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Light and Sound

Week 8: Grades 3-5

Day	Topics	Related Standards
1	Reflection	**Ask questions and investigate** the relationship between light, objects, and the human eye.
2	Refraction	
3	Engineer an Instrument: Ask and Imagine	**Plan and carry out an investigation** to explore how sound waves affect objects at varying distances.
4	Engineer an Instrument: Plan and Create	
5	Engineer an Instrument: Test and Improve	

Light and Sound

Day 1: Reflection

Teacher/Parent Background:

The image we see in a reflection is a flipped image from the original. Because light travels in straight lines, the angle of incoming light equals the angle of the reflected outgoing light on shiny surfaces. On dull surfaces, light rays reflect in many directions, called "scattered light. The color the eye detects depends on which wavelengths of light are absorbed and reflected. If dull objects scatter all wavelengths, they appear white. If they absorb all wavelengths, they appear black. If dull objects absorb all wavelengths but reflect red, the eye detects red objects. When a surface is very smooth, like polished metal, glass, or the surface of still water, light is reflected like a mirror.

Overview: In this activity, students test reflection of light. Students will use a PhET simulation to better understand reflection of light.

Related Standards:

Ask questions and investigate the relationship between light, objects, and the human eye.

Key Terms:

- Reflection: Energy waves bouncing on the surface of an object (mirrors or echoes return energy back to the source.)

Materials List:

- Computer with internet access
- Laser pointer or flashlight and multiple mirrors (for extension)

Activity Description:

1. Give students access to the Bending Light PhET simulation
2. Ask students to follow instructions on the Student Resource page.
3. Student answers will vary. Students should come away with the understanding that the angle of the incoming light beam will be reflected the same amount.

Closure:

Discuss the following with students:

1. What is reflection? Reflection occurs when light hits a shiny surface and bounces off.
2. Give examples of materials that reflect light. Answers will vary. Possible answers include: a mirror, shiny metal, and a white board.
3. Can you design a product to look around corners? What materials would you use? Yes, materials should include a mirror as well as other various, appropriate items.

Extensions:

Bending Light!: Ask students to create a system to bounce light from one mirror to another to hit a bull's-eye. Students should use as many mirrors as they can to hit the bull's-eye with the laser pointer or flashlight. Focus on how they set up and adjust their mirrors in the system. Note: Mirrors have to be placed at different angles for light to bounce off and hit the bull's-eye. *Precautions:Tell students the dangers of shining the laser pointers in each other's eyes.*

Student Resources

Did you know? When light hits the surface of a body of water, some of it is reflected and some of it is transmitted into the water. The reflected light makes a reflection of the surroundings on the surface of the water. The transmitted light helps us to see the fish, rocks, and other objects in the water.

Procedure

1. Click on Intro.

2. Place the protractor so that 90 is on the surface of the water and 0 is on the dotted line.

3. Place the intensity meter above the protractor.

4. Turn the laser on.

5. Place the laser at 20 degrees.

6. Drag the sensor to the reflected light beam and measure the light intensity.

7. Record it in the data table.

8. Drag the sensor to the transmitted light beam and measure the light intensity.

9. Record it in the data table.

10. Move the laser to each degree listed on the data table, and then measure and record the reflected light intensity.

Angle of Incoming Light	Intensity of Reflected Light	Intensity of Transmitted Light
20		
30		
40		
50		
60		

Conclusions

1. How does the angle of the incoming light beam affect how much it is reflected?

2. If you are trying to see the reflection of the trees on the surface of the water, at what angle should you look at the water? Hint: The light must be reflected for you to see a reflection on the water. Explain or draw a labeled diagram.

3. If you are trying to see down into the water, at what angle should you look into the water? Hint: The light must be transmitted for you to see into the water. Explain or draw a labeled diagram.

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Day 2: Refraction

Teacher/Parent Background:

A refracted image is distorted or changed from the original. When light rays are transmitted or pass from one medium to another (from air to water) other than straight on, the speed of light changes slightly, which causes the light rays to change direction slightly at the boundary of those two mediums. This bending of light rays is called refractionThis happens when you look at a pencil in water, and the part below the surface of the water looks bent. This refraction of light can cause partially submerged objects in water to appear distorted. Refracting light is important to the eye. The amazing flexible convex lens inside the eye focuses incoming light that our brain interprets as the world humans see. For those with poor vision, eyeglass lenses can refract or bend light rays to focus better or to magnify the image. Convex lenses (curved away from incoming light) are also used to make objects appear closer. Hand lenses, microscopes, telescopes, or binoculars are examples of convex lenses. Concave lenses (curved toward incoming light) are used to spread out images. Concave lenses are used in glasses to correct nearsightedness (myopia), and in door viewers, or peepholes.

Overview: In this activity, students test refraction of light. Students will refract light using various tools and newspaper.

Related Standards:

Ask questions and investigate the relationship between light, objects, and the human eye.

Key Terms:

- Refraction: The bending or redirection of energy waves as they pass from one substance to another.
- Lens: A clear piece of curved glass or plastic that bends passing light to focus or spread light rays.

Materials List:

- Newspaper or other source of small print
- Magnifying glass
- Marble, clear

- Glass with water
- Eyeglasses

Activity Description:

1. Give students the Student Resource page and ask them to follow the instructions.
2. Student answers should be as follows:

Refraction Test Item	Picture of Results	Description of Results
Eyeglasses	Answers will vary.	Words get bigger.
Marble	Answers will vary.	Words appear distorted.
Water in a jar	Answers will vary.	The words look broken and larger.
Magnifying Glass	Answers will vary.	The words appear larger.

Closure:

Discuss the following with students:

1. What is refraction? Refraction occurs when light bends as it moves from one medium to another.
2. Give examples of materials that refract light. Answers will vary. Possible answers include: eyeglasses, lenses, and water.
3. Explain how water can reflect and refract light. Water can refract (bend) light as light rays move pass from the air into the water, making objects appear distorted. On a sunny day, light shining on a body of water reflects light, acting like a mirror. The Sun on the water creates the shiny surface.

Extensions:

Watch and Learn!: Watch How Telescopes Work to better understand how reflecting and refracting light helps us to see far away objects. Later, stargaze with a telescope.

Student Resources

1. Place each refraction test item over the newsprint (or other source of small print) and record your observations.

Refraction Test Item	Picture of Results	Description of Results
Eyeglasses		
Marble		
Water in a jar		
Magnifying Glass		

2. Write your own definition of the word *Refraction.*

Light and Sound

Day 3: Engineer an Instrument

Teacher/Parent Background:

Sound energy is produced by vibrating objects. Although sound is detected by the ear, students can feel sound vibrations when they touch their throats while talking and they can see sound vibrations when they put a paper plate or some candy sprinkles on top of a loud radio that causes the sprinkles to bounce around. Sound is produced in nature when animals make sounds, the oceans pound the shores, and the wind blows through the trees. Sound is also produced by vibrating objects, such as musical instruments, radios, and moving machines.

Over the ages, the use of sound energy from vibrating objects has changed from beating drums for passing messages in ancient times to modern audio devices like iPods and band amplifiers that can produce sound for one person or for thousands. Early phonographs recorded sound on wax tubes. Today, sounds can be recorded on tape or digitally by using computer hardware and software. All audio devices, old and new, produce sound energy based on vibrations. Sound energy from musical instruments produces vibrations by variations of pounding, plucking, blowing, or strumming motions that cause distinct frequencies of sound waves to reach the ear as music.

Overview: In this activity, students will create an instrument to replace the fiddle for the cat from the nursery rhyme Hey Diddle, Diddle.

Related Standards:

Use models to provide evidence that vibrating matter creates sound and sound can make matter vibrate.

Key Terms:

- Sound- Energy vibrations that you can hear.
- Vibration- Rapid back and forth motion.
- Energy- What is needed to do work or cause change.

Materials List:

- Scissors
- Glue
- Tape
- Markers

- Possible materials for construction of musical instruments
    - Paper plates
    - Jingle bells
    - String
    - Ribbon
    - Toilet paper rolls
    - Wax paper
    - Rubber bands
    - Cans
    - Empty water bottles
    - Dried beans or unpopped popcorn kernels
    - Empty tissue boxes
    - Paper towel rolls
    - Straws
    - Wooden chopsticks
    - Empty plastic eggs
    - Pennies
    - Elbow macaroni
    - Washers

Activity Description:

1. Ask students to close their eyes and listen to the nursery rhyme Hey Diddle, Diddle.
2. Ask the students if they have ever heard this particular poem.Call on students to describe what they visualized while listening to the poem with their eyes closed. Discuss the rhyming words in the poem and how they affect the images students can see in their minds. Tell students that authors use rhyme and sound effects to make their poems more imaginative and interesting. Poetry is often read out loud to give it more impact. The way poetry sounds is very important to the author and the listeners.
3. Ask the following questions:
    a. What is sound?
    b. What sense allows you to hear sounds?
    c. How are sounds produced?
    d. What other creative people use sound to get their message across besides poets? (Students might mention actors, TV announcers, etc. If no one mentions it, bring up the idea of musicians. Music can portray ideas and feelings, even if it is instrumental and not vocal.)
4. Tell students that acoustical engineering is a branch of engineering dealing with how sound behaves in, and is affected by, a structure. Acoustical engineers are sound experts. They have to know what causes

sounds and how to control the types and effects of sounds produced by a variety of objects.Tell the students that they are going to be acoustical engineers for a day.

5. Introduce the design challenge: The cat in the nursery rhyme is tired of playing the fiddle. Design and create a new musical instrument for the cat to play.
6. Discuss the design challenge criteria:
    a. You may only use the given materials in your design.
    b. The instrument must require the cat to use at least two body parts to operate.
    c. The instrument must be able to produce more than one sound.
    d. You must design and construct the instrument within a 30-minute time limit.

Extensions:

Play and Learn!- Sound for Kids

Student Resources

ASK

1. What is the problem? (State the problem in your own words.)

A. How is sound produced?

B. What are at least two different ways sound can be produced by a musical instrument?

Brainstorm and design 2 solutions to the problem
Imagine
Idea #1

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Idea #2

Light and Sound

Day 4: Engineer an Instrument

Teacher/Parent Background:

Sound energy is produced by vibrating objects. Although sound is detected by the ear, students can feel sound vibrations when they touch their throats while talking and they can see sound vibrations when they put a paper plate or some candy sprinkles on top of a loud radio that causes the sprinkles to bounce around. Sound is produced in nature when animals make sounds, the oceans pound the shores, and the wind blows through the trees. Sound is also produced by vibrating objects, such as musical instruments, radios, and moving machines.

Over the ages, the use of sound energy from vibrating objects has changed from beating drums for passing messages in ancient times to modern audio devices like iPods and band amplifiers that can produce sound for one person or for thousands. Early phonographs recorded sound on wax tubes. Today, sounds can be recorded on tape or digitally by using computer hardware and software. All audio devices, old and new, produce sound energy based on vibrations. Sound energy from musical instruments produces vibrations by variations of pounding, plucking, blowing, or strumming motions that cause distinct frequencies of sound waves to reach the ear as music.

Overview: In this activity, students will create an instrument to replace the fiddle for the cat from the nursery rhyme Hey Diddle, Diddle.

Related Standards:

Use models to provide evidence that vibrating matter creates sound and sound can make matter vibrate.

Key Terms:

- Sound- Energy vibrations that you can hear.
- Vibration- Rapid back and forth motion.
- Energy- What is needed to do work or cause change.

Materials List:

- Scissors
- Glue
- Tape
- Markers

- Possible materials for construction of musical instruments
    - Paper plates
    - Jingle bells
    - String
    - Ribbon
    - Toilet paper rolls
    - Wax paper
    - Rubber bands
    - Cans
    - Empty water bottles
    - Dried beans or unpopped popcorn kernels
    - Empty tissue boxes
    - Paper towel rolls
    - Straws
    - Wooden chopsticks
    - Empty plastic eggs
    - Pennies
    - Elbow macaroni
    - Washers

Activity Description:

1. Remind students of the design challenge: The cat in the nursery rhyme, "Hey Diddle, Diddle" is tired of playing the fiddle. Design and create a new musical instrument for the cat to play.
2. Remind students of the design challenge criteria:
    a. You may only use the given materials in your design.
    b. The instrument must require the cat to use at least two body parts to operate.
    c. The instrument must be able to produce more than one sound.
    d. You must design and construct the instrument within a 30-minute time limit.
3. Today students will be planning and building their instruments.

Extensions:

Watch and Learn!- Understanding Vibration and Pitch

Student Resources

Refer back to the two solutions you brainstormed, yesterday.

Choose the best solution and draw a plan of how to make it. Include which specific materials you will use.
Plan

- Once your plan is complete begin building your design exactly as planned!

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Light and Sound

Day 5: Engineer an Instrument

Teacher/Parent Background:

Sound energy is produced by vibrating objects. Although sound is detected by the ear, students can feel sound vibrations when they touch their throats while talking and they can see sound vibrations when they put a paper plate or some candy sprinkles on top of a loud radio that causes the sprinkles to bounce around. Sound is produced in nature when animals make sounds, the oceans pound the shores, and the wind blows through the trees. Sound is also produced by vibrating objects, such as musical instruments, radios, and moving machines.

Over the ages, the use of sound energy from vibrating objects has changed from beating drums for passing messages in ancient times to modern audio devices like iPods and band amplifiers that can produce sound for one person or for thousands. Early phonographs recorded sound on wax tubes. Today, sounds can be recorded on tape or digitally by using computer hardware and software. All audio devices, old and new, produce sound energy based on vibrations. Sound energy from musical instruments produces vibrations by variations of pounding, plucking, blowing, or strumming motions that cause distinct frequencies of sound waves to reach the ear as music.

Overview: In this activity, students will create an instrument to replace the fiddle for the cat from the nursery rhyme Hey Diddle, Diddle.

Related Standards:

Use models to provide evidence that vibrating matter creates sound and sound can make matter vibrate.

Key Terms:

- Sound- Energy vibrations that you can hear.
- Vibration- Rapid back and forth motion.
- Energy- What is needed to do work or cause change.

Materials List:

- Scissors
- Glue
- Tape
- Markers

- Possible materials for construction of musical instruments
    - Paper plates
    - Jingle bells
    - String
    - Ribbon
    - Toilet paper rolls
    - Wax paper
    - Rubber bands
    - Cans
    - Empty water bottles
    - Dried beans or unpopped popcorn kernels
    - Empty tissue boxes
    - Paper towel rolls
    - Straws
    - Wooden chopsticks
    - Empty plastic eggs
    - Pennies
    - Elbow macaroni
    - Washers

Activity Description:

1. Remind students of the design challenge: The cat in the nursery rhyme, "Hey Diddle, Diddle" is tired of playing the fiddle. Design and create a new musical instrument for the cat to play.
2. Remind students of the design challenge criteria:
    a. You may only use the given materials in your design.
    b. The instrument must require the cat to use at least two body parts to operate.
    c. The instrument must be able to produce more than one sound.
    d. You must design and construct the instrument within a 30-minute time limit.
3. Today students will be testing and improving their instruments.

Extensions:

STEAM Challenge!- Have students write and illustrate a comic book about the different places and ways they encounter light and sound energy during their day.

Student Resources

Describe the instrument you built.

Test

- ❑ Does your instrument take at least two body parts to operate?
- ❑ Is your instrument able to produce more than one sound?

Improve

A. Was this the best solution to the problem? Explain.

B. What could you have done differently?

C. Can you add to your solution to make it better? Explain.