Inquiry Labs

TEACHER ENRICHMENT RESOURCE PACKET

Light and Sound

An *Inquiry Lab* for 1st and 4th Grades

Experiment with the wave nature of light and sound. Use patterns of light and sound to send coded messages. Use an oscilloscope to visualize sound waves.

what's inside

Think it.
Try it.
Explorit.

Light and Sound

Welcome

Thank you for choosing Explorit Science Center's Inquiry Labs to supplement your ongoing science curriculum. Whether you use the program to kick off a new unit, wrap up a nearly completed unit, or purely to excite and interest your students in the wonderful world of science, advance preparation and follow up with your students are critical to achieve the greatest educational benefit from this unique science experience.

Explorit provides two resources to help prepare you and your students for Inquiry Labs. First, simple logistics of the program are detailed in the confirmation letter. Second, this Teacher Enrichment Resource Packet outlines appropriate science content and processes to help you:

- successfully prepare your students prior to visiting Explorit;
- participate fully in the *Inquiry Lab* yourself; and
- follow-up with your students back in the classroom.

Learning Objectives

Learning objectives provide a broad overall guide to what students will begin to experience and understand through participation in Explorit's Light and Sound Inquiry Lab designed for Grades 1 and 4. During this program, students will:

- work collaboratively in teams to complete science challenges
- experiment with the properties of sound including its wave nature;
- understand how coded patterns of light and sound can be used to transmit information; and
- use an oscilloscope to visualize sound waves.

Science Standards

Explorit Science Center's Inquiry Labs programs address concepts teachers need to teach under the Next Generation Science Standards. The alignment of Inquiry Labs with the science standards allows you, the teacher, to bring exciting fun-filled science experiences to your students while at the same time fulfilling your requirement to teach particular science content and processes. For specific science standard concepts covered by Light and Sound, refer to Science Standard Alignment, page 8.

Our Mission:

To ignite and foster curiostiy about science and nature through inquiry and discovery.

Background Information

Vision and hearing are two of the primary tools young scientists use to explore their world. The properties of light and sound, how they travel, how they transmit energy, and how we use them for communication are the discoveries that await your students in Explorit's Light and Sound Inquiry Lab program. Light and sound are some of the most basic, but also most baffling, aspects of our world. The study of light and sound provides an opportunity for students to practice the processes used by scientists. As part of this program, students will use some or all of the following science skills: observing, communicating, comparing, testing, quantifying, and asking questions.

Ridin' the Wave

Light, like sound, travels as a wave. But light can also act like a particle. This dual nature of light is called the "wave-particle duality" and is a wonder of physics. As a particle, light can bounce off of a mirror and be reflected back in a different direction. Blocking the movement of light particles creates a shadow. As a wave, light can bend into a rainbow. Particles and waves are two ways of explaining light's behavior.

Fabulous Physics Fact:

"Ultrasonic" refers to any sound that with a frequency above the range of human hearing (above 20,000 hertz)!

Sound also travels in waves. Sound waves are vibrations that travel through a medium such as air or water. A vibrating object makes a sound, and sound makes objects vibrate. Sound waves can be measured in terms of frequency and wavelength. Frequency refers to how many waves pass a given point in a second. Frequency is measured in hertz. Wavelength refers to the distance between a given point on a sound wave (for example, the crest) and the corresponding point on the next wave.

What do light and sound have to do with energy?

Anything that moves uses energy, and light and sound are no exception. When a ray of light shines through a window or a sound wave strikes your eardrum, energy is being used. But energy can never be lost or destroyed; it can only be transferred to another object or changed into another form. Stretch out a rubber band, then pluck it with your finger. You'll hear its sound, but you'll also see and feel the vibrations created by the energy of that sound.

Light energy travels in particles called "photons", which scientists describe as tiny energy packets. When a beam of light shines on an object, the photons that make up that light transfer their energy to the object. That's how our skin gets sunburned.

Background Information
continued

Plants also use the energy of light to make their own food through photosynthesis. Radiation, microwaves, and solar power all capitalize on the energy of light.

What about communication?

As they travel, light and sound can communicate information over long distances; the key is in their pattern.

Fabulous Physics Fact:

"Reflection" is when light hits a surface like a mirror and bounces off. "Refraction" is when light passes through a surface and bends or is sent in a different direction.

An excellent example of using patterns to communicate is Morse code. Relying on a series of short and long signals that correspond to the letters of the alphabet and Arabic numerals, Morse code messages can be sent with audio tones, light flashes, or pulses of electricity.

Named for Samuel F.B. Morse, the creator of the telegraph, the first version of Morse code made its debut in 1836. The code has been refined and modified in the years since. International Morse Code, the current standard, was adopted in 1865, and played a critical role in military communications throughout the twentieth century.

Another great example of coded communication is binary code. Binary code reduces text or computer instructions into a series of 1s and 0s, and is the basis of modern computer coding. Binary coding using two single-digit numbers was first developed in the seventeenth century, but other forms of binary code using light and dark or long and short sounds have existed from the ancient world. Morse code is one form of a binary code. Braille is another.

Most communication codes rely on either auditory or visual transmission, making use of the wave nature of light and sound to transfer not only energy, but also information.

Fabulous Physics Fact:

Sound waves are sometimes called pressure waves. As sound waves travel through a medium such as air, they push the air particles out of their way using pressure.

Conclusion

Through Explorit's Light and Sound program, students will explore a wide array of properties and behaviors of light and sound, experiment with obstructing their travel, visualize their waves, and use them to communicate and transfer energy.

Vocabulary

This list includes words that may be used during *Inquiry Labs*. Specific vocabulary used depends on students' grade level and prior knowledge.

Absorption – when light stops traveling because its path is obstructed by an opaque object
Amplitude – the measure of a sound wave
Binary – any code made with only two factors (light/dark, long/short, 1/0), examples include Morse code and Braille
Circuit – a system of energy transfer including the source of energy, the item using the energy, and any transmission mediums such as wires
Echo – a sound reflection that occurs when sound waves bounce off of a surface and travel back in a different direction
Frequency – a measurement of how many sound waves pass a given point in a second
Opaque – an object that absorbs or reflects all light, letting no light pass through it
Oscilloscope – a machine that visualizes sound waves or electronic frequencies
Perception – how things appear or look, may differ from how things really are
Photon – a particle of light
Pitch – how high or low a sound is based on the frequency of vibrations
Radiometer – a device that measures the intensity or force of radiation
Reflection – when light hits an opaque surface and bounces off, traveling in another direction
Refraction – when light travels through a transparent or translucent material and is bent
Spectrum – the intensity of light as a function of wavelength
Translucent – allows some light to pass through
Transparent – allows most light to pass through
Ultrasonic – any sound above the range of human hearing
Ultraviolet – light with a wavelength shorter than that of the violet end of the visible spectrum, but longer than that of X-rays
Vibrate – back and forth movement
Volume – a measurement of how much sound energy reaches the ear so that sound can be heard
Wavelength – the length between a given point on a sound wave and the corresponding point on the next wave

Fabulous Physics Fact:

Many animals can see parts of the light spectrum that humans can't. For example, most insects can see UV light.

Classroom Activities

For your convenience, the following activities can be used as you deem most appropriate to integrate Explorit's Light and Sound into your ongoing curriculum. The activities are grade-level appropriate, but please note that this program is designed for a broad grade range (1&4) and thus all activities may not be appropriate for every group of children. Choose those activities that will work well for your students.

Activity #1: "Solar S'mores"

Objective: To experience the physical and chemical transformations that can occur from exposure to the sun's radiation

Materials:

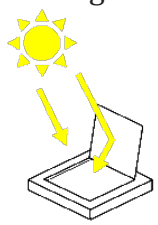
- Cardboard boxes
- Scissors
- Masking tape
- Aluminum foil
- Graham crackers
- Chocolate bars
- Marshmallows
- Paper towels

Science Standards:

- K-2-ETS1-2
- 4-PS3-2
- 4-PS3-4

Procedure:

1. Have students work together in teams to cut open the cardboard boxes according to this diagram:



2. Have the students cover all exposed surfaces of the box with aluminum foil, securing with tape if necessary. Discuss the reflective properties of foil. How will the sunlight react with the aluminum foil? How could that help us cook our food?
3. When solar ovens are finished, place a graham cracker, chocolate piece, and marshmallow in the oven for each student. Place the ovens in the sun and watch what happens! On a warm, sunny day, it may only take a few minutes for the chocolate begin to melt.
4. As students enjoy their snack, discuss any visible changes to the chocolate and marshmallows. How did the sunlight or heat cause those changes? What did we do to the sun's light to help our cooking?

Activity #2: "Wave Count"

Objective: To visualize the wave nature of sound and experience wavelength and frequency

Materials:

- Stopwatches
- Clipboards
- Paper
- Pencils
- Beach balls

Science Standards:

- 4-PS4-1

Procedure: Organize a field trip to the beach or a large lake where students can witness wave action.

1. Have students pair up and equip each pair with a stopwatch, clipboard, paper, and a pencil.
2. Run the stopwatch for 60 seconds and count the number of waves you see form and break on the shore. Then divide the number of waves counted by seconds to learn the frequency. Frequency = number of waves ÷ time.

Classroom Activities
continued

3. Have students take turns tossing beach balls into the waves breaking on shore. Use the stopwatches to time how long it takes for the ball to wash up on land. Discuss how the ball was carried by the waves. Waves transfer energy.

Activity #3: "Doppler Drive"

Materials:
Car

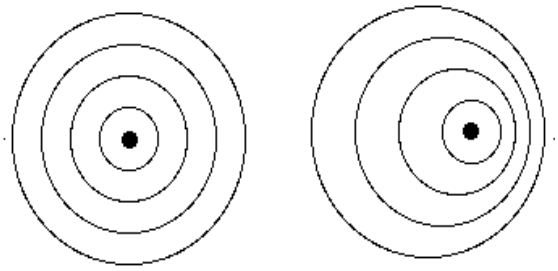
Science Standards:
4-PS4-1

Objective: Students will experience the Doppler Shift as an effect of speed on the wavelength of sound waves.

Procedure:

1. Take the students outside and have them line up on the sidewalk in front of the school. Caution the students to stay on the sidewalk and out of the street for safety.
2. Have a parent or other adult drive a car down the street in front of the students at a consistent speed with the horn blaring the whole time.
3. Discuss student observations. Did the volume of the horn change or seem to change? What factors could cause it to sound different?
4. The Doppler Shift explains the change in how a noise sounds when it is moving towards or away from you. When the car is stationary, the sound waves from the horn move at the speed of sound equally in all directions, as long as nothing is muffling it. But as the car moves past you, say from left to right, the horn is moving into the sound waves radiating out in front of it, and adding to them. The result is a shorter distance in between the sound waves, or a greater frequency of waves. When the car passes you and begins to move away again, you will notice a sudden change in the sound's horn because now you are behind the car and the distance between the waves in increasing; their frequency decreasing.

Doppler Effect



(a) stationary source (b) moving source

Supplemental Resources

BOOKS

Baum, Arline and Joseph. **Opt: An Illusionary Tale**. Puffin Books, 1987. *An excellent introduction to optical illusions for younger children. Includes explanations of each illusion, plus instructions for more illusions children can make themselves.*

Burnie, David. **Eyewitness Science: Light**. Dorling Kindersley, Inc., 1992. *Thorough and accessible resource for the science of light, from optics through particle physics. Includes content on the history of science and the cultural significance of light in past civilizations.*

Watson, Philip. **Light Fantastic**. Lothrop, Lee and Shepard Books, 1982. *Lots of fun activities related to different aspects of light: color, photosynthesis, photography, reflection, and more. Includes a glossary of important science terms in the back.*

WEB SITES

Annenberg Learner: The Science of Light

http://www.learner.org/teacherslab/science/light

A variety of interactive activities on light and color with discussions of light as both a wave and a particle.

Explain that Stuff: Sound

http://www.explainthatstuff.com/sound.html

A wealth of information about sound waves.

How Stuff Works: How Light Works

http://science.howstuffworks.com/light.htm

A thorough but accessible discussion and history of the science of light.

How Stuff Works: Sound

http://science.howstuffworks.com/sound-info.htm

A comprehensive guide to the science of sound.

The Physics Classroom: Waves

http://www.physicsclassroom.com/class/waves

Mini lessons on sound, music, light, energy transfer and the measurment of waves.

Science Standards Alignment

Below is the exact language of the Next Generation Science Standards that Explorit's **Light and Sound** program addresses either during your visit to Explorit or through materials in this Teacher's Packet that you may use.

NEXT GENERATION SCIENCE STANDARDS

Physical Sciences

Grade 1:

1-PS4-1: Plan and conduct an investigation to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

1-PS4-3: Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.

1-PS4-4: Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.

Grade 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.

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.

4-PS4-3: Generate and compare multiple solutions that use patterns to transfer information.

Engineering, Technology, and Applications of Science

Grade 1:

K-2-ETS1-2: Develope a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

Explorit's Inquiry Labs *involve students' use of many science process skills. For grade level specific skills, see Next Generation Science Standards at www.nextgenscience.org.*

Explorit Programs for Schools and Groups

At Explorit's Site

Discovery Lessons & Inquiry Labs Visit our current museum exhibition or try a series of team challenges

Nature Safaris Visit Explorit's outdoor spaces at Mace Ranch Park

Explorit in Your Classroom

Classroom Adventures Explorit educators visit your classroom for hour-long presentations

For the Whole School

Health in Your World Learn about keeping your body and the world healthy and safe

Science in Your World The ultimate family science night

Reservations required.
For information please
call 530.756.0191

Think it.
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HOW TO CONTACT US

explorit
EXPLORIT SCIENCE CENTER

Location: 3141 5th St, Davis
Phone: 530.756.0191
Fax: 530.756.1227
E-mail: explorit@explorit.org
Web: www.explorit.org