end.
4. Make 2 snips with your scissors about 2 inches from the other end of the straw. This opening will be a short cut for the air to escape from rather than traveling the entire distance of the straw. Make sure you do not cut the straw into 2 pieces.
5. Place the reed end of the straw in your mouth and cover up the hole you just cut with your finger. Make sure it doesn't touch your cheek or tongue and blow through the straw.
6. Now uncover the hole and blow into the reed end of the straw. If no sound is produced, be sure the reed end is still open and free to vibrate.

Questions:

1. What is the difference in the sound when the hole is covered versus not covered?

   When the hole is covered, the straw produced the lowest pitch. When the hole is uncovered, the straw produced a higher pitch.
2. What is the only difference between the two situations that produce the two sounds?

   The difference is in the length of the column of air in both cases. The covered hole has a longer pathway for the air to vibrate and the open hole makes the pathway shorter because the air goes out the hole rather than traveling down the whole straw.
3. Which situation, the uncovered or covered hole, had the most air vibrating?

   The uncovered hole had the most air vibrating.
4. Which situation, the uncovered or covered hole, had the lowest pitch?

   The uncovered hole had the lowest pitch.
5. Write a sentence that describes the relationship you discovered between the amount of air (volume of air) that vibrated and the sound that was produced. You can start your sentence with any of the examples below or write a sentence that is all your own!

   The largest amount of air (volume of air) creates a **low** sound.

   The smaller the air column, the **higher** the sound is that can be produced.

Activity #3: (Optional)

1. Take a straw and cut in half.
2. Take an ink pen and write the letter "F" on one of the halves.
3. Take the other piece of that straw and cut it in half, thus making two pieces that are 1/4 of the original straw.
4. Label one of those pieces "S" and throw the other piece out.
5. Take a second straw and measure its length. It should be about 30 cm.
6. Measure down 10 cm and cut that piece off.
7. Label that piece "T."
8. Take the other, longer piece which is about 20 cm and cut it into half. Cut that half again thus making a 5 cm piece and label the piece "O."
9. Take the second piece remaining 10 cm piece and measure 4 cm down and cut it.
10. Label the 4 cm piece "P" and the 6 cm piece "Z."
11. Take your six pieces of straw and blow across the top of each one until you get a note. Put the straws in order of lowest not to highest note. Record the order below and make sure to LABEL WHICH END OF YOUR ORDER IS THE HIGHEST NOTE PRODUCER AND WHICH END IS THE LOWEST NOTE MAKER.

Questions:

1. What happens to the sound as the length of the straw gets longer or in other words the column or amount of air increases?

As the length of the straw gets longer, the sound gets lower.

2. How are these results similar to the bottles filled with air and water activity you explored?

This is similar to the bottle exploration because we found out that when we blew over bottles, the one with the most amount of air (longest column of air) had the lowest sound.

3. Write a sentence that describes the relationship you discovered between the amounts of air (volume of air) that vibrated and the sound that was produced. You can start your sentence with any of the examples below and fill in the missing part or write a sentence that is all your own!

• The largest amount of air (volume of air) creates a **low** sound.

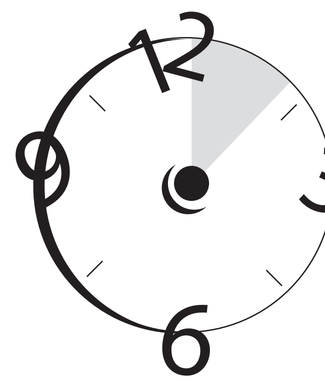
• The smaller the air column, the **higher** the sound is that can be produced.

Sound Right about Sound!

Connections

Time Allocation: 1 hour, 30 minutes

Required Materials and Resources on Page 121



Lesson Overview

Students in this lesson will explore the nature of a musical scale and how different vibrating sources can produce the pitches needed to create a scale. In the activity students will be challenged by a fictitious movie company to create a musical instrument that can play a full, eight-note scale of music. They will name their invention and share with class members its versatility and appropriateness for an animated adventure movie.

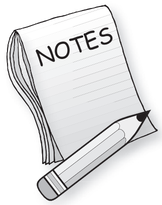
Guiding Questions

- How can I make a musical instrument out of every day materials?
- What do all instruments have in common?

BIG IDEA

Musical Creativity

SOUND'S STORY: H-EAR THE PITCH



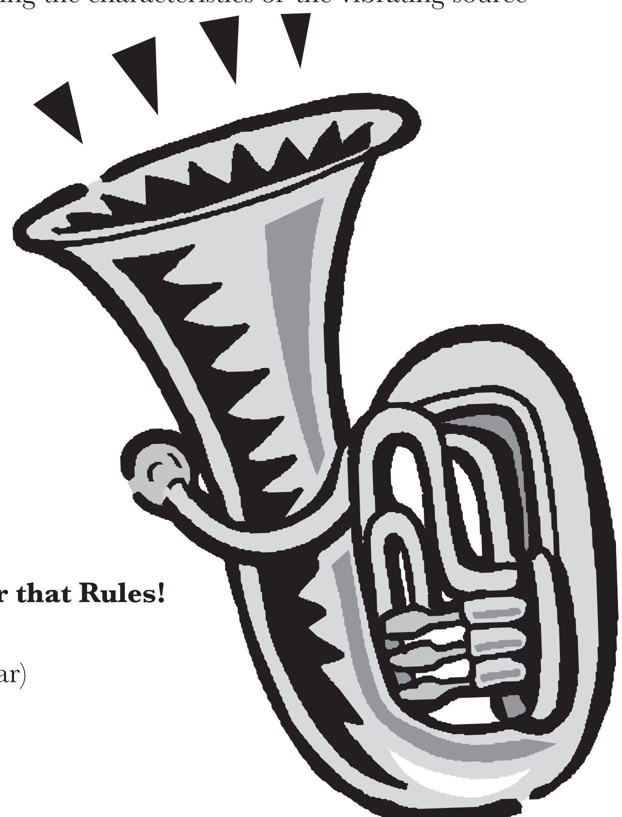
Content Goals

Universal Theme(s)

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.
- Form and function are interdependent.

Principles and Generalizations

- Pitch can be changed by altering the characteristics of the vibrating source that produces the sound.



Concepts

- Pitch

Teacher Information

N/A

Skills

- Make observations
- Compare and contrast
- Identify cause and effect

Materials and Resources

1. Materials to make the **Guitar that Rules!**
    - paper cup
    - kite string (2 ft long per guitar)
    - masking tape
    - ruler (1 per guitar)
    - paper clips (2 per guitar)
    - push pin (1 per group or teacher making a guitar)

2. Various musical instruments ,e.g., percussion (drum, cymbals), wind reed (e.g., clarinet), wind whistle (e.g., flute), wind brass (e.g., trumpet)
3. Various sizes of blocks of wood or metal
4. Straws with various sized diameters
5. Various rubber bands, thick and thin ones, short and long ones, ones with high and low tension
6. Various size metal cans
7. Various glass bottles
8. Various pots and pans
9. Sticks of various kinds and/or lengths
10. Hubcap, grater, spoon , or any pieces of metals that could be used to make an instrument

Preparation Activities

1. Copy the lab activity, **So You Think You Can Make an Instrument!** for each student.
2. Make a "paper-cup guitar" or if there is sufficient time and/or student interest, have students make their own guitars. See page 6 for the **Instructions for Making the Guitar the Rules!**
3. Gather the instruments that you intend to use as a way to demonstrate the varied ways in which sounds can be made.

Introductory Activity (10 minutes)

- Collect students' lab sheet, **This is Music to My Ears!**
- As a way of reviewing yesterday's work, ask students to think about the musical instruments they know, including the musical instruments you have to show them. Make sure to demonstrate the homemade **Guitar that Rules** or have students make one if time permits, and you think they can benefit from the activity.
- Invite a student to press down the string a couple of inches away from the S-hook until the string touches the ruler.
- Pluck the string again and listen to the sound.
- Have a student push down at different points on the string. Ask them how these changes affect the sound that is produced. They will see that as the string shortens, the pitch goes up.
- Ask students how these instruments you brought in for demonstration make sounds. Lead students to identify which part of the instrument is actually causing the sound.

- Encourage students to recognize that some instruments produce sounds by hitting them like the drum, xylophone, and bells (they vibrate); some make sounds by blowing into them like the recorder, reed instruments and horns (the lips or the air vibrates), and some vibrate a string like the piano, violin and cello.
- Tell students they are going to face a challenge in the next activity that involves developing their own musical instrument.

Pre-assessment

N/A

Teaching and Learning Activities (50 minutes)

1. Pair students up, making sure that each group has a student who has the ability to differentiate among different notes.

2. Distribute and review the instructions for **So You Think You Can Make an Instrument!**

3. Invite students to explore what factors of the materials provided could contribute to changing pitch for their instruments, such as the tension in an elastic band, the diameter or length of a pipe, as seen in a wind chime, and the shape, mass, and length of blocks of wood.

4. Tell students to start exploring all the materials provided with the intent of using them to meet *Pixar's* challenge of creating an instrument to be used in a movie.

5. Circulate among the groups helping them when needed to create and name their instrument.

Products and Assignments

- Students' musical instruments, names and the movies for which the instruments were designed

Extension Activities

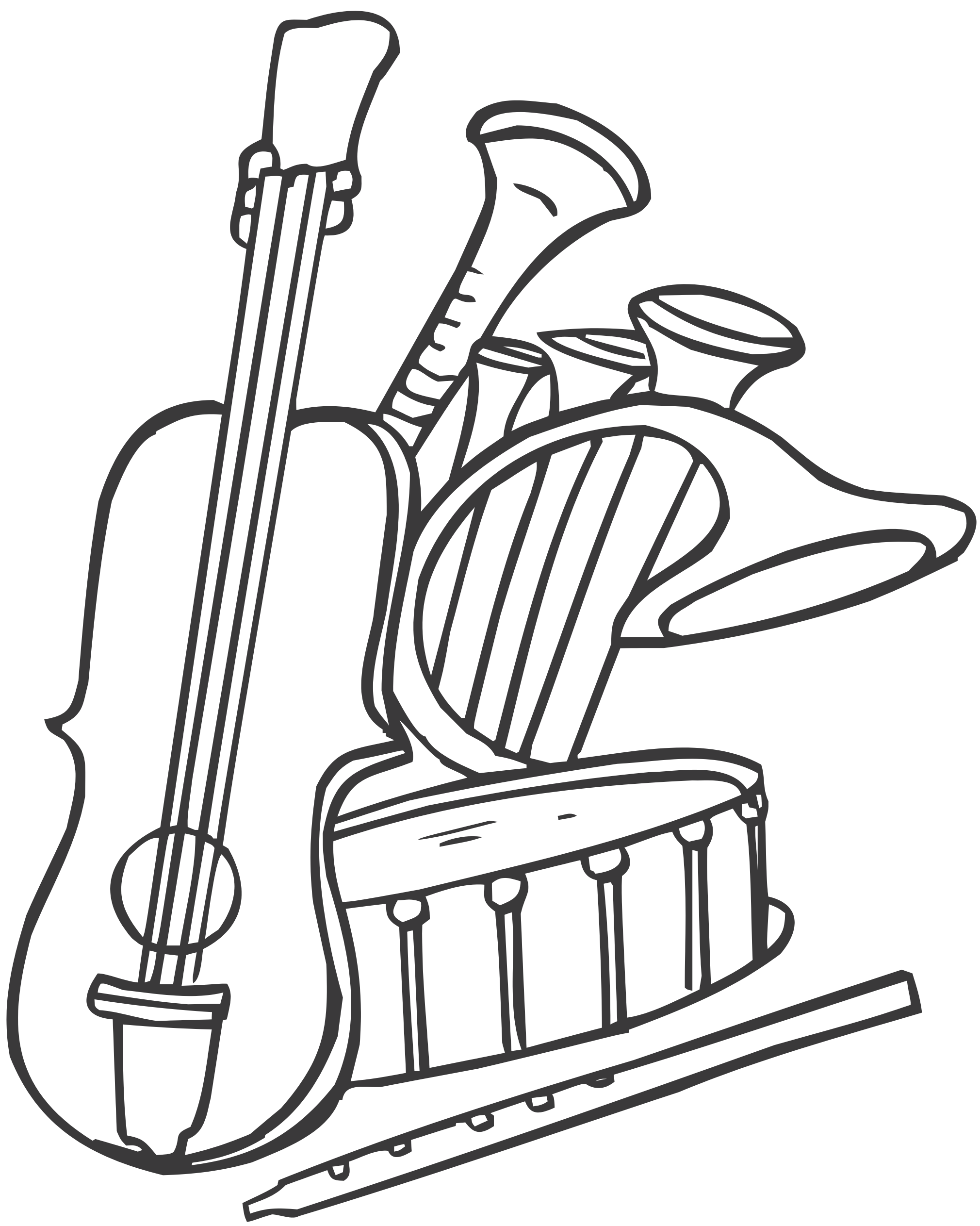
N/A

Post Assessment

N/A

Debriefing and Reflection Opportunities (30 minutes)

1. Let each pair of students introduce their instrument by name, demonstrate its sounds, and explain what the movie is in which it will be featured.
2. Ask students what all instruments have in common. Students should be able to conclude that all instruments must have something that vibrates that ultimately makes air vibrate.



Name ______________________________ Date______________

So You Think You Can Make an Instrument!

We, from *Pixar*, a movie company combining the talents of George Lucas (*Star Wars* fame) and Disney have made computer animated films, including *Toy Story, Toy Story 2, A Bug's Life, Finding Nemo, The Incredibles and Monsters Inc.* We are running a contest in which the challenge is to come up with an instrument that can make special sounds for a new animated adventure movie that we will be creating that incorporates the sounds from the winning instrument. Your challenge is: (a) to create the instrument, (b) name the instrument, (c) identify how you envision its use in the movie and (d) demonstrate its ability to play a musical scale to the other members of the class.

1. What materials have you used?

2. What is the name of your instrument?

3. What changes the pitch for your instrument? (As you develop your instrument, identify below what material and specifically which part is being changed/added to change the pitch as you progress through the scale. For instance, you may change the length of something, which changes the pitch.) Document in the chart below what part of your instrument creates each note and be specific if its length, tension, etc. has anything to do with the sound production.

Pitch	DO	RE	MI	FA	SO	LA	TI	DO
Material/ Item								

4. What will your instrument be used for in the movie? In other words, how will this particular instrument enhance (add to) the movie?

Instructions for Making the Guitar that Rules!

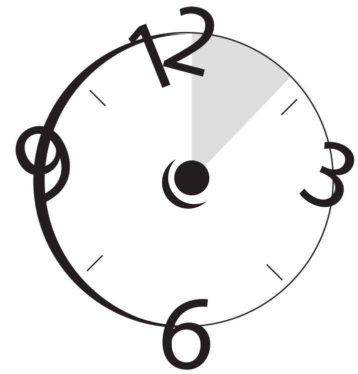
1. Use the push pin to push a small hole near the center of the cup's bottom.
2. Pass the string through the cup hole.
3. On the inner side of the cup tie the paper clip to the end of the string.
4. Pull the opposite end of the string so the paper clip becomes pressed to the inside of the cup's bottom.
5. Lay the side of the cup on the end of the ruler and use tape to secure the cup to the ruler.
6. Bend the other paper clip into an S shape.
7. Fasten the S hook to the opposite end of the ruler and secure with tape.
8. Tie the free end of the string to the S hook located at the end of the ruler. The string should be tied so it is taut and can be plucked.
9. Trim away any excess string and pluck the string and listen to its sound.

Sound Right about Sound!

Core/Identity/AID

Time Allocation: 1 hour, 20 minutes

Required Materials and Resources on Page 121



Lesson Overview

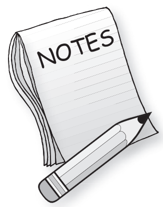
Students have seen how sound can be transmitted though materials. In this lesson they will explore the absorption and reflection of sound, as it strikes various substances. They will see the similarity between a sponge's ability to absorb water and a porous substance's ability to absorb sound. They also will discuss sound reflection as experienced through echoes and in places (e.g., loud restaurants) where sounds are not absorbed sufficiently. Finally, students will discuss some of the similarities between some of sound's and light's behaviors.

Guiding Questions

- Why some restaurants so loud, but others are are not?

BIG IDEA

Sound waves can be absorbed or reflected.



Content Goals

Universal Theme(s)

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.
- Form and function are interdependent.

Principles and Generalizations

- Sound waves can be absorbed.
- Not all materials absorb sound energy in the same manner.
- Sound waves can be reflected.
- Solid surfaces reflect sound better than porous surfaces.
- Echoes are an example of sound reflection.

Concepts

- Model
- Absorption of sound
- Porous
- Insulator
- Soundproof
- Echo
- Acoustics (AID)

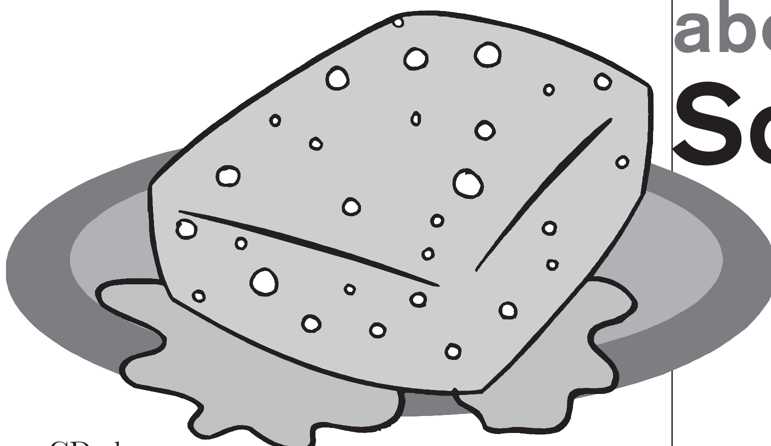
Teacher Information

N/A

Skills

- Predict
- Make observations
- Compare and contrast
- Identify cause and effect

Sound Right about Sound!



Materials and Resources

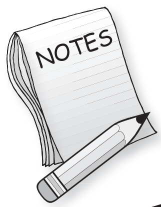
1. Sponge
2. Water
3. Overhead projector
4. Screen or blank wall
5. Rubber ball
6. Blanket
7. Radio, cassette player, or CD player
8. Cardboard box slightly larger than the radio, cassette player, or CD player
9. Newspaper
10. Plastic bags
11. Pillows
12. Foam packing chips
13. Aluminum foil
14. Internet access

Preparation Activities

1. Copy the class activity sheet, **Stop that Sound!** for each student.
2. Copy the **Answers to Stop that Sound!** for yourself.
3. Download and copy materials (see websites in Teaching and Learning Activities) for careers in acoustics if computers are not available for student use.

Introductory Activity (15 minutes)

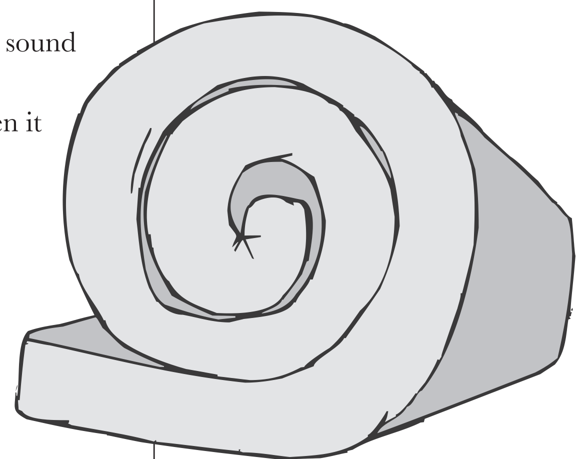
- Invite students to summarize what they have learned about sound's behavior thus far in the unit. In addition to referencing the activity designed to show what sound is (e.g., bouncing rice), students will probably describe some of the activities in which they investigated how sound is transmitted through substances including air (e.g., wire hanger, tuning fork, flour, water).
- Question students, "Can sound do anything else?"
- As they are thinking, use a dry sponge to soak up some water.
- Ask, "Where did the water go?" The water was absorbed into the sponge.
- Discuss the word *absorb* (to soak up). Then relate the demonstration to light absorption. Turn on an overhead projector without a transparency and shine the light on a screen, white board or wall. Have the students



look at the light. Then stand a volunteer between the projector and the screen so that everyone can see his/her shadow. Question the students. Why can't we see all the light that we saw before? What is this black part on the screen? What happened when light hits the student? Discuss the students' thinking. Use questions to guide them to see that the student's body is absorbing the light waves just like the sponge absorbed the water.

- Ask students whether sound can be absorbed like light. Students probably will say it can and may mention sound-proofing materials as example of a substance that is used to absorb sound. If they do not, it is okay.
- Explain to them that they will be exploring what happens to sound when it strikes various materials. If they have already explored light, you can mention that the absorption of sound by different substances might be similar to light's behavior when it strikes various substance having different colors and textures.
- Ask students whether sound can be reflected like light. Students probably will have had some experience with echoes. If they mention echoes, ask them what the best environment in which to produce echoes is. Students might realize the less textured, fluffy, layered material involved, the more chance an echo would be produced.
- Do not judge the accuracy of students' answers at this point. This discussion serves as an informal assessment of what students currently think about sound absorption and reflection. **SEARCHLIGHT**: Be aware of students who demonstrate an above average knowledge or have demonstrated that they learn the material more quickly than their peers; they may be ideal candidates for the extension activities.
- Throw a rubber ball off a wall gently. Tell students that the ball is going to represent a sound wave bouncing off a wall. Toss the ball against the wall, but this time have a student mark the spot the ball hits the floor after bouncing off the wall. Then have another student measure the distance from the wall to the spot the ball hit the floor.
- Have two students hold a blanket vertical to the floor. (Make a blanket wall.)
- This time toss the ball at the blanket and have a student mark the spot the ball hits the floor after bouncing off the blanket wall. Then have another student measure the distance from the blanket wall to the spot the ball hit the floor.

- Compare the two measurements. Ask the students what they noticed (When the ball bounced off the wall, it bounced a greater distance than when it hit the blanket wall.)
- Ask them why they think there was a difference. (When the ball hit the wall, it bounced back with more energy than when it hit the blanket wall. The blanket absorbed some of the energy from the ball so the ball could not bounce back as far.)
- Tell students that what they just observed was a "model" for what sound might do when it strikes various objects.
- Tell them that they will be examining what happens to sound when it strikes real materials.



Pre-assessment

N/A

Teaching and Learning Activities – Part I (30 minutes)

1. Distribute the lab sheet, **Stop that Sound!**

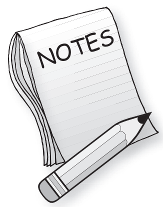
2. Tell students that they will be sitting in a semicircle, facing the front of the room and that this investigation will be done as a whole class.

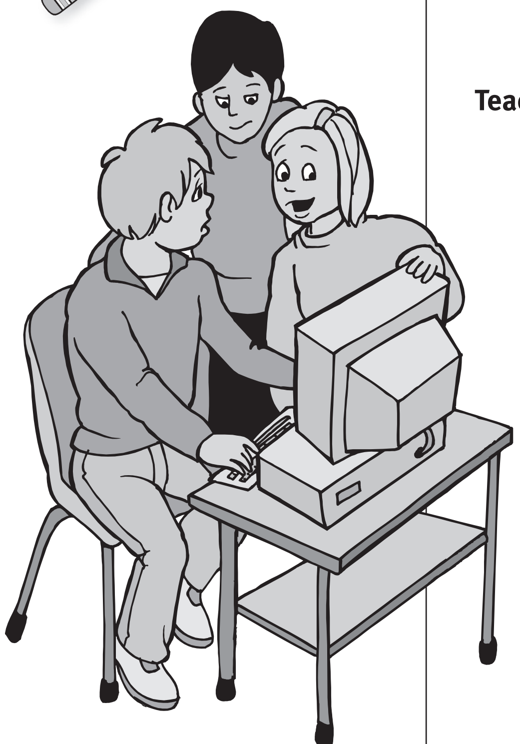
3. Place the radio, cassette player or CD player in the box and adjust the volume so everyone can just barely hear the music when the box is closed.

4. At their seats have the students predict which materials will be the best sound insulators. Tell them to rank the materials on the lab sheet from 1 to 6 in the **Prediction** column.

5. Place the radio in the box and crumple the newspaper around it. Close the box and listen. Discuss the newspaper's ability to absorb sound energy. Repeat this step with the plastic bags, pillows, blanket, foam packing chips and aluminum foil.

6. Have the students rank the materials from the best (1) to the worst insulator (6). Share results and discuss. (The softer, fuzzier materials muffled the sound the most because there are more tiny air holes in these materials that will trap the sound. Also the thicker the soft, fuzzy material, the better it will muffle the sound.)





7. Tell the students complete the questions on the lab sheet.

Teaching and Learning Activities – Part II (30 minutes)

1. Have students form groups of three or four. Take them to a computer lab or a library with computers, unless you have sufficient computers in your room. (In none of these options are available, visit the website yourself and print off the information for the groups.) Direct students to go to the following website: http://asa.aip.org/acou_and_you.html Students will find 10 pages of information on careers in acoustics. Have each group read about the different careers and then choose one of them that they would like to know more about (architectural acoustics, engineering acoustics, musical acoustics, physical acoustics, speech and hearing, and bioacoustics and medical acoustics).
2. Once the group has chosen one of the careers dealing with acoustics, have them find at least one other website with information on that career. Some suggestions for age appropriate sites are : http://www.eaiinfo.com/home.html (engineering acoustics); http://oceanlink.island.net/oinfo/acoustics/acoustics.html (underwater acoustics); http://www.phys.unsw.edu.au/music/ (music acoustics – This website allows students to even explore a particular instrument!); and http://www.easterseals.com/site/PageServer?pagename=ntl_understand_sh (for speech and hearing acoustics) Other sites can easily be found by using the Google search engine.
3. Instruct each group to prepare a short description of the career they chose, including at least three interesting facts they have learned.
4. Have groups share with the class the three interesting facts they found about an acoustics career as well as their thoughts about someday pursuing that career and the reasons for their decision.

Products and Assignments

Group acoustics career descriptions

Extension Activities

- (AID) For those students needing an additional challenge, you could have them investigate how architects use the science of acoustics when they are designing large spaces, such as concert halls.

- (AID) Have students find information on how architects use ornamentation on the walls (small designs and statues), acoustic tiles on the ceiling and/or walls, large chandeliers, cloth seats, carpet and drapes.

Post Assessment

N/A

Debriefing and Reflection Opportunities (5 minutes)

1. Ask a representative from each group to put their answers to questions #1 and 2 on the board.
2. Review the class results with the students, looking for consensus but addressing any discrepancies by retesting the particular material, thus reinforcing the idea that science is not about opinion but rather is based on data.
3. Ask students if they have ever been in a restaurant that was much too loud.
4. Ask them if they noticed how the restaurant was decorated. Did it have drapes, chairs with cushions, pictures and other items on the walls or were the walls rather bare and unadorned?
5. Ask students to share their ideas on where is it necessary to soundproof a room. (e.g., libraries, music lesson rooms, recording studios and hearing testing rooms).
6. Tell students to complete questions #3 and 4 for homework.

Name ______________________________ Date______________

Stop that Sound!

Instructions and Data:

1. Look at the list of materials below on the chart.
2. Predict which materials will absorb sound the best. Rank the materials from 1st to 6th. Mark the material that you think will absorb sound the best as #1 and the material that will absorb sound the least as #6.
3. Test each material and then mark each material from the best insulator to the worst. Use the numbers 1 to 6.

Materials to Test	Prediction	Actual
Newspaper		
Plastic Bags		
Pillows		
Blanket		
Foam Packing Chips		
Aluminum Foil		

Questions:

1. Which material was the best sound insulator?

____

2. Which material was the worst sound insulator?

____

3. What kinds of materials do you think make good sound insulators? Why?

____

____

4. When would knowledge of soundproofing be important?

Answers to Stop that Sound!

Instructions and Data:

1. Look at the list of materials below on the chart.
2. Predict which materials will absorb sound the best. Rank the materials from 1st to 6th. Mark the material that you think will absorb sound the best as #1 and the material that will absorb sound the least as #6.
3. Test each material and then mark each material from the best) to the worst in its ability to sound-proof (insulate). Use the numbers 1 to 6.

Materials to Test	Prediction	Actual
Newspaper	Student response	5
Plastic Bags	Student response	4
Pillows	Student response	1 or 2
Blanket	Student response	2 or 3
Foam Packing Chips	Student response	2 or 3
Aluminum Foil	Student response	6

The actual experimental results may vary because of the amount of material you happen to use, but students will be able to conclude that the more substance you have that is porous, has spaces inside, where sound can be trapped (e.g., pillows foam packing chips) the more sound-proof the material is. Substances that are hard and non-porous like plain walls or aluminum foil do not absorb sound well.

Questions:

1. Which material was the best sound insulator?

pillow (answers may vary see above)

2. Which material was the worst sound insulator?

aluminum foil (answers may vary see above)

3. What kinds of materials do you think make good sound insulators? Why?

Materials that have lots of pores or spaces to trap sound make good sound insulators.

4. When would knowledge of soundproofing be important?

If you are taping a TV show or recording music and do not want any outside noise to disturb the recording, you would want to do it in a soundproof room.

If you are in a place like a shooting range and you do not want the noise to affect outside businesses, you would want that room to be soundproof.

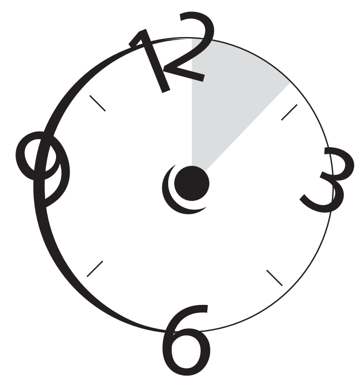
If you owned a bar near a residential neighborhood and had bands play at night, you would want to soundproof to some extent the room in which the band plays, so that the neighbors would not be disturbed by the noise.

H-ear’s the Pitch: Listen Up!

Connections

Time Allocation: 50 minutes

Required Materials and Resources on Page 121



Lesson Overview

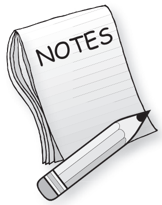
Students will explore how the human ear is built to detect sound. Students will better understand the connection between the biological structures and functions of the ear’s parts.

Guiding Questions

- What structures in the ear allow for it to function so effectively?

BIG IDEA

The Structure and Function of the Human Ear



Content Goals

Universal Theme(s)

- Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena.
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.
- Form and function are interdependent.

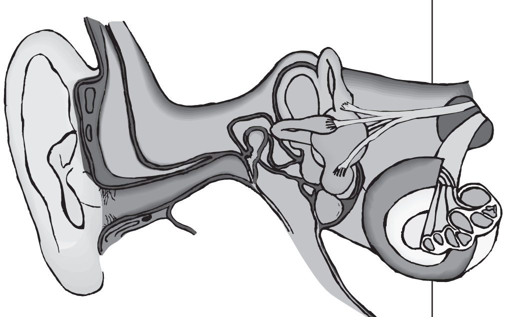
Principles and Generalizations

- The ear is an organ for hearing and balance.
- Air vibrations cause the ear drum to vibrate, which in turn causes other parts of the inner ear to vibrate which is then translated by the brain into sounds.

Concepts

- Structure and function of the ear

Teacher Information



- The ear consists of three parts: the outer ear, the middle ear and the inner ear. The outer and middle ear mostly collect and transmit sound. The inner ear analyzes sound waves and contains an apparatus that maintains the body's balance.
- The outer ear is the part that is visible and is made of folds of skin and cartilage. It leads into the ear canal, which is about one inch long in adults and is closed at the inner end by the eardrum.
- The eardrum is a thin, fibrous, circular membrane covered with a thin layer of skin. It vibrates in response to changes in the air pressure that constitute sound. The eardrum separates the outer ear from the middle ear.
- The middle ear is a small cavity that conducts sound to the inner ear by means of three, tiny, linked, movable bones called "ossicles." They are the smallest bones in the human body and are named for their shape. The hammer (*mallus*) joins the inside of the eardrum. The anvil (*incus*) has a

broad joint with the hammer and a very delicate joint to the stirrup (*stapes*). The base or footplate of the stirrup is attached to a flexible membrane covering an opening into the inner ear called the oval window.

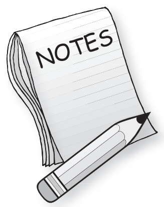
- The inner ear is a very delicate series of structures deep within the bones of the skull. It consists of a maze of winding passages, called the "labyrinth." The front (see cochlea) is a tube resembling a snail's shell and is concerned with hearing. The rear part (vestibular and semi-circular canals) is concerned with balance. Moving back and forth like a piston, the stapes, middle ear component, sets in motion the fluids located in the narrow tube called the cochlea. The moving fluid creates "pressure waves." The cochlea contains cells with tiny sensing hairs that transform sound waves into electrical signals that eventually reach the brain.
- Sound is amplified 20 times in the short journey from the eardrum to the inner ear.

Skills
- Analyze
- Draw conclusions

Materials and Resources
1. Go to the following website for a good diagram of the human ear, http:/ www.mscd.edu/~biology/Bio1000/Bio1000inf.htm When you get to the site, scroll down to Chapt. 13, and click on ear diagram for an excellent image of the human ear for the handout, **Hear! Hear! Let's Cheer for the Ear!**

Preparation Activities
1. Reserve Internet access so that students to see an animated diagram of an ear (http://www.innerbody.com/anim/ear.html).
2. Make copies of the diagram, **Hear! Hear! Let's Cheer for the Ear!**

Introductory Activity (10 minutes)
- Collect students' lab sheets, **Stop that Sound!**
- Invite students to share their answers to questions #3 and #4. Students should realize that good insulators have lots of pores or spaces to trap sound and areas like libraries, restaurants, museums and practice music rooms must use sound proofing effectively.



Pre-assessment
N/A

Teaching and Learning Activities (35 minutes)

1. Use a computer or computer lab that has Internet access to a site that has Internet access and some computers.

2. Tell students that you have a computer site where they can actually see interactions of sound waves with an eardrum and an animated diagram of an ear in action.

3. Ask student to predict what happens to an eardrum when sound hits it. Write their predictions on the board.

4. Take students to a computer lab and/or show the three sites below *in order* to the in class on a computer:
   i.) http://www.physicsclassroom.com/mmedia/waves/edl.html
   ii.) http://www.innerbody.com/anim/ear.html
   iii.)http://www.bbc.co.uk/science/humanbody/body/factfiles/hearing/hearing_animation.shtml

5. After seeing the animation, distribute the sheet, **Hear! Hear! Let's Cheer for the Ear!**

6. Go over the three main areas of the ear, outer, middle and inner ear. Discuss the major parts (see Teacher Information) with students using the diagram.

Products and Assignments

- Students' lab sheets, **Stop That Sound**

Extension Activities
N/A

Post Assessment
N/A

Debriefing and Reflection Opportunities (5 minutes)

Remind students how wonderfully complex, sensitive and special the ear and its parts are. Discuss with students the importance of taking care of their ears and not listening to music too loudly as they can easily damage their hearing.

Name ______________________________ Date______________

Hear! Hear! Let's Cheer for the Ear!

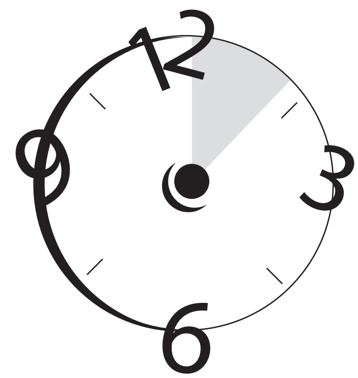
Go to this website for an excellent diagram of the ear with an inset of the inner ear http://www.mscd.edu/~biology/Bio1000/Bio1000inf.htm Scroll down to Chapt. 13 and click on ear diagram.

H-ear's the Pitch: Listen Up!

Core/AID

Time Allocation: 1 hour

Required Materials and Resources on Page 121



Lesson Overview

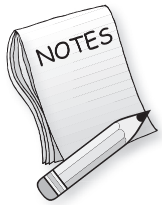
There is a whole different world to see and hear that humans cannot experience without the help of technology. In this lesson students listen to a conventional whistle and then try to hear a dog whistle. They soon realize that humans cannot hear what some other animals can.

Guiding Questions

- Can dogs hear sounds that I can't?
- Can I damage my ears without knowing it?

BIG IDEA

Some animals can hear sounds humans cannot.



Content Goals

Universal Theme(s)

- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.
- Form and function are interdependent.

Principles and Generalizations

- The range of sound is broad, and there are many sounds that humans cannot hear.
- Some animals can hear sounds that humans cannot.

Concepts

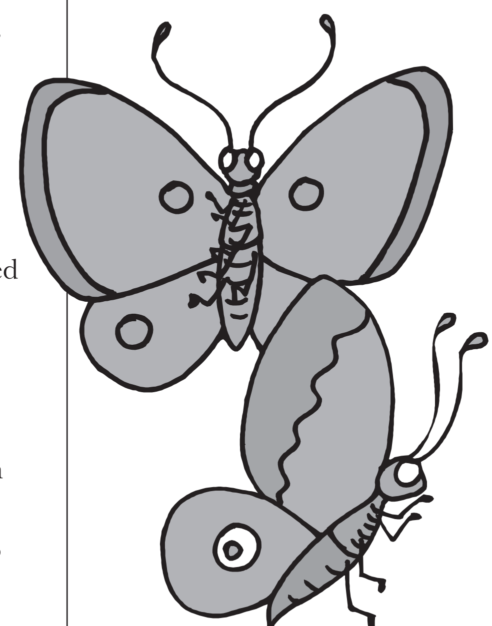
- Sound intensity
- Decibel
- Echolocation
- Sonar
- Sound amplification
- Fetus (AID)

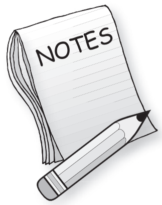
Teacher Information

- Hertz is a unit that measures the number of vibrations a sound wave makes each second.
- The Hertz unit of measurement was named after the German physicist, Rudolph Hertz, who lived from 1857 to 1994 and was the first person to produce and detect radio waves.
- The average human can hear sound waves within a range from 20 to 20,000 hertz.
- The human voice can produce sounds between 85 and 1,100 hertz.
- The loudness or intensity of a sound is measured in decibels (dB). The unit was named after Alexander Graham Bell, the inventor of the telephone.

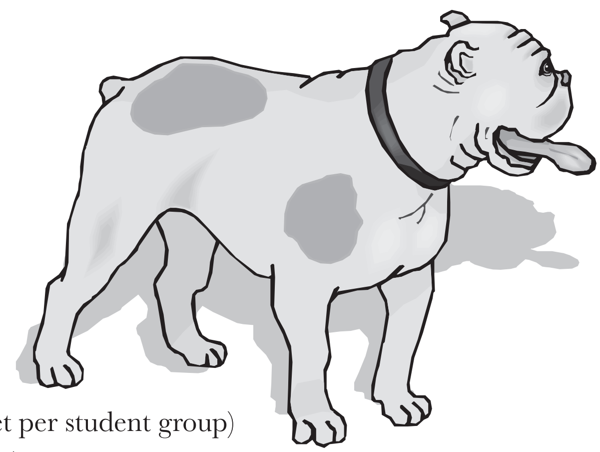
H-ear's the Pitch: Listen Up!

- Ultrasounds are sound frequencies above the range of human hearing.
- Echolocation is the process of bouncing sound off objects to provide information about size, location and movement of those objects.
- Bats use ultrasound to locate insects to eat and for navigation. Their ability to catch flying insects while flying full speed in pitch darkness is astounding. Their sophisticated echolocation permits them to distinguish between a moth (supper) and a falling leaf. Bats use ultrasounds to communicate with mates, as do murid rodents (rats and mice) and various sorts of moths.
- Orca whales produce a wide variety of clicks, whistles and pulsed calls. They vary in frequency from 1 to 25 kHz. Individual pods of whales have their own distinctive dialect of calls, similar to songbirds. Some such calls are known to be stable over a period of 10 years.
- Humpback whales produce a variety of moans, snores, and groans that are repeated to form what we might call songs. The frequencies of these songs range from about 40 Hz to 5 kiloHertz (kHz).
- Singing whales are usually solitary males who exhibit sounds in a shallow smooth-bottomed area where sound propagates well. They are interpreted as territorial and mating calls.
- Whales are also known to produce some very intense low frequency sounds which they may use to stun or disorient small fish for prey. Bottlenose dolphins produce sounds in the range 7 to 15 kHz which are continuously variable in pitch. In addition, they produce short burst from 20 to 170 kHz, presumably for better echolocation.
- A dolphin's clicks come from small knobs near its blowhole. There are no vocal cords.
- Moths can hear ultrasound. They use the ability to avoid capture from bats that use it to detect the presence of insects like moths. They also use it to find females.
- Rodent pups use ultrasound to call their mother if they become isolated from her.
- Some squirrels can produce ultrasonic warning calls.
- Pigeons can detect ultra-low frequency sound, those produced by crashing waves and thunder storms, for example that are useful in navigation.
- Echo sounders are used to measure water depth by sending acoustic pulses via a transducer. The acoustic pulses are reflected at the sea floor and the





reflected echoes are received at the transducer. Echo sounders repeatedly "ping" the seafloor with a narrow cone of sound (<5 degrees) as the ship moves along the surface, producing a continuous line showing depths directly beneath the ship. A conventional, single beam echo sounder records the time taken for the acoustic pulse to travel from the transducer to the sea-bottom and back again. The water depth is then calculated from the two-way travel time and the assumed velocity of sound in water (1500 m/s). In the early days of ocean exploration until as recently as 15 years ago, marine geologists wrote down individual readings from echo sounders, plotted them on navigation charts showing the ship's position, and then drew contour lines joining points of equal depth (isobaths). In this way, they produced bathymetry maps of the sea floor. This method was used in most places to map the sea floor in the South Pacific during the early 1980's. Currently multi-beam echo sounders are used to obtain more accurate and complete pictures of ocean bottoms.



Skills

- Make observations
- Compare and contrast
- Identify cause and effect

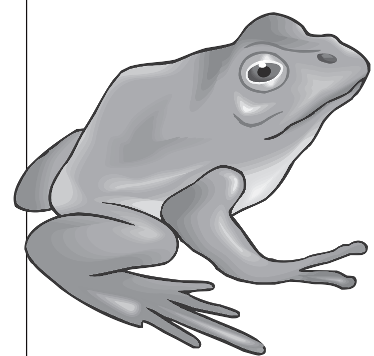
Materials and Resources

1. Regular whistle
2. Dog whistle
3. Flexible plastic tubing (3 feet per student group)
4. Funnels (2 per student group)

Preparation Activities

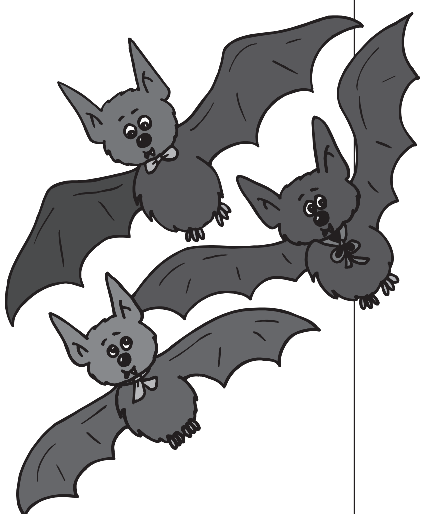
1. Copy the chart, **Hearing Ranges for Animals Other than Humans**, for each student.
2. Copy the lab activity, **Sound Amplification**, for each student.
3. Copy the **Answers to the Sound Amplification** for yourself.
4. Copy the **Answers to the Fetal Ultrasound Extension Activity** for yourself.
5. Copy the extension activity, **Fetal Ultrasound Extension Activity** (AID) for appropriate students.

H-ear's the Pitch: Listen Up!



Introductory Activity (15 minutes)

- Using the diagram of the ear from Lesson 8, review the major parts of the ear and what their functions are by using the model and selecting different parts for students to identify and describe.
- Blow a regular whistle. Have the students raise their hands if they heard it.
- Then blow a dog whistle and have the students raise their hands if they heard it. (Do not blow the dog whistle too hard or the students will hear some sound.)
- Question students about why they think humans cannot hear dog whistles.
- Ask students if we can see all types of light. They should know from personal experiences (or remember from their study of light of that has been previously taught) that humans cannot see all types of light (e.g., ultraviolet light and infrared (although the latter can be felt as it is converted to heat).
- See if students know that there are sounds that humans cannot hear as well.
- Share with students that there is a unit of measurement for the number of sound vibrations or frequencies just like there is a unit of measurement for weight (e.g., pounds or kilograms). It is called "hertz." Tell students that the frequency or number of hertz determines the pitch of any sound we can hear.
- Ask students what they think the name "hertz" might come from. (see **Teacher Information**)
- Tell them that the average human hears a range of sound frequencies between 20 – 20,000 Hz. There are frequencies below 20 Hz that we cannot hear, and there are frequencies above 20,000 Hz that we cannot hear.
- Query students about what the dog whistle tells them about animal's range of hearing. Students should conclude that the hearing range of animals can go lower than 20 Hz and/or higher than 20,000 Hz.
- Distribute the chart, **Hearing Ranges for Animals Other than Humans.**
- Elicit an answer about which animal on the chart has the greatest range of hearing? (Porpoise) Why do you think the porpoise would need such a large range of hearing for survival? Which animal on the chart has the smallest range of hearing? (Bullfrog) How do you think the bullfrog survives with such a small range of hearing? (A bullfrog does not have to use hearing very much because it lives in a small area, eats insects and does not need to communicate much.)



- Ask students what they think animals use their hearing for. Students should mention things like, finding prey, avoiding predators, sending signals that might indicate danger is near, and using sounds for mating.
- Invite students to name some animals that use sounds for specific purposes. Students will mention birds for sure and may mention bats, dolphins, toothed whales or porpoises.
- Ask students if all the sounds animals use can be heard by humans.
- Inquire if they have ever seen bats at dusk darting around the sky. Ask them what they think the bats are doing (feeding). Ask students what bats feed on (insects).
- Ask them how they think bats are locating these tiny insects like mosquitoes (ultrasound).
- Introduce the terms ultrasound and echolocation. If you have access to the Internet, have students use these two live links and investigate the definitions of these words themselves. Students will discover that some animals use ultrasound to communicate with each other and echolocation to navigate.
- Depending on student interest, you can share some of the facts from the **Teacher Information** section regarding other animals that use ultrasound and echolocation to survive or you can make up a homework assignment that asks students to investigate an organism to see how it uses sound to survive. **SEARCHLIGHT**: Be on the lookout for students with above average interest/and or knowledge of the subject. They might be candidates for the extension activities.
- Conclude the discussion with this interesting tidbit. During periods of extreme drought, many trees will let out ultrasonic chirps too high to be heard by humans, but that sound is in the range of hearing for bark beetles and other insects. The beetles know the tree is stressed when they hear this sound so that's when they usually attack. To protect the trees, the U.S. Forest Service is designing beetle traps that set off ultrasonic sounds to attract the bark beetles elsewhere, far away from the trees!

Pre-assessment

N/A

Teaching and Learning Activities (35 minutes)

1. Play a note on some instrument or bang a glass bottle softly and then again loudly.

2. Ask the students what the difference is. They should conclude that it has to do with the intensity of the sound. They may say that sounds can vary in their volume or they might even say energy, which is accurate but not necessary for them to conclude. The idea is that sounds have another property in addition to pitch, in that they can be loud or soft.

3. Inquire of students if they know the unit that is used to measure the loudness of sounds (decibels). If not, tell them and then ask them who invented the telephone. Someone will probably say Alexander Graham Bell, and you then can mention that the unit of measurement for sound intensity was named after him.

4. Ask students if they think sound can hurt them. Let students share their ideas and knowledge.

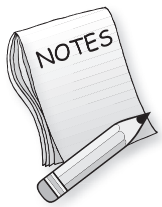
5. Lead them to understand that certain sounds over 85 dB can damage their ears and that a rock concert has music in that can reach 120 dB, the equivalent of thunder.

6. Tell them that high levels of sound over time can cause cumulative damage. In other words, they may not even realize they are hurting their hearing by listening to loud music with headphones until years later when they actually suffer permanent hearing loss.

7. Distribute the lab activity, **Sound Amplification**.

8. Debrief after the activity and introduce the idea that sound can be channeled and thus amplified by preventing it from spreading out and thus decreasing its intensity or loudness.

9. Depending on the factors of time and student interest, choose to have some or all students do the **Extension Activity.**



Products and Assignments

- Students' **Sound Amplification** lab activity sheets.
- (AID) Students' **Fetal Ultrasound Extension Activity** worksheets

Extension Activities

1. (AID) Some sounds are loud and some sounds are soft. A decibel (dB) measures the loudness of a sound. The lowest sound humans can hear is 0 dB. Physical damage to the ear starts to occur at around 85 dB. Investigate normal everyday sounds and their average decibel levels. Create a safety poster to show the sounds and their decibel levels. Label the dangerous sounds.

Sample Student Findings:

Normal breathing	10dB
Rustle of leaves	10dB
Whispering	30dB
Quiet library	40dB
Normal rainfall	50dB
Normal conversation	60dB
Freeway traffic	70dB
Alarm clock	80dB
Piano	80dB
Food Processor	90dB
Train	90dB
Snowmobile	100dB
Baby crying	110dB
Rock concert or thunder	120dB
Airplane taking-off	140dB
Firecracker	150dB

2. (AID) Invite students who have the maturity and interest work in pairs to do the **Fetal Ultrasound** activity sheet below. They will need access to resources to assist them, such as medical encyclopedias or Internet sites like http://www.mayoclinic.com/health/fetal-ultrasound/PR00139 or http://www.mayoclinic.com/health/fetal-ultrasound/PR00054 explain how fetal ultrasound works. Ask students what a fetus is.

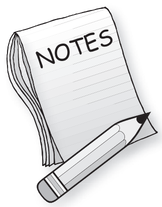
3. (AID) Students could explore how we have developed technology that allows us to "see" sounds by investigating oscilloscopes.

Post Assessment

N/A

Debriefing and Reflection Opportunities (10 minutes)

1. To wrap things up, ask student how humans use sound to do more than make music. How do we use sound to help us? Students will probably mention **sonar**, a tool to find underwater objects or distances to the ocean floor.
2. Ask them how sonar works. Students should realize that sound waves are sent out and the time it takes for them to bounce off the object (e.g., seafloor) and return to the source is recorded. When scientists know how fast sound travels and the time it takes for the sound waves to travel to the object and return, they can calculate the distance to that area on the ocean floor.
3. If students mention the use of ultrasound in medicine, such as seeing a baby in a mother's womb, use your judgment as to the depth of discussion you want to have or whether you want to have students do some independent research on these topics.
4. Ask students to describe some ways in which animals for survival use their ability to hear frequencies higher or lower than humans can hear.
5. Be prepared for possible student responses that might include some information about how bats have poor eyesight but can hear ultrasound. Bats that eat flying insects use very high-frequency sound waves to find and chase their prey.
6. Discuss what they think happened to sound when it was funneled through the plastic tubing.



Hearing Ranges for Animals Other than Humans

Animal	Approximate Hearing Range (Hz)
Bat	1,000-120,000
Beluga Whale	1,000-123,000
Bullfrog	100-3,000
Cat	60-65,000
Cow	23-35,000
Dog	15-50,000
Dolphins	100-110,000
Horse	55-33,500
Human	20-20,000
Mouse	1,000-91,000
Porpoise	75-150,000
Rabbit	360-42,000
Rat	200-76,000

Name ______________________________ Date______________

Sound Amplification

Instructions:

1. Connect each funnel to one end of the plastic tubing.
2. Put one funnel to your heart and let your partner listen.
3. Now place one funnel to your stomach. Let your partner listen to your stomach.

Questions:

1. Describe what you hear in both cases:

2. What do you think the funnel is doing to the sounds from the heart and stomach?

3. What instrument that is used by doctors is similar to the “funnel amplifier”?

Answers to the Sound Amplification

Instructions:

1. Connect each funnel to one end of the plastic tubing.
2. Put one funnel to your heart and let your partner listen.
3. Now place one funnel to your stomach. Let your partner listen to your stomach.

Questions:

1. Describe what you hear in both cases:

   Students will hear the heart beats and the gurgle in the stomach. The sounds will be much louder than what they would hear without the "funnel amplifier."

2. What do you think the funnel is doing to the sounds from the heart and stomach?

   The funnel picks up the sound waves and leads them directly into the listener's ear. The funnel and tubing hold the sound waves together so they do not spread out into the air as quickly. Therefore, the sound intensity is increased (amplified).

3. What instrument that is used by doctors is similar to the "funnel amplifier" ?

   Stethoscope

Name ____________________________ Date_____________

Fetal Ultrasound Extension Activity

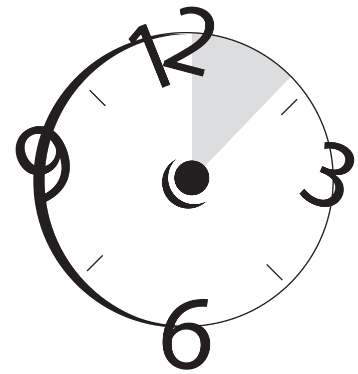
Go to the following website for background information and a student activity sheet complete with ultrasound images. http://galileo.phys.virginia.edu/outreach/8thgradesol/Ultrasound.htm

H-ear’s the Pitch: Listen Up!

Connections/AID

Time Allocation: 35 minutes

Required Materials and Resources on Page 121



Lesson Overview

In this lesson students will enjoy using sound variations, specifically the Morse code, to communicate with one another. They will make a connection between science and those people who invent things that use scientific concepts. They also will have the opportunity to get a historical perspective on an inventor by researching Samuel Morse’s life, the inventor of the telegraph and, of course, the Morse code.

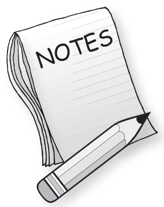
Guiding Questions

- Can the Morse code still be helpful?

BIG IDEA

Morse Code

SOUND'S STORY: H-EAR THE PITCH



Content Goals

Universal Theme(s)

- Scientific evidence consists of observations and data on which to base scientific explanations.

Principles and Generalizations

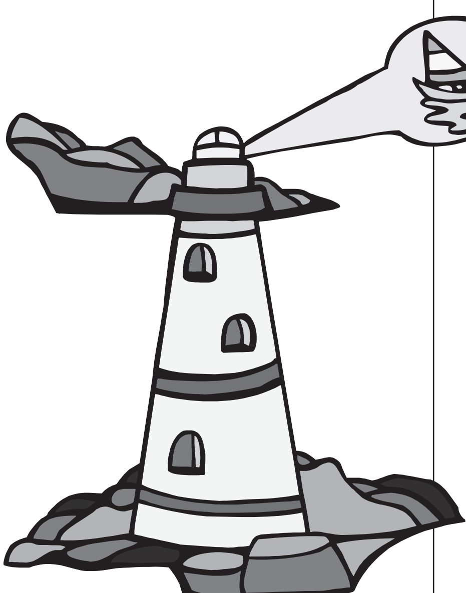
- Sound can be encoded and used as a means of communication.

Concepts

- Communication using a code of sounds

Teacher Information

- Samuel Morse (1791-1872) was an American painter and inventor.
- Samuel Morse built the first American telegraph.
- Samuel Morse used a code, consisting of dots and spaces, to represent the letters of the alphabet and numbers.
- This code was later refined to include dots, dashes and spaces.



Skills

- Make observations
- Interpret data

Materials and Resources

Flashlights (1 per student group)

Preparation Activities

1. If possible, see if you can locate someone in your area who is very conversant in Morse code. Have him or her visit your class for a demonstration during the second activity of this module.
2. Copy the **Morse Code Information Sheet** for each student.

Introductory Activity (10 minutes)

- Share with students that light and sound have been used to communicate with people for thousands of years! Lighthouses were first built by the ancient civilizations. A lighthouse sends a powerful beam of light across the sky so that it appears as a series of flashes to anyone at sea. Today's lighthouses are more high-tech. Each lighthouse has its own code. Sailors count the time between flashes to get the code. Then they can check the code on their charts and know their exact location!

- Ask students if they know that people use sound to send messages using a special code. Ask them if they know what this code is called.
- Share with them that in the 1800's Samuel Morse built the first American telegraph. He used a system of dots and spaces. This system was later improved by adding dashes. The dots are short flashes of light or short sounds. The dashes are longer flashes of light or longer sounds.
- In a time of cell phones, students may wonder if Morse code is even necessary. Ask them if they can think of a situation where Morse code might be useful. Students may realize that when phone lines or electric lines are down, and cell phone signals are impossible, Morse code might be a useful tool for communication. Share with them that it is still used in emergency situations, as well as in the military.

Pre-assessment

N/A

Teaching and Learning Activities (20 minutes)

1. Distribute the **Morse Code Information Sheet**. The dots represent quick flashes of light, and the dashes represent longer flashes of light.

2. Darken the room. Have the groups use their flashlights to send a SOS signal.

3. Tell students that a SOS is an international distress signal. Contrary to popular belief, it is not an acronym. Many people think it means "Save Our Ship" or "Save Our Souls," but SOS is not an acronym. The S (•••) is three quick flashes of light. The O (---) is three longer flashes of light. Then repeat the three quick flashes of light for the final S (•••).

4. Have the students select another word to signal. The word should be one that may be used in an emergency situation. For example: fire, hurt, cold,

etc… The students can signal to their own group members. The group members should note the flashes as long or short in their science journals. Then they can use the information sheet to crack the code!

5. Inform students that sound can also be used to communicate in Morse code. Just tap on any surface! Have the groups tap a SOS message. The S (•••) is three quick taps. The O (**---**) is three longer taps. Then repeat the three quick taps for the final S (•••).

6. Have students pair up.

7. Tell them to each take a turn selecting another word to signal using tapping sounds on their desk. The word should be a word that may be used in an emergency situation. For example: fire, hurt, cold, etc… The group members should note each tap, as long or short, on the back of their **Morse Code Information Sheets**. Then they should use the information sheet to crack the code!

Products and Assignments

N/A

Extension Activity

- (AID) To further challenge those students who benefit from independent work tell them to research Samuel Morse's life and present to the class what they learned about his life, art and inventions.

Post Assessment

N/A

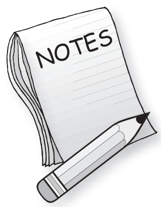
Debriefing and Reflection Opportunity (5 minutes)

1. Convene the class as a group and begin a discussion about Morse code.
2. Ask students such questions as "How might Morse code be helpful for people?" "Under what circumstances might you use light to send a signal?" "Under what circumstances might you use sound to send a signal?" Students may realize that if they were stranded or lost, they could reflect sunlight with a mirror to send a Morse code message that could be seen by rescuers on a search plane. If they were trapped in a collapsed building or a cave, they could tap a Morse code message so the rescuers could locate them.

Morse Code Information Sheet

A	• –
B	– • • •
C	– • – •
D	– • •
E	•
F	• • – •
G	– – •
H	• • • •
I	• •
J	• – – –
K	– • –
L	• – • •
M	– –
N	– •
O	– – –
P	• – – •
Q	– – • –
R	• – •
S	• • •
T	–
U	• • –
V	• • • –
W	• – –
X	– • • –
Y	– • – –
Z	– – • •
0	– – – – –
1	• – – – –
2	• • – – –
3	• • • – –
4	• • • • –
5	• • • • •
6	– • • • •
7	– – • • •
8	– – – • •
9	– – – – •

SOUND'S STORY: H-EAR THE PITCH

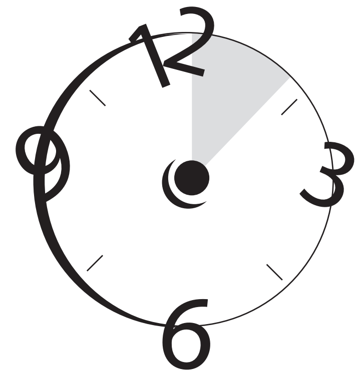


Sound Right with Sound! and H-ear's the Pitch: Listen Up!

Core

Time Allocation: 45 minutes

Required Materials and Resources on Page 121



Lesson Overview

Students in this lesson answer post assessment questions that demonstrate their current understandings regarding the nature of sound, its connections to their anatomy, specifically the function of the ear, and its uses in technology applications, such as sonar and ultrasonic devices.

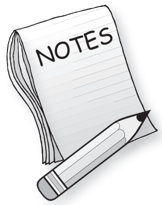
Guiding Questions

- How are sounds made?
- What makes different sounds that come from the same object sound differently?
- Can sound travel through water?
- Can a singer really shatter a glass across a room?
- Can sound travel through empty space?
- Can sound be produced when no one is around to hear it?
- What makes a sound louder?

BIG IDEA

What did I learn about sound?

SOUND'S STORY: H-EAR THE PITCH



Content Goals

Universal Theme(s)

- Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena.
- Scientific evidence consists of observations and data on which to base scientific explanations.
- Using evidence to understand interactions allows individuals to predict changes.
- Properties of some objects and processes are characterized by change.
- Form and function are interdependent.

Principles and Generalizations

- Sound is produced when material vibrates.
- Sounds are abundant most everywhere and most all the time.
- Sound is the invisible transfer of motion from one object or material to another.
- Sounds can be amplified.
- Sound travels through solids, liquids and gases.
- The nature of a substance determines how well sound travels through it (AID).

Concepts

- Model
- Sound
- Vibration
- Transfer of sound
- Sound amplification
- Pitch
- Intensity or loudness of sound

Teacher Information

N/A

Sound Right with Sound! and H-ear's the Pitch: Listen Up!

Skills

- Predict
- Make observations
- Record data
- Interpret data
- Identify characteristics
- Compare and contrast
- Draw conclusions
- See relationships

Materials and Resources

N/A

Preparation Activities

1. Copy the post assessment, **Post Assessment for the Sound Unit** for each student.
2. Copy the Possible Answers to the **Post Assessment for the Sound Unit** for yourself.

Introductory Activity

N/A

Pre-assessment

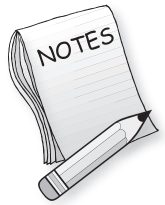
N/A

Teaching and Learning Activities (45 minutes)

1. Tell students to answer the questions to the best of their knowledge and tell them not to worry if they do not know the answers to all of the questions.

2. Explain that the purpose of the post assessment is for the teacher to have information related to what his or her students know or do not know, so that instructional activities can be improved for future students.

3. Distribute the **Post Assessment for the Sound Unit**.



Products and Assignments

Completed post assessments

Extension Activities

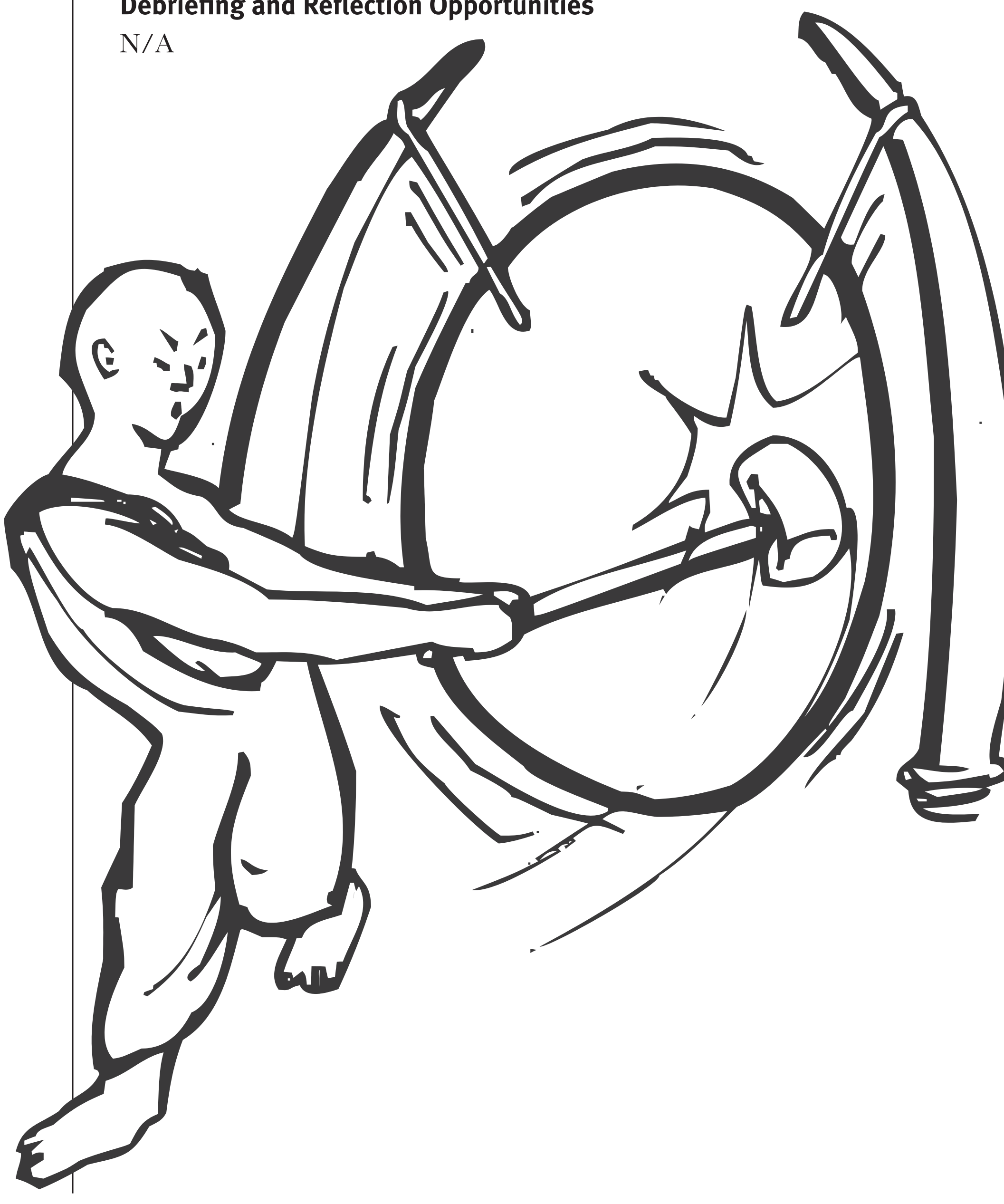
N/A

Post Assessment

Post Assessment for the Sound Unit

Debriefing and Reflection Opportunities

N/A



Name ______________________________ Date______________

Post Assessment for the Sound Unit

1. Would you be most likely to hear an echo in a room that is:
   a. Empty
   b. Filled with drapes, curtains, carpet, and furniture
   c. Contains one couch
   d. None of the above

2. What medium would sound travel through most quickly?
   a. Wood
   b. Water
   c. Air
   d. None of the above

3. What object would absorb the most sound?
   a. Wood
   b. Cement
   c. Pillow
   d. None of the above

4. What object would reflect the most sound?
   a. Glass
   b. Blanket
   c. Air
   d. None of the above

5. ______ must occur to produce sound.
   a. Heat
   b. Vibrations
   c. Nuclear
   d. None of the above

6. What does reflection of sound mean?
   a. Sound waves bouncing off an object
   b. Sound waves absorbed by an object
   c. Sound waves travel through matter
   d. None of the above

7. What does absorption of sound mean?
   a. Sound waves are taken into the object
   b. Sound waves bounce off the object
   c. Sound waves skip over the object.
   d. None of the above

8. If you held a Ziploc bag by your ear and you wanted to hear someone tapping on it the most clearly, what would you put inside?
   a. Air
   b. Water
   c. Wood
   d. None of the above

For the following questions, answer as completely as you can!

9. Can sound travel through each of the states of matter listed below? If so, **list an example** and **explain**.

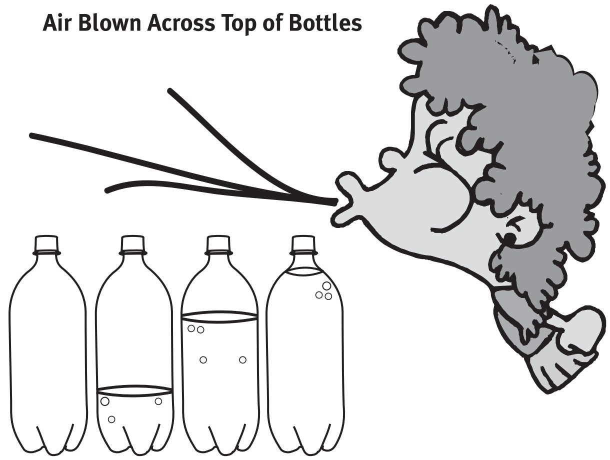
   Liquids?

   Solids?

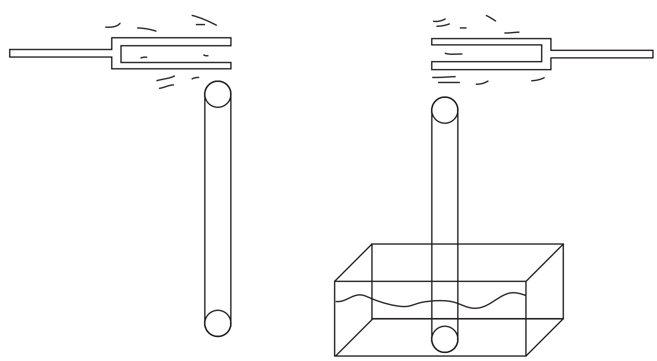
   Gases?

10. Can sound travel through a vacuum (empty space)? **Explain** your answer.

11. Suppose you have four bottles. One is empty, one is 1/4 full of water, one is about 2/3 full of water, and one is nearly full. Predict what difference, if any, there will be if you blow across the top of each bottle. Give reasons for your predictions.



12. If you held a vibrating tuning fork above a cylinder with both ends open, predict how the sound would change as you lowered the cylinder into a container of water (changing the length of the air column).



Hollow Glass Tube Open on Each End

Glass Tube Lowered into Water

13. Why do you think the outer ear is shaped the way it is?

14. Why can't humans hear dog whistles? Explain your answer.

Possible Answers to the Post-assessment for the Sound Unit

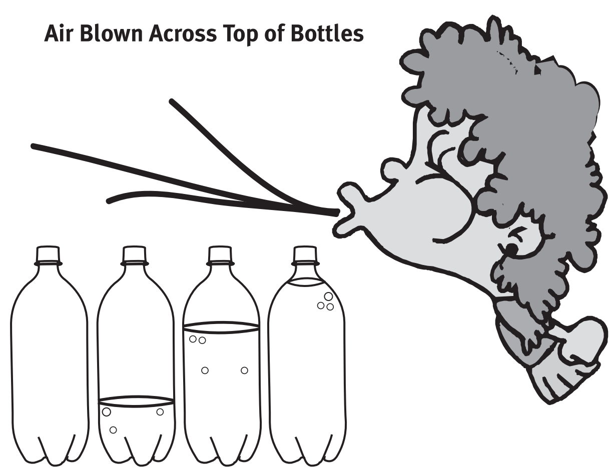
1. **A**
2. **A**
3. **C**
4. **A**
5. **B**
6. **A**
7. **A**
8. **C**
9. Can sound travel the states of matter listed below? If so, list an example and explain.
   Correct answer: Yes, for all three states of matter.
   Liquid: **whale or porpoise noises underwater**
   Solid: **When you put your ear to the ground and hear sounds**
   Gas: **When you hear someone speaking across a room**

   Possible incorrect answer: No or are not sure. Examples could be incorrect

10. Can sound travel through a vacuum (empty space)? **Explain** your answer.

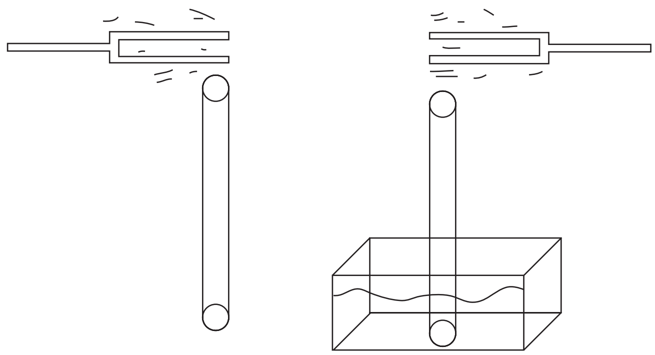
    No, because sound needs a vibrating substance to exist and since a vacuum is empty, there is nothing to vibrate, hence no sound.

11. Suppose you have four bottles. One is empty, one is 1/4 full of water, one is about 2/3 full of water, and one is nearly full. Predict what difference, if any, there will be if you blow across the top of each bottle. Give reasons for your predictions.



The sound or pitches will be different for each bottle because the amount of vibrating air (column length varies for each bottle).

12. If you held a vibrating tuning fork above a cylinder with both ends open, predict how the sound would change as you lowered the cylinder into a container of water (changing the length of the air column).



Hollow Glass Tube Open on Each End

Glass Tube Lowered into Water

The sound would change its pitch (highness or lowness) because the column of air vibrating would be smaller (shorter).

13. Why do you think the outer ear is shaped the way it is?

It funnels or directs the sound, concentrates it so by the time it gets to the inner ear it is amplified and easier to hear.

14. Why can't humans hear dog whistles? Explain your answer.

The sounds are out of their hearing range. Dogs can hear higher sounds than humans can.

15. What technology do you know that uses sound to assist humans? Explain your answer.

We use sounds to detect things under the water. It is called sonar. We also use sound, ultrasound, to make pictures of fetuses.

“Curriculum Map”

Author: : Fie Budzinsky
Curriculum Map: Sound's Story: H-Ear the Pitch
Grade Level: 4-5

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
1. Pre-assessment	CORE 45 minutes	• Sound is produced when material vibrates. • Sounds are abundant most everywhere and most all the time. • Sound is the invisible transfer of motion from one object or material to another. • Sounds can be amplified. • Sound travels through solids, liquids and gases. • The nature of a substance determines how well sound travels through it (AID).	• Model • Sound • Vibration • Transfer of sound • Sound amplification • Resonance • Pitch • Intensity or loudness of sound	• Predict • Make observations • Record data • Interpret data • Identify characteristics • Compare and contrast • Draw conclusions • See relationships	• Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena. • Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change. • Form and function are interdependent.	• How are sounds made? • What makes different sounds that come from the same object sound differently? • Can sound travel through water? • Can a singer really shatter a glass across a room? • Can sound travel through empty space? • Can sound be produced when no one is around to hear it? • What makes a sound louder?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
2. Sound is produced when material vibrates.	CORE 1 hour	• Sounds are abundant most everywhere and most all the time. • Sound is the invisible transfer of motion from one object or material to another. • Sounds can be amplified.	• Model • Sound • Vibration • Transfer of sound	• Predict • Make observations • Compare and contrast • Identify cause and effect • Draw conclusions	• Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena. • Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change. • Form and function are interdependent.	• How are sounds made?
3. Sound travels through solids, liquids and gases.	CORE/AID 50 minutes	• Sound is the invisible transfer of motion from one object or material to another. • The nature of a substance determines how well sound travels through it (AID).	• Sound • Vibration • Transfer of motion • Resonance	• Make observations • Compare and contrast • Identify cause and effect • Draw conclusions	• Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena. • Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change. • Form and function are interdependent.	• What makes different sounds sound differently? • Can sound travel through water? • Can a singer really shatter a glass across a room?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
4. Pitch can be changed by altering the characteristics of the vibrating source that produces the sound.	CORE 55 minutes	• The stronger the vibration of the source (stronger the input) for a sound, the greater the volume or loudness will be. • Larger volumes of material vibrate more slowly and vise versa. • Different lengths of vibrating air produce different sounds.	• Pitch • Loudness of sound	• Predict • Make observations • Record data • Compare and contrast • Identify cause and effect • Draw conclusions	• Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena. • Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change. • Form and function are interdependent.	• Why do you think a doctor thumps on an abdomen during a medical exam? • What makes different sounds that come from the same object sound differently? • Can sound travel through empty space? • Can sound be produced when no one is around to hear it? • What makes a sound louder?
5. Pitch can be changed by altering the characteristics of the vibrating source that produces the sound.	CORE/AID 50 minutes	• The stronger the vibration of the source (stronger the input) for a sound, the greater the volume or loudness will be.	• Pitch • Volume of sound	• Predict • Make observations • Record data • Compare and contrast • Identify cause and effect • Draw conclusions • Research (AID)	• Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena. • Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change. • Form and function are interdependent.	• What makes different sounds that come from the same object sound differently?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
6. Pitch can be changed by altering the characteristics of the vibrating source that produces the sound.	CONNECTIONS 1 hour, 30 minutes		• Pitch	• Make observations • Compare and contrast • Identify cause and effect	• Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena. • Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change. • Form and function are interdependent.	• How can I make a musical instrument out of everyday materials? • What do all instruments have in common?
7. Sound waves can be absorbed.	CORE/ IDENTITY/ AID 1 hour, 20 minutes	• Not all materials absorb sound energy in the same manner. • Sound waves can be reflected. • Solid surfaces reflect sound better than porous surfaces. • Echoes are an example of sound reflection	• Model • Absorption of sound • Porous • Insulator • Soundproof • Echo • Acoustics (AID)	• Predict • Make observations • Compare and contrast • Identify cause and effect	• Scientific evidence consists of observations and data on which to base scientific explanations. • Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change. • Form and function are interdependent.	• Why are some restaurants so loud but others are not?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
8. The ear is an organ for hearing and balance.	CONNECTIONS 50 minutes	• The ear is an organ for hearing and balance. • Air vibrations cause the ear drum to vibrate, which in turn causes the other parts of the inner ear to vibrate which is then translated by the brain into sounds.	• Structure and function of the ear	• Analyze • Draw conclusions	• Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena. • Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change. • Form and function are interdependent.	• What structures in the ear allow it to function so effectively?
9. The range of sound is broad, and there are many sounds that humans cannot hear.	CORE/AID 1 hour	• Some animals can hear sounds that humans cannot.	• Sound intensity • Decibel • Echolocation • Sonar • Sound amplification • Fetus (AID)	• Make observations • Compare and contrast • Identify cause and effect	• Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change. • Form and function are interdependent.	• Can dogs hear things that I can't? • Can I damage my ears without knowing it?
10. Sound can be encoded and used as a means of communication.	CONNECTIONS/AID 35 minutes		• Communication using a code of sounds	• Make observations • Interpret data	• Scientific evidence consists of observations and data on which to base scientific explanations.	• Can the Morse code still be helpful?

Major Principles and Generalizations	Time Allocation and Parallel	Minor Principles and Generalizations	Concepts	Skills	Themes	Guiding Questions
11. Post-assessment	45 minutes CORE	• Sound is produced when material vibrates. • Sounds are abundant most everywhere and most all the time. • Sound is the invisible transfer of motion from one object or material to another. • Sounds can be amplified. • Sound travels through solids, liquids and gases. • The nature of a substance determines how well sound travels through it. (AID)	• Model • Sound • Vibration • Transfer of sound • Sound amplification • Pitch • Intensity or loudness of sound	• Predict • Make observations • Record data • Interpret data • Identify characteristics • Compare and contrast • Draw conclusions • See relationships	• Science involves making hypotheses, theories and conceptual models to represent, explain and predict phenomena. • Scientific evidence consists of observations and data on which to base scientific explanations. • Using evidence to understand interactions allows individuals to predict changes. • Properties of some objects and processes are characterized by change. • Form and function are interdependent.	• How are sounds made? • What makes different sounds that come from the same object sound differently? • Can sound travel through water? • Can a singer really shatter a glass across a room? • Can sound travel through empty space? • Can sound be produced when no one is around to hear it? • What makes a sound louder?

"Materials Chart"

Lesson	Primary Materials	Book	Additional Materials (Supplied by Teacher)
1	**Pre-assessment for the Sound Unit** (included)		
2	Rubber bands, masking tape, string (1 12" piece for each student group), tuning fork (6-8 per class), student journals		Wooden spoon (1 for demonstration, 1 for each student group), rice 10-12 grains for teacher demonstration or for each student group), plastic wrap (enough to cover the top of each can), ping pong ball (1 per student group), balloon (9" latex – 1 per student or student group)
3	Paper cups (2 per student group), string (15 feet per student group), paper clips (2 per student group), pushpins (1 per student group), Baggies (3 per student), sand, sugar or flour (enough to fill a baggie half way), water, yarn (5 meters per student group)		Coin, (AID) tin soup cans (2 similar sized cans per student group), kite string (AID) (5 meters per student), fishing line (5 meters per student group), picture wire (5 meters per student group) (AID), plant wire (AID) (5 meters per student group)
4	Rulers (1 per student or student group)		Cassette or CD of Beethoven and a player or use an Internet clip of some of his music by going to the site www.shoutcast.com. Select classical under the genre area, search for Beethoven and you will find a piece of music to play.
5	10" plastic straws (1 per student for Variation #1 of Activity 2 or 2 per student for Variation #2), scissors (1 per student or student group), water (3 liters per student or group), masking tape		Empty plastic 2-liter bottles (4 per student or student group), liter bottle for measuring purposes (1 per student or student group)
6	Materials to make the "Guitar that Rules!": paper cup, kite string (2 ft. long per guitar), masking tape, ruler (1 per guitar), paper clips (2 per guitar), push pin (1 per group) Various musical instruments: e.g., percussion (drum, cymbals) wind reed (e.g., clarinet), wind whistle (e.g., flute), wind brass (e.g., trumpet), straws with various sized diameters, various rubber bands, thick and thin, short and long		Various sizes of blocks of wood or metal, straws with various sized diameters, various sized metal cans, various glass bottles, various pots and pans, sticks of various kinds and/or lengths, hubcap, grater, spoon, or any pieces of metals that could be used to make an instrument
7	Sponge, water		Internet access, overhead projector, screen or blank wall, rubber ball, blanket, radio, cassette player, or CD player, cardboard box slightly larger than the radio, cassette player, or CD player, newspaper, plastic bags, pillows, foam packing clips, aluminum foil
8	Good diagram of the human ear for student handout (The following website has a good one: http://www.mscd.edu/~biology/Bio1000/Bio1000inf.htm (Page down to Chapt. 13, and click on ear diagram)		Internet Access

Lesson	Primary Materials	Book	Additional Materials (Supplied by Teacher)
9	Flexible plastic tubing (3 feet per student group) funnels (2 per student group		Regular whistle, dog whistle
10	Flashlights (1 per student group)		
11	**Post Assessment for the Sound Unit** (included)		