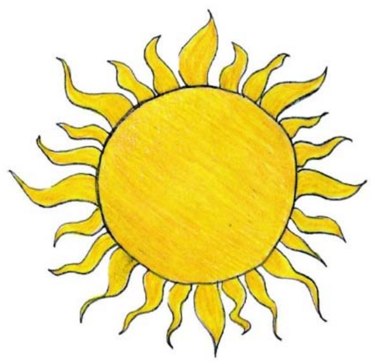
CEREAL CITY SCIENCE
by BCAMSC

Teacher Guide and Student Journal

Sample Planning and Activity Pages


4th grade
Energy & Waves

Teacher Guide

Sample

Planning Sections & Activity #3

4th grade

Energy and Waves

CEREAL CITY SCIENCE
by BCAMSC

Energy and Waves

4PNG

A Fourth Grade Unit
supporting
Next Generation Science Standards and
the Michigan Science Standards

developed and written by
Battle Creek Area Mathematics and Science Center
for

Energy and Waves

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ENERGY AND WAVES

UNIT INTRODUCTION

GRADE LEVEL:
- Fourth Grade

THIS UNIT BUILDS KNOWLEDGE AND IS A PREREQUISITE FOR:
- Fifth Grade: *Matter and Energy in Ecosystems*
- Middle School: *Energy*

THIS UNIT BUILDS ON KNOWLEDGE FROM:
- First Grade: *Waves: Light and Sound*

ABOUT THIS UNIT:
This unit serves as the introduction to the concept of energy. Students have some experience with sound and light (first grade) and their properties, but have not considered sound or light as forms of energy. The concept of energy is an abstract idea that will require students to think beyond what they can see, feel, hold, or sense. Students will be asked to identify energy in terms of evidence and that energy is involved when a change is observed. In this unit, three basic manifestations of energy are addressed: kinetic/motion, thermal/particle, and potential/ field or position energy, as well as the fact that energy moves from place to place through processes such as heating, colliding, and radiating. "At the macroscopic scale, energy manifests itself in multiple phenomena, such as motion, light, sound, electrical and magnetic fields, and thermal energy" (*A Framework for K–12 Science Education*, National Academies Press, 2013, p. 121).

Students come to fourth grade with knowledge of motion and how the speed of an object can be changed by a push or pull, or by increasing or decreasing the ramp of a slope. They have had the opportunity to engage in an engineering experience when looking for a solution to a change that can be solved through the development of a new or improved object or tool. Their experience may assist in building a design to show energy movement from one place to another. At the third-grade level, students continued their explorations into forces and interactions (balanced and unbalanced forces) and types of interactions (magnetic and electric). Students may be able to draw on their knowledge of balanced and unbalanced forces, and contact and noncontact forces, to help them in their understanding of energy related to motion.

In this unit the activities are geared toward exploring energy associated with heat, light, sound, electricity, and motion, and with energy moving from place to place. Students are introduced to energy transfer by watching video clips of Rube Goldberg devices. Students will be given the opportunity to recognize what they need to know about energy and explore heat, light, sound, electricity, and motion to gather sufficient information to design and build their own device that demonstrates the transfer of energy from one form to another.

NEXT GENERATION SCIENCE STANDARDS

Disciplinary Core Ideas/Performance Assessments	Activities
PS3.A: Definitions of Energy • The faster a given object is moving, the more energy it possesses. • Energy can be moved from place to place by moving objects or through sound, light, or electric currents.	1,2,3,4,5,7
4-PS3-1: Use evidence to construct an explanation relating the speed of an object to the energy of that object.	1,2,4
4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.	1,3,4,5,6,7,8
4-PS3-3: Ask questions and predict outcomes about the changes in energy that occur when objects collide.	1,2,4
PS3.B: Conservation of Energy and Energy Transfer • Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. • Light also transfers energy from place to place. • Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.	1,2,3,4,5,6,7,8
4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.	1,3,4,5,6,7,8
4-PS3-3: Ask questions and predict outcomes about the changes in energy that occur when objects collide.	1,2,4
4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	3,4,5,6,7,9
PS3.C: Relationship Between Energy and Forces • When objects collide, the contact forces transfer energy so as to change the objects' motions.	1,2,8
4-PS3-3: Ask questions and predict outcomes about the changes in energy that occur when objects collide.	1,2,4
PS3.D: Energy in Chemical Processes and Everyday Life • The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.	1,4,7,8
4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	3,4,5,6,7,9

NEXT GENERATION SCIENCE STANDARDS

PS4.A: Wave Properties • Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; it does not move in the direction of the wave except when the water meets the beach. • Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).	6* ,8
4-PS4-1: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.	3
PS4.C: Information Technologies and Instrumentation • Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa.	8
4-PS4-3: Generate and compare multiple solutions that use patterns to transfer information.	2,3,4
ETS1.A: Defining Engineering Problems • Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	5,8
• 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	3,4,5,6,7,9
ETS1.C: Optimizing the Design Solution • Different solutions need to be tested in order to determine which of them best solves the problem, given criteria and the constraints.	5,8
• 4-PS4-3: Generate and compare multiple solutions that use patterns to transfer information.	2,3,4

NEXT GENERATION SCIENCE STANDARDS

Science and Engineering Practices	
Asking Questions and Defining Problems Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause-and-effect relationships.	2,3,4,8,
4-PS3-3: Ask questions and predict outcomes about the changes in energy that occur when objects collide.	1,4
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (4-PS3-2)	2,3,4
4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.	1,3,4,5,6,7,8
Constructing Explanation and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-1) • Apply scientific ideas to solve design problems. (4-PS3-4)	1,2,3,4,5,6,
4-PS3-1: Use evidence to construct an explanation relating the speed of an object to the energy of that object.	1,2,4
4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	3,4,5,6,7,9
4-PS4-3: Generate and compare multiple solutions that use patterns to transfer information	2,3,4
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods. • Obtain and combine information from books and other reliable media to explain phenomena.	1,5,6,7,8,
4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.	1,3,4,5,6,7,8
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Develop a model using an analogy, example, or abstract representation to describe a scientific principle.	3,5,6,8,
4-PS4-1: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.	3

NEXT GENERATION SCIENCE STANDARDS

Crosscutting Concepts	
Cause and Effect • Cause-and-effect relationships are routinely identified and used to explain change.	1,2,4,5,
4-PS3-1: Use evidence to construct an explanation relating the speed of an object to the energy of that object.	1,2,4
4-PS3-3: Ask questions and predict outcomes about the changes in energy that occur when objects collide.	1,2,4
4-PS4-1: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.	3
Energy and Matter • Energy can be transferred in various ways and between objects.	1,2,3,4,5,
4-PS3-1: Use evidence to construct an explanation relating the speed of an object to the energy of that object.	1,2,4
4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.	1,3,4,5,6,7,8
4-PS3-3: Ask questions and predict outcomes about the changes in energy that occur when objects collide.	1,2,4
4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	3,4,5,6,7,9
Patterns • Similarities and differences in patterns can be used to sort and classify natural phenomena. • Similarities and differences in patterns can be used to sort and classify designed products.	1,2,4,5
4-PS4-1: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.	3
4-PS4-3: Generate and compare multiple solutions that use patterns to transfer information.	3,4
Connections to Engineering, Technology, and Applications of Science	
Interdependence of Science, Engineering, and Technology • Knowledge of relevant scientific concepts and research findings is important in engineering.	5
4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	3,4,5,6,7,9

Influence of Engineering, Technology, and Science on Society and the Natural World • Engineers improve existing technologies or develop new ones • Over time, people's needs and wants change, as do their demands for new and improved technologies	8
4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	3,4,5,6,7,9
Connections to Nature of Science	
Science is a Human Endeavor • Most scientists and engineers work in teams. • Science affects everyday life.	1,2,3,4,5,6,7,8,
4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	3,4,5,6,7,9

UNIT AT A GLANCE

Activity	Time to Complete	Question	Phenomena	Summary: Students Will...
1 What is Energy?	Preparation: 20 min. Activity: 2 classes Lesson 1A: 50–55 min. Lesson 1B: 60–65 min.	How do we define energy?	Observe video of a Rube Goldberg device. Energy Stations: 1: First domino falls and remaining dominos fall in order. 2: Ball released from top of ramp travels farther than ball released halfway down ramp. 3: A stretched rubber band can travel a distance when released and returns to original shape. 4: Turning the switch to the on position causes light to shine. The light beam illuminates objects in its path. 5: Marble magnets attract other magnets and cause motion from a distance.	• Introduce performance task: Rube Goldberg device. • Brainstorm ideas about energy. • Explore Energy Stations. • Compare initial ideas about energy as related to energy moving from place to place.
2 The Energy of Motion	Preparation: 15 min. Activity: 8 classes Lesson 2A: 45–50 min. Lesson 2B: 45–50 min. 2B: 45–50 min. Lesson 2C: 45–50 min. Lesson 2D: 30–35 min. 30–35 min. Lesson 2E: 30–35 min. 30–35 min.	What can we learn about energy when we measure and collect data related to motion, bouncing, and collisions?	When objects move at different speeds down a ramp, the distance traveled changes. When a ball is dropped from different heights, the height of the bounce changes. When there is a collision, there is a change in motion of the objects.	• Investigate energy related to motion. • Make measurements and collect data to determine the relationship between speed and amount of energy. • Investigate energy transfer as it is related to bounce. • Investigate energy and energy transfer as related to collisions of objects.
3 Energy of Sound	Preparation: 20 min. Activity: 7 classes Lesson 3A: 45–50 min Lesson 3B: 45–50 min. Lesson 3C: 45–50 min. Lesson 3D: 45–50 min. 20–25 min. Lesson 3E: 45–50 min. 20–25 min.	How can I model how sounds are produced?	Vibrations from a tuning fork can be heard and felt. Sound vibrations can cause water to move. Vibrations of different materials cause different pitches.	• Investigate vibrations and how sounds are made. • Build a model instrument to demonstrate vibrations and sound waves. • Demonstrate how energy can move from one place to another by sound. • Compare different instruments to determine how vibrations of different materials create different pitches.
4 Rube Gold-berg	Preparation: Activity 4: Set the time frame for building the Rube Goldberg devices as one of the limitations that is appropriate for your class.	How can a Rube Goldberg device demonstrate how energy moves from place to place?	Models can be developed using the Engineering Design Plan to build a Rube Goldberg device that demonstrates energy transfer and how energy moves from place to place.	• Design and build a device that solves a problem and demonstrates how energy can move from one place to another. • Complete the task within constraints and limitations.

Students Figure Out How To:	Practices	Performance Expectation (PE) at Lesson Level and Assessment
• Construct explanations of the concept of energy through definitions, characteristics, and examples. • Determine when energy is present and how it transfers from place to place.	**Asking Questions** **Constructing Explanations** **Patterns**	**PE at Lesson Level** Develop an initial understanding of the possible definitions of energy. **Formative Assessment** Freyer Model Energy Station probes Journal Entries
• Gather evidence to demonstrate that energy is present in moving objects. • Make observations to determine that energy can be transferred from place to place by moving objects and collisions. • Recognize the cause-and-effect relationships between motion and energy transfer from place to place.	**Asking Questions and Defining Problems** **Planning and Carrying Out Investigations** **Constructing Explanations** **Cause and Effect** **Patterns**	**PE at Lesson Level** Use evidence to communicate understanding of the change in energy when there is a change in speed. Use evidence to communicate understanding of how colliding objects transfer energy from one object to another. **Formative Assessment** What We Think About Energy chart Scientific Explanation: Claim, Evidence, Reasoning (CER) **Summative Assessment** Journal Entries (CER)
• Construct explanations of sound energy and how vibrations produce sound. • Compare different sounds in terms of amplitude and frequency. • Construct explanations of how energy can move from place to place by sound. • Make a model of a wave that demonstrates amplitude and wavelength.	**Developing and Using Models** **Obtaining, Evaluating, and Communicating Information** **Constructing Explanations** **Cause and Effect** **Patterns**	**PE at Lesson Level** Use models to observe how vibrations produce sound. **Formative Assessment** What We Think About Sound Energy chart Activity Page **Summative Assessment** Journal Entries Respond to Text Instruments and Presentations
• Design, test, and refine a device that converts energy from one form to another that ends with the production of a sound or signal.	**Developing and Using Models** **Constructing Explanations and Designing Solutions** **Cause and Effect**	**PE at the Lesson Level** Develop and build a Rube Goldberg device and communicate understanding of how energy is present in motion, light, heat, sound, and electrical current. Demonstrate how energy moves from place to place. **Summative Assessment** Rube Goldberg device Rube Goldberg presentation

UNIT AT A GLANCE

Activity	Time to Complete	Question	Phenomena	Students Will…
5 Heat Energy	Preparation: 10 min. Activity: 5 classes Lesson 5A: 45–50 min. Lesson 5B: 45–50 min. 30–35 min. Lesson 5C: 45–50 min. 30–35 min.	How does heat energy move from one object to another?	Rubbing your hands together makes them warmer. Holding a hot dog over a campfire heats the hot dog. Hot water warms the container it is in. Adding ice to a beverage makes the beverage colder.	• Investigate temperature change due to rubbing. • Collect data to determine how heat energy moves from warm objects to cold objects. • Relate heat energy transfer to how adding ice to a beverage decreases the temperature of the beverage.
6 Light Energy	Preparation: 15 min. Activity: 4 classes Lesson 6A: 45–50 min. 45–50 min. Lesson 6B: 45–50 min. 45–50 min.	What happens to the temperature of objects when placed in the light?	Walking across the black asphalt is hotter on the feet than walking on the grass or dirt path.	• Gather evidence to demonstrate how light energy transforms to heat energy. • Design and conduct an investigation into the transformation of light energy to heat energy in a variety of materials.
7 Electric-ity	Preparation: 15 minutes Activity: 7 classes Lesson 7A: 45–50 min. 20–25 min. Lesson 7B: 45–50 min. 20–25 min. Lesson 7C: 45–50 min. 45–50 min. Lesson 7D: 45–50 min.	How can I build an electrical circuit?	When an electrical circuit is complete (or closed), the lightbulb will light.	• Experiment with a battery, bulb, and wire to make a complete circuit. • Gather evidence to demonstrate how electrical energy can transform to different types of energy. • Use their knowledge about a complete circuit to design a switch.
8 Energy All Around	Preparation: 10 minutes Activity: 3 classes Lesson 8A: 45–50 min. Lesson 8B: 45–50 min. Lesson 8C: 45–50 min.	What further information about energy can I gather through text and videos?	Energy exists whenever there is change or motion.	• Use and compare resources to gather information about energy. • Analyze and compare their previous ideas about energy with their new knowledge. • Look for patterns and common characteristics that can be applied to all forms of energy.
9 Energy We Use	Preparation: 20 minutes Activity 9: 4 classes Lesson 9A: 45–50 min. 45–50 min. Lesson 9B: 45–50 min. 20–25 min.	How can energy be used to communicate?	Energy is used to communicate over a distance.	• Gather information about early communication systems. • Design a communication system using sound waves, light, and/or electricity. • Present and compare communication systems.

Students Figure Out How To:	Practices	PE at Lesson Level and Assessment
• Provide evidence that energy can be transferred from place to place by heat. • Determine how heat transfers from warm objects to cooler objects.	Constructing Explanations Planning and Carrying Out Investigations Developing and Using Models Cause and Effect	**PE at Lesson Level** Plan and conduct an investigation to provide evidence that heat moves from warm objects to cooler objects. Develop a model that demonstrates how heat moves from place to place. **Formative Assessment** What We Think About Heat Energy chart Investigations and Journal Entries
• Provide evidence that energy can be transferred from place to place by light. • Determine how light energy from the sun transfers to heat energy and warms Earth.	Planning and Carrying Out Investigations Constructing Explanations Asking Questions and Defining Problems Cause and Effect Patterns	**PE at the Lesson Level** Use evidence to communicate understanding of the temperature change of objects placed in the light. **Formative Assessment** What We Think About Light Energy chart Scientific Explanation (CER) **Summative Assessment** Student-led investigations and conclusions Journal Entries
• Design and build an electrical circuit to demonstrate how energy is transferred from place to place by electricity. • Determine that electrical energy transforms to heat, light, and sound.	Developing and Using Models Constructing Explanations Obtaining, Evaluating, and Communicating Information Patterns Matter and Energy Science as a Human Endeavor	**PE at the Lesson Level** Develop a model to demonstrate how an electrical current can produce light,sound, motion, and heat. **Formative Assessment** What We Think About Light Energy chart Electrical circuit trials Switch model Lightbulb circuit explanation **Summative Assessment** Journal Entries Respond to Text
• Recognize patterns and commonalities among the different forms of energy. • Make connections among information gained through their investigations and information in written text and video.	Obtaining, Evaluating, and Communicating Information	**PE at Lesson Level** Obtain and evaluate information from text and video and compare information with observations from investigations and activities. **Formative Assessment** Freyer Model Summary Discussion Energy Stations Data Chart discussion **Summative Assessment** Respond to Text Journal Entries
• Explore how patterns can communicate using sound, light, and electricity to carry messages over a distance. • Design and construct a system that will communicate over a distance using sound, light, and/or electricity.	Obtaining, Evaluating, and Communicating Information Connections to Engineering, Technology, and Applications of Science Interdependence of Science, Engineering, And Technology	**PE at Lesson Level** Obtain information from text and video and use information to make a model of a device that will communicate over a distance. **Formative Assessment** Communication device Engineering plan Activity Page **Summative Assessment** Communication device and presentation Journal Entries

Activity 3: The Energy of Sound

Teacher Background Information

Sound begins when something vibrates. Vibrations are movement up and down or back and forth. Vibrations push air around and make a sound wave. When an object vibrates, particles of matter in contact with the object are set in motion. In turn, these particles start other particles moving, producing a wavelike pattern or sound wave. In this activity, students will explore materials that help them to produce sound waves from vibrations. They feel the vibrations they create and then relate the motion of sound waves to energy.

Energy related to sound involves the mechanical energy of motion transferred to vibrations that create sound waves and travel through air and other media. This activity builds on student information on vibrations and sound through experience and the first-grade unit, *Waves: Light and Sound*. In their first-grade unit, students investigated vibrating objects to provide evidence that vibrating objects make sound and that sound can also vibrate objects. By the fourth grade, students will most likely need a review of the relationship between vibrations and sounds to be able to build on their knowledge and relate sound to energy and energy transfer.

This activity includes a reading integration element using a science trade book to enhance the understanding of the science goals for this activity, and to help increase student literacy skills and ability to gain scientific knowledge through text.

Explore the Concept (continued)

In the lessons that follow, students continue their exploration into energy and take a closer look at energy associated with sound, how sound waves can transfer energy from place to place, and the kinetic energy related to vibrations. Students apply their understanding of energy to phenomena associated with sound.

ESTIMATED TIME

Lesson 3A: 45–50 minutes
Lesson 3B: 45–50 minutes
Lesson 3C: 45–50 minutes
Lesson 3D: 45–50 minutes
20–25 minutes
Lesson 3E: 45–50 minutes
20–25 minutes

OBJECTIVES

- Relate sound to the concept of energy.
- Provide evidence that energy can be transferred from place to place by sound.
- Observe how sound is made through vibrations and travels in waves.

KEY QUESTIONS

- How are sounds made?
- How is sound related to energy?
- How does sound transfer energy from place to place?

MATERIALS NEEDED

For each student:
- 4 student pages

For each team of 2:
- 1 plastic ruler with marker
- 1 comb
- 2 pieces of wax paper, 5″ x 6″
- 1 tuning fork
- 1 cup water, 9 oz.

For the class:
- tuning fork
- 2 balls (from previous lessons)

Teacher provides:
- paper (16 sheets)
- masking tape
- water
- clipboards
- felt-tip marker

What We Think About Sound

What We Think About Sound	How Can We Find Out?	What Do We Conclude?

TEACHING TIP

Explore a variety of websites that demonstrate the vibrations related to a tuning fork. Simply do a search for "vibrating tuning forks" and choose the video that works best for your classroom.

Lesson 3A: The Energy of Sound

Advance Preparation

Cut the wax paper into 32 pieces measuring 5″ x 6″.

Tape a felt-tip marker to the end of each ruler. Position the marker so the tip extends out beyond the end of the ruler 2 to 3 centimeters.

Make a What We Think About Sound chart.

Do a search for a video of "bass track shaking windows."

Review the following websites and choose the video of the tuning fork that is most appropriate for your class.
http://www.acs.psu.edu/drussell/Demos/TuningFork/fork-modes.html
https://www.youtube.com/watch?v=vNuDxc9tZMk
http://www.geek.com/science/good-vibrations-tuning-fork-hitting-water-at-1600fps-1551996/
Ruler: https://www.youtube.com/watch?v=QoIW-OminAY

Procedure

Engage the learner.

Show a video of a bass track shaking windows and nearby objects.

Ask the class: Have you ever heard a sound that was so loud that you could feel it? Have you ever heard a sound that was so loud that it shook the house or rattled the windows? Have the students share their experiences with loud sounds, such as fireworks, thunder, loud music, and bass tracks. Share any personal experiences that may trigger some ideas for the students (loud thunder, fireworks or explosions, loud music, bass track music from another car).

Make a class list on the board of as many sounds the students recall that they felt or that moved something. Listen for ideas that refer to vibrations. Ask students to explain their thinking.

Review the student findings from their investigations into collisions and recall that sound was produced by the collisions and was an example of how energy moved from place to place. Ask students to relate their previous findings to how energy related from sound can move from place to place. Roll two balls from the previous lessons and have the students listen for any sound produced when they collide. Ask students for their ideas of how they can find out how we can feel sounds and how energy related to sound moves from place to place. Record their ideas on the class chart.

Explore the concept.
Show the class the tuning forks and discuss their previous experiences exploring sound with the tuning fork. Demonstrate how to strike the tuning fork on the palm of your hand or the sole of your shoe and have the class listen to the sound. Ask students to explain how the sound is made. Accept all reasonable answers at this time. Distribute one tuning fork to each team. Remind the students not to strike the fork on a hard surface. Give students sufficient time to take turns striking the fork, listening to the tone it produces, and discussing how the tuning fork is making the sound. Listen for early references to vibrations in the tuning fork that produce the sound.

Facilitate the team exploration of the tuning fork by circulating among the students and listening to their ideas. To help students recall what they have learned about sound and relate it to what they have learned about energy so far and how it is related to sound, ask:

- Can someone explain what you have observed so far?
- Why do you think that is happening? What do you mean when you say *vibrate*?
- What is causing the vibrations? What is the effect?
- What do you think is vibrating? How do you know?
- How could you find out?
- How is sound related to energy? What do we know about energy that relates to sound?
- How do you think sound travels from one place to another?
- How might you find out or confirm?

Distribute one cup of water to each group after students have observed and discussed their ideas about sound related to tuning forks. Have students record their observations and ideas in the Student Journal.

1. *How would you describe the sound of the tuning fork?*
2. *Describe what the tuning fork felt like when it made a sound.*
3. *Draw the effect of placing the tuning fork in the cup of water.*
4. *Explain what you think caused that effect.*

After the students have had sufficient time to explore the tuning fork, display the What We Think About Sound Energy chart. Record students' initial ideas about sound energy and how they might investigate their ideas. To help students

TEACHING TIP
Caution students not to strike the tuning fork against a hard surface or sharp edge such as the desk, as the tuning forks may break.

PS3.A: DEFINITIONS OF ENERGY
- The faster a given object is moving, the more energy it possesses.
- Energy can be moved from place to place by moving objects or through sound, light, or electric currents.

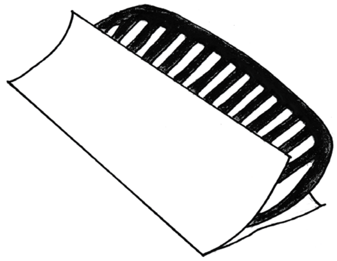
CAUSE AND EFFECT
- Cause-and-effect relationships are routinely identified and used to explain change.

TEACHING TIP
Allow students to collaborate and discuss their ideas for responses to the Student Journal prompts.

FORMATIVE ASSESSMENT
Use the What We Think About Sound chart to assess the students' preconceptions regarding sound as a form of energy.

OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION

- Obtain and combine information from books and other reliable media to explain phenomena.



Comb Kazoo

TEACHING TIP

Some students may need to practice the way to blow on a kazoo before they try with the comb and paper. Have them gently blow through pursed lips at the same time they are humming. They may get a small vibration feeling in their lips without the comb. Then add the comb, and the vibration will be increased.

generate ideas, review some of their ideas and conclusions from the previous charts.
Take this opportunity to show the class one of the videos of the tuning fork. Discuss the vibrations between the tines and how sound is produced through vibrations.

Elaborate on the concept.
Divide the class into teams of two and distribute one comb and two pieces of wax paper to each team. Tell students that they are going to experience vibrations with their sense of touch or feel. Demonstrate how to fold the piece of wax paper in half and then place the comb in the folded paper between the two sides of wax paper, making sure that the teeth of the comb are facing the fold. Have them place their lips lightly against the wax paper and hum through their lips against the wax paper across the top of the teeth of the comb, similar to the way a kazoo is blown.

Give the teams sufficient time to mess about with their "kazoo combs" and explore different ways to blow the wax paper over the comb. Encourage students to try to explain what they feel. Students may describe the vibration as a tickle.

1. *Describe what you feel when you lightly place your lips against the wax paper and hum.*
2. *Write what you think causes the wax paper and comb to move back and forth.*

Explain the concept and define the terms.
Ask students to explain what they felt when they hummed against the wax paper. Ask the students what further evidence they have that supports the idea that sound is a result of objects vibrating. What was vibrating on the comb? What else was vibrating? Explain that as we hum we are making a sound, and we now know that whenever there is a sound there are vibrations. Explain that the vocal cords vibrate and produce sound waves that travel through the air. When these waves enter the ear, the brain interprets them as sounds.

Explain that the vibrations felt on the students' lips were a demonstration of the up-and-down movements of something vibrating. Have the students return to the vibrations of the tuning fork and compare the feel of the vibrating paper and comb to the vibrations of the fork. Take this opportunity to show the class one of the slow-motion videos of the tuning fork. Discuss what is vibrating and how the sound is made.

Elaborate further on the concept.
Explain that the class will continue their investigation into vibrations by using a model that will give students a visual representation of vibrations that result in sound. Distribute a plastic ruler with attached marker and paper to each team. Demonstrate how to place the plastic ruler on the edge of the desk or table, hold the ruler firmly in place on the table, and pluck the ruler so it vibrates up and down.

Ask the students to distinguish between the sound made by the ruler hitting the table and the ruler moving the air around it. Encourage students to explore making sounds with the ruler without using the paper to become familiar with the best way to pluck the ruler. Suggest trying different lengths of ruler that hang over the edge of the desk.

After students have become acquainted with the procedure and have begun to describe the sounds of the ruler, have one student pluck the ruler while the other student places the piece of paper on a clipboard or with a book behind it, at the tip of the marker. Tell the students that the marker will record the distance the ruler vibrates up and down. Then have the students change the length of the ruler hanging over the desk and repeat the procedure on the other side of the paper.

Facilitate the team activity by circulating among the teams, observing their techniques and assisting, if necessary. To check student progress and understanding, ask:

- Can you explain what you have done so far? What are you measuring with the marker on the paper?
- How does this demonstration help you to relate vibrations to sound?
- Can anyone explain how the vibrations of the ruler are similar to the vibrations of the tuning fork in the previous activity?
- What do you think would happen if you were able to place the vibrating ruler in a cup of water?
- Do you get the same sound with different lengths of ruler extending over the edge of the desk? How does that relate to the different sounds of the different lengths of tuning fork?
- Why do you think that happens?

DEVELOPING AND USING MODELS

- Develop a model using an analogy, example, or abstract representation to describe a scientific principle.

Ruler with marker

TEACHING TIP

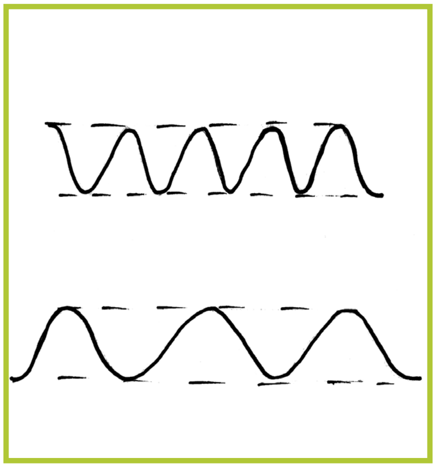
Students may struggle with holding the paper just at the end of the marker. If they push on the marker the vibrations will stop. Tell the students that the recording of the marker will be lighter than the usual darkness of marker when they are writing.

TEACHING TIP

Instruct the students to pluck the rulers carefully and gently to prevent breakage.

CAUSE AND EFFECT

- Cause-and-effect relationships are routinely identified and used to explain change.



Frequency: High Pitch and Low Pitch

PS4.A: WAVE PROPERTIES

- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).

PATTERNS

- Similarities and differences in patterns can be used to sort and classify natural phenomena.

Summary Discussion

After students have completed their observations of the behavior of various lengths of the vibrating ruler, conduct a whole-class sharing of their observations and understandings. Ask students to share their observations and the markings from the long ruler and short ruler. Ask them to describe the difference in what they heard with the long ruler and short ruler. Explain that the difference in the sound of the rulers is called pitch. The longer ruler produced a sound that was low. The shorter ruler produced a sound that was higher. Draw a wavy line on the board that represents a low pitch and a wavy line that represents a higher pitch. (See illustration.)

Have the students complete the Journal Entry.

Journal Entry

1. *Write what you hear and see when you pluck the ruler that is long.*
2. *Write what you hear and see when you pluck the ruler that is short.*
3. *Use your observations of the different ruler lengths to predict what you would hear if you plucked a ruler that was longer than your classroom ruler. Tell what evidence you have that makes you think that.*
4. *How does the model of the ruler with the marker demonstrate how sounds are made?*

Assessment

Use the class discussion and Journal Entry to assess the students' ability to distinguish the effect of fast or slow vibrations as pitch.

Use the Journal Entry to assess the students' ability to use observations to produce data and evidence to construct an explanation. (Constructing Explanations and Designing Solutions)

Lesson 3B: Reading About Sound

Procedure

Evaluate the students' understanding of the concept.
Explain to the class that they will be reading the book *Loud or Soft? High or Low? A Look at Sound* to learn more about sounds and their vibrations. If your school has multiple copies of the book, divide the class into reading teams of two students and distribute a copy of the book to each team.

Do a "book walk" and have the class discuss the title, *Loud or Soft? High or Low? A Look at Sound*, cover illustration, and key features in the book. Ask students to look at the pictures and describe how some of the pictures are similar to the activities they have performed in the unit so far.

Decide on a reading strategy appropriate for your class. If you choose to have students read the book in a group reading conference, join reading pairs to listen and observe their reading skills and how they interact when discussing the text and pictures. If you choose to read the book aloud to the class, pause at each page and ask students to identify text clues that relate to sound and vibrations. Take this opportunity to assist the students with their note-taking skills and how to identify important information in text.

Conduct a whole-class reading conference. Ask student volunteers to reread different sections of the text that relate to electrical energy and electrical circuits. Examples of text to reread and discuss:

- Page 4: Read the chapter title, "What is Sound?" Ask students to explain their ideas of the meaning of the word *sound* and refer to the text that led to their ideas.
- Ask, "Are all sounds made by something vibrating?" Ask students to answer the question using information in the text in their response. Ask students to give examples of sounds they have heard and relate them to the vibrations that caused the sound.
- Ask students for evidence, referring to the text and experiences, that sound can travel through a solid and a liquid.

MATERIALS NEEDED
For each student:
student pages
For the class:
book: *Loud or Soft? High or Low? A Look at Sound*

KEY IDEAS AND DETAILS

RI.4.1: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

RI.4.2: Determine the main idea of a text and explain how it is supported by key details; summarize the text.

RI.4.3: Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION

Obtain and combine information from books and other reliable media to explain phenomena.

TEXT TYPES AND PURPOSES

W.4.2: Write informative/explanatory texts to examine topic and convey ideas and information clearly.

PRODUCTION AND DISTRIBUTION OF WRITING

W.4.5: With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising and editing.

TEACHING TIP

Give sufficient time for students to share their writing with peers and respond to questions and suggestions for revision and editing to strengthen their writing.

CRAFT AND STRUCTURE

RI.4.4: Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area.

RI.4.5: Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a part of a text.

RI.4.6: Compare and contrast a firsthand and secondhand account of the same event or topic; describe the differences in focus and the information provided.

- Make a class list of how pitch can be high or low, referring to the author's examples (speed of vibration, length of object vibrating, length of air tube, length of string, tension of string).
- Use the pictures in the "How Are Sounds Made?" chapter and ask the students to explain how the different objects or actions make sounds. Check for understanding that objects vibrate, making the surrounding air vibrate.
- Inform the class that in following activities they will be given the opportunity to make their own instruments that make different sounds.
- Ask students if they can "see" sound and use details in the text to explain their answers.
- Refer to the initial ideas of the main idea of the book and ask students how their ideas have changed or been confirmed through the reading of the book.
- Read the Respond to Text prompt in the Student Journal. Decide on a classroom rubric for what is expected in the response. (See Rubrics in the Assessment section.)

Take this opportunity to have the students respond to the text from *Loud or Soft? High or Low? A Look at Sound.*

Pre-Writing Strategy

Read the Respond to Text prompt in the Student Journal to the class. Model how to write a response to the text using a "think aloud." Ask one or two volunteers to name a sound that he or she has heard today. Then describe the sound in terms of its pitch, volume, and how it traveled to the listener's ears. Ask the students to discuss how the sound was made. Write key words such as *loud, soft, vibrations, waves, ears, high, low,* and *pitch* for students to use in their responses in the Student Journal, creating a collaborative writing of responses to a shared reading experience. Using the "think aloud" helps students to know how to respond effectively to the text.

Complete the whole-class discussion regarding the properties of sound described in the book. Invite students to find a partner and discuss a sound that they will write about. Allow sufficient time for the teams to reread sections in the book and use the book as a reference in their responses.

Respond to Text
Describe a sound that you have heard or made today. Tell how the sound was generated, the pitch of the sound, the volume of the sound, and how the sound traveled to your ears.

Review the exploration with the comb and wax paper. Ask students if there was a vibration that was related to the sound from the comb. What was their evidence of a vibration? Explain that they felt the vibrations, using their sense of touch, and that the movement up and down of the wax paper on their lips was evidence of vibrations. Review the vibrations of the tuning fork. Ask students to explain what was vibrating and how the sound was produced.

Review the use of the ruler to make sounds. Ask the students to describe the sounds of the plucked rulers, long and short. Ask, "Were there vibrations involved in the sounds made by the rulers? What evidence do you have?" Look for student responses that the observation of the motion of the ruler and the recording of the movement of the rulers both provide evidence that vibrations were involved in the sound of the plucked rulers.

Before students complete their writing, discuss the term *evidence* and review evidence in the comb and ruler investigations. Revisit the What We Think chart from the beginning of the activity and add to or adjust their ideas on the chart.

Assessment
Use the Respond to Text to assess the students' ability to use information from text to explain how sound travels.

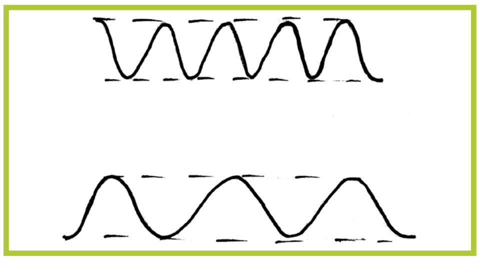
OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION
Obtain and combine information from books and other reliable media to explain phenomena.

EXTENSION
Repeat the activity with long, thin objects other than rulers that can be plucked to create a vibration.

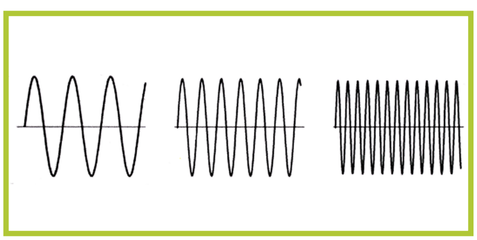
Lesson 3C: Building Instruments

Teacher Background Information

Sound is produced by a movement or vibration created by a force. Some vibrations cause air to move, to create sound waves we can hear. The pitch of a sound (high or low) depends on how fast the object vibrates. An object that vibrates at a very fast rate produces a high pitch, and an object that vibrates at a slower rate produces a lower pitch. The pitch (speed) at which an object vibrates depends on characteristics of the object, such as length, thickness, and tension. With stringed instruments, we pluck, strum, or move a bow across the string as the force that causes the string to vibrate. The sounds of the strings can be changed by using different lengths and widths of strings, changing the size and shape of a bridge that supports the strings, using different material, or altering the tension of the string.



The illustration above demonstrates the difference between the sound waves of a high-pitched sound and a low-pitched sound. The distance between the top of one wave and the top of the next wave is called a wavelength. Each wave of a sound has a frequency. Frequency is the number of wavelengths that pass a particular point in a certain amount of time. Waves with longer wavelengths have lower frequencies, producing a lower pitch. Waves with shorter wavelengths have higher frequencies, producing a higher pitch.



Advance Preparation

Make copies of the handouts: *The Washtub Bass, The Native American Drum, The Stoneware Jug, Making a Kazoo.* You will need sufficient copies for one-third of your students in each group.

MATERIALS NEEDED

For each student:
- student pages

For the strings groups:
- rubber bands (variety of sizes)
- 8 meat trays (2 different sizes)
- fishing line
- 8 dowels
- 8 large paper clips
- 8 thumbtacks
- 8 deli containers, 16 oz.

For the drum group:
- 2 deli containers, 8 oz.
- 2 deli containers, 16 oz.
- 2 deli containers, 32 oz.
- ¼ cup rice
- rubber bands (variety of sizes)
- plastic wrap
- 8 balloons (round)

For the horn group:
- 8 straws

Teacher provides:
- small boxes for strings
- variety of containers for drums
- variety of materials for drumheads
- scissors
- different sizes of bottles for horns

PS4.A: WAVE PROPERTIES
- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).

TEACHING TIP

You will need to have 2 or 3 teams for each category of instrument. Encourage the teams to choose different materials for strings, drums, and horns. The strings will be making different sizes of guitars, ukuleles, and washtub basses. The drum team will be making drums of different sizes and materials for drumheads and shakers, and the horn teams will all be making kazoos and bottle horns.

KEY IDEAS AND DETAILS

RI.4.1: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

RI.4.2: Determine the main idea of a text and explain how it is supported by key details; summarize the text.

RI.4.3: Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION

Obtain and combine information from books and other reliable media to explain phenomena.

In this lesson, student teams explore sound and pitch through strings, drums, and horns or wind instruments. Your unit provides a variety of containers for students to explore; however, due to space and possible breakage in transport, the unit is limited to plastic containers. To help students in their explorations, collect a variety of containers made of different materials and sizes. For example: oatmeal canisters, coffee cans, wide-mouth glass jars, bottles of different sizes, shoe boxes and other small boxes.

Prepare a materials table for students to choose items to make their model of an instrument. Arrange the table with a section each for the string team, drum team, and horn team.

Procedure

Engage the learner.

Ask students to share their experiences with different instruments, such as guitars, violins, ukuleles, drums, and horns. Ask them to share their initial ideas of how different instruments make a sound. Record their ideas on the What We Think About Sound chart. Ask students to make connections between the vibrations of the tuning forks, combs, and rulers in the previous activity and the sounds that instruments make. Ask them what must be present for a sound to be made and heard (vibrations).

Explore the concept.

Divide the class into teams: strings, drums, and horns. Tell the class that all students will be given the opportunity to become engineers and design and build an instrument that will show vibrations and demonstrate how sounds are made and how the pitch changes. They will work in teams to collaborate and share ideas. Review the *Engineering Design Process* with the class. (See Appendix, pp. 168–69.)

Inform the teams that they will be presenting and explaining the vibrations in their instruments to the rest of the class. Display the following materials to each of the teams:

- Strings: different sizes of rubber bands and meat trays, small boxes, fishing line, dowel, large paper clips, thumbtack, *The Washtub Bass* handout.
- Drums: Different sizes of deli containers with lids, rice, rubber bands, plastic wrap, balloons, variety of containers for drums, variety of material for drumheads, *The Native American Drum* handout.

- Horns: Straws, scissors, different sizes of bottles, *The Stoneware Jug* handout, *Making a Kazoo* handout.

Distribute the appropriate handouts to each student in the teams. Give the teams sufficient time to plan, design, build, and test their instruments. Inform the teams that they will be asked to choose one or two of the instruments to present to the rest of the class. They should be prepared to explain how the instrument was built, why they chose their material, what is vibrating, and how the instrument makes different pitches.

As the teams are working, facilitate the activity by circulating among the groups and listening to their ideas. To help teams that struggle getting started, ask:

- Would it help to create a diagram?
- What materials would you like to begin with? How will the materials you have chosen help you to make sounds?
- What have you tried so far? What has the rest of the group tried?
- Can you think of a way to make one change that will produce a different pitch? What part of the instrument will be creating the vibrations?

Have the students record their building plan and procedure on the Activity Page in the Student Journal.

1. *List the materials you used to make your instrument.*
2. *Draw your instrument.*
3. *Draw and write what causes your instrument to make sounds.*

Assessment

Use the students' diagrams and instrument models to assess their ability to develop and build a model to represent an instrument. (Developing and Using Models)

DEVELOPING AND USING MODELS

Develop a model using an analogy, example, or abstract representation to describe a scientific principle.

TEACHING TIP

Coordinate with the music teacher to continue the discussion of sound and vibrations with voice and the different instruments in the music department.

CAUSE AND EFFECT

- Cause-and-effect relationships are routinely identified and used to explain change.

Lesson 3D: Evaluating and Revising Our Instruments

Advance Preparation
Make copies of the *Instrument Presentation Product Descriptor* for each student.

Make copies of the handouts: *The Washtub Bass, The Native American Drum, The Stoneware Jug*

Plan for sufficient time for all groups to present their instruments, get feedback from others, and revise to improve. Invite others to listen to the presentations (administration, support staff, parents, etc.) so the students have an audience outside of their classmates.

Procedure
Explain the concept and define the terms.
Have the groups prepare and present an explanation of their instruments to share with the rest of the class. Distribute the *Instrument Presentation Product Descriptor* to each student. As a class, discuss the elements required in the presentations. Explain that the listeners will be taking notes on the presentations to aid in making suggestions to improve the instruments at the end of the activity.

Have the groups present all the strings, then all the drums, and finally all the horns. As each group completes their presentations, fill in the class data chart.

Type of Instrument	Materials Used	How Sound is Made	How the Pitch Changed	Suggestions for Improvement
Strings				
Drums				
Horns				

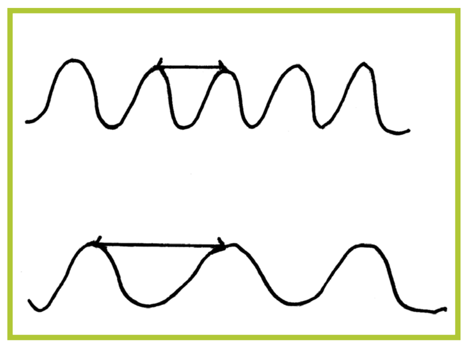
Draw the wavy lines that represent the sound waves on the board. (See Teacher Background Information.) Explain that sound travels outward from the vibrating matter in waves and the pitch of the vibration depends the material that is vibrating. Explain that different pitches of sound are a result in the difference in the wavelength (spacing between wave peaks). For example, the smaller, more taut rubber band produces a higher pitch, which means that the wavelength is shorter.

MATERIALS NEEDED
For each student:
- student pages
- instruments from the previous lesson
- handout: *Instrument Presentation Product Descriptor*

For each group:
- *Word Sort Card Set* (sound, energy, vibrations, vibrate, wavelength, pitch, high, low)
- handouts: *The Washtub Bass, The Native American Drum, The Stoneware Jug*

For the class:
- chart paper
- markers

PS4.A: WAVE PROPERTIES
- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).



FORMATIVE ASSESSMENT
Use the class data chart to assess the students' developing ideas regarding sound as a form of energy and how sound waves have different frequencies and wavelengths.

CONSTRUCTING EXPLANATIONS AND DESIGNING SOLUTIONS

- Use evidence (e.g., measurements, observations, patterns) to construct an explanation.
- Apply scientific ideas to solve design problems.

PATTERNS

- Similarities and differences in patterns can be used to sort and classify natural phenomena.

OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION

Obtain and combine information from books and other reliable media to explain phenomena.

KEY IDEAS AND DETAILS

RI.4.1: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

RI.4.2: Determine the main idea of a text and explain how it is supported by key details; summarize the text.

RI.4.3: Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

As a class, look at the data collected from the different presentations. Ask students to look for patterns that help to explain the vibrations that determine a high or low pitch and apply the pitch to the wavelength of the sound wave from each category of instrument. Students should recognize a pattern with:

- The size of strings (rubber band)
- The tightness or how taut the string is
- The size of the tray or box
- The size of the drum container
- The tightness of the drumhead
- The size of the straw
- The size of the bottle

After the class chart is complete, ask students what information they can learn from the data on the chart. Ask students to identify patterns in their findings. Based on their observations, students can conclude that the tension and size of the part of the instrument that is vibrating determines if it is a high note or a low note. Ask students if the information can be used to help improve the performance of their instruments. Give sufficient time for students to make improvements based on feedback and new information.

Elaborate on the concept.
Divide the class into three groups: *The Washtub Bass, The Native American Drum, The Stoneware Jug.* Distribute the appropriate handout to each student within the groups. Allow sufficient time for the groups to read and discuss the information in the handouts.

Review and discuss the information presented in the stories about the washtub bass, Native American drums, and stoneware jugs. Ask the students how the instruments make a sound. What is vibrating? How does the musician change the pitch of the instrument?

Read the *Story of the Stone Jug Band* in the Student Journal.

Discuss the information presented in each handout and the story and review what is vibrating in each instrument and how energy moves from place to place by sound.

Invite the students to pool their instruments and give a stone jug band performance.

Summary Discussion
Evaluate the students' understanding of the concept.
Review the different instruments the students designed in the activity. Ask students what properties of each instrument made it possible to play sounds with different pitches. Discuss the meaning of vibrations and how different vibrations produce different pitches. Review the diagram of the sound waves. Ask students to identify the sound wave that produces the highest pitch and explain what that vibration would look like, feel like, and sound like. Repeat the questioning with the lower pitch.

Return to the class chart, What We Think About Sound, and relate the sounds produced by the instruments to energy and how energy moves from place to place. Record the students' ideas about sound related to energy with instruments on the chart. Are there any conclusions that they can add to the chart at this time? Review the previous chart and student ideas about energy related to motion, collisions, light, and electricity. Discuss how energy, through sound waves, can be transferred from place to place. Tell the class that they will explore sound as related to energy further in the following lessons.

Discuss any changes they made in their initial thinking. Revisit the Freyer Model chart from the beginning of the unit. Ask students if they have any adjustments they would like to make to the chart at this time. Take this opportunity to revisit their initial ideas on the Energy Stations Data Chart and Lesson 1B Journal Entry. Have students make adjustments and explain how their ideas have changed.

Pre-Writing Strategy: Science Talk/*Word Sort Card Set*
Divide the class into groups of four. Give students sufficient time to orally express what they are going to write and draw and listen to the ideas of others. Distribute the *Word Sort Card Set* to each group. Circulate among the groups and listen to their discussions. To help students elaborate on their explanations of how stringed instruments make sounds, ask:

- Why do you think that? What have you observed in making your own instruments that make you think that?
- What do you know is necessary for sound to be produced? How do you know that?
- What do you mean when you say…?
- Tell me more about…

TEACHING TIP
Take this opportunity to check for conceptual shifts and deeper understanding of sound as it is related to energy. Check for students' ability to relate what they have learned; it may give them some ideas that will help them build a Rube Goldberg device and explain the transfer of energy within the device.

PS3.A: DEFINITIONS OF ENERGY
- Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-1)

PS3.B: CONSERVATION OF ENERGY AND ENERGY TRANSFER
- Energy is present whenever there are moving objects, sound, light, or heat.

CAUSE AND EFFECT
- Cause-and-effect relationships are routinely identified and used to explain change.

EXTENSIONS

Have students do research into other instruments that were used in a band with a washtub bass and explain how the instruments were made to produce different pitches.

Have the music teacher bring in samples of musical instruments for the students to explore and identify how the instruments make vibrations to produce high and low pitches.

INTEGRATIONS

Music: Explore the human voice and how the vocal cords are tightened and loosened to produce high and low pitches.

Music: Learn to play a simple song on a stringed instrument.

Science: Research the different sounds produced by different animals, such as a songbird and an elephant, and relate their sounds to pitch.

- How might you find out if your ideas are correct?
- How will you use the words on the cards in your written response? What do you mean by...?

Journal Entry

1. *Draw and label a model of waves to describe the amplitude and wavelength of the sound produced by your instrument.*
2. *Write an explanation of how energy can be transferred from place to place through sound. Include the cause of the sound made.*

Assessment

Use the Journal Entry to assess the students' understanding of amplitude and wavelength and how energy can move from place to place by sound. (4-PS3-2, 4-PS4-1)

Use the student presentations to assess the students' understanding of how vibrations cause sounds.

Student Journal

Sample

Activity #3

4th grade

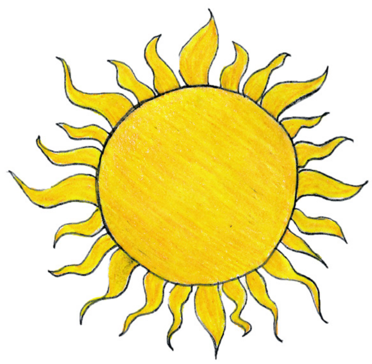
Energy and Waves

CEREAL CITY SCIENCE by BCAMSC

CEREAL CITY SCIENCE
by BCAMSC

Student Journal
4.PS.NGSS

Energy and Waves


A 4th Grade Unit
supporting the
Next Generation Science Standards
and the Michigan Science Standards

Name: ____________________

Name: ______________________________

Date: ______________________________

ACTIVITY **3A**

The Energy of Sound

1. How would you describe the sound of the tuning fork?

2. Describe what the tuning fork felt like when it made a sound.

3. Draw the effect of placing the tuning fork in the cup of water.

4. Explain what you think caused that effect.

The Energy of Sound

Name: ______________________________

Date: ______________________________

1. Describe what you feel when you lightly place your lips against the wax paper and hum.

2. Write what you think causes the wax paper and comb to move back and forth.

Name: ______________________________

Date: ______________________________

1. Write what you hear and see when you pluck the ruler that is long.

2. Write what you hear and see when you pluck the ruler that is short.

Name: ______________________________

Date: ______________________________

3. Use your observations from the short and long ruler lengths to predict what you would hear if you used a ruler that was longer than your classroom ruler. Tell what evidence you have that makes you think that.

4. How does the model of the ruler with the pencil demonstrate how sounds are made?

Name: ______________________________

Date: ______________________________

Describe a sound that you have heard or made today. Tell how the sound was generated, the pitch of the sound, the volume of the sound, and how the sound traveled to your ears.

3C ACTIVITY

Building Instruments

Name: ______________________

Date: ______________________

1. List the materials you used to make your instrument.

2. Draw your instrument.

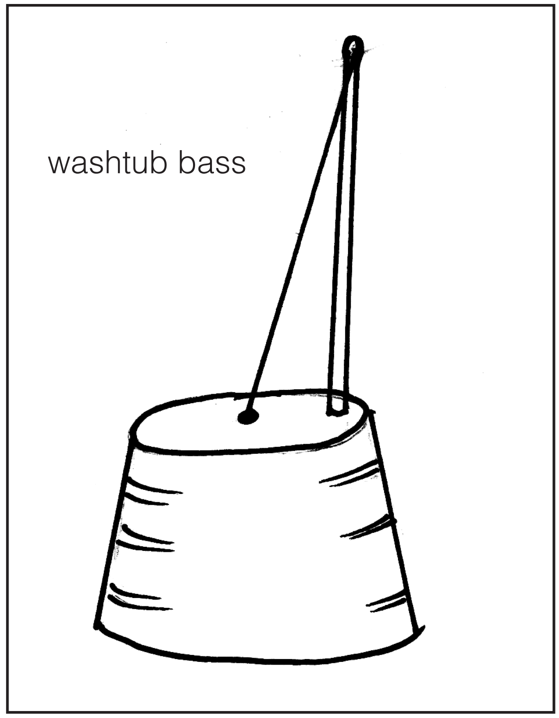
3. Draw and write what causes your instrument to make sounds.

Name: ____________________

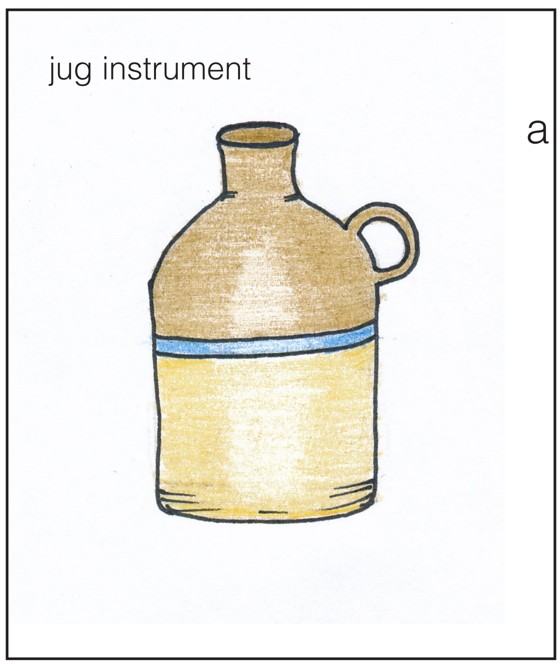
Date: ____________________

The Story of the Stone Jug Band

The stone jug band has a long history. It is often called the “poor man’s jazz” because most bands started when people did not have enough money to purchase instruments. They made their own instruments from common kitchen and household items. Beginning in the 1890’s and though the 1920’s and 1930’s musicians traveled up and down the Ohio River and Mississippi River playing their music in cities along the way. Early jug bands performed in Vaudeville shows, on street corners, in barns, and as traveling minstrels.



The instruments in a jug band are made up of some traditional instruments and homemade instruments. The traditional instruments were usually the banjo, guitar, bass, and mandolin. Some jug band members even made their own banjos out of broom sticks and bread pans or gourds!

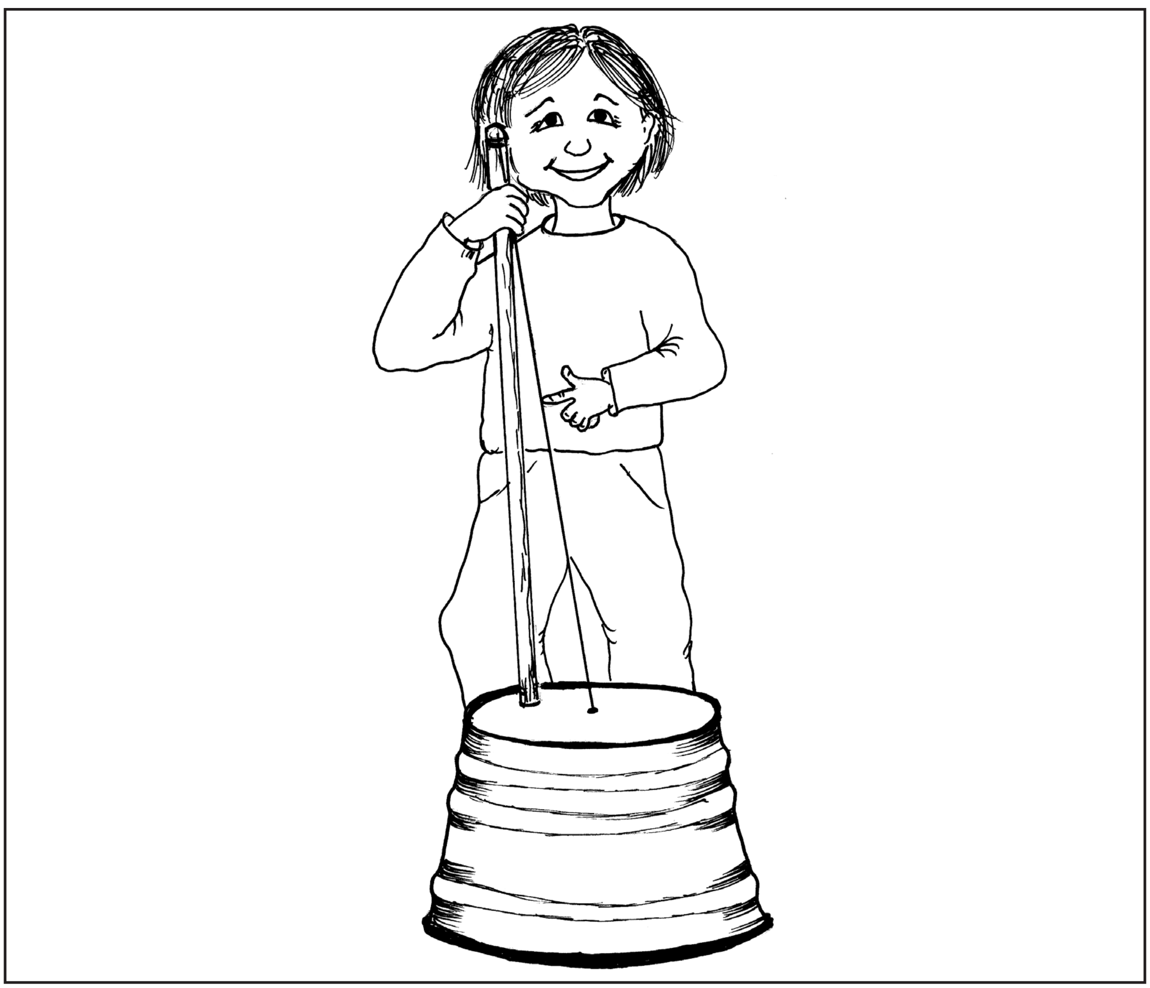


Name: ____________________

Date: ____________________

Most homemade instruments in a jug band were the washtub bass, washboards, kazoos, stoneware or glass jugs, pots, pans, and spoons. The homemade instruments were called “odd ball” instruments and the players invented sounds from things that are not traditional instruments.

The popularity and creativity of the jug bands is a tribute to the ingenuity of the poor people in the 1920’s and 1930’s. Their music has an influence on jazz, country music, ragtime music, and rock and roll.



Name: ______________________________

Date: ______________________________

1. Draw and label a model of waves to describe the amplitude and wavelength of the sound produced by your instrument.

2. Write an explanation of how energy can be transferred from place to place through sound. Include the cause of the sound made.

3E JOURNAL

Sound Waves Can Make Things Move

Name: ______________________

Date: ______________________

In this activity, you explored different models that demonstrate waves and how sound travels (CD player and sand, water wave model, human wave, Dominoes, sound wave Internet models). Choose the wave model that you think best represents how sound travels and energy can move from place to place by sound. Explain the different parts of the model that represented vibrations, sound waves, air and energy.