

Lenses and Lighthouses

Parent Guide, page 1 of 2

Read the Directions sheets for step-by-step instructions.

SUMMARY

In this activity, you and your child will explore how some lighthouse lenses work and find out more about a specific lighthouse. Then you imagine a new invention that would use the lighthouse lens technology.

WHY

Careful observation allows you to gather all of the information that is available from a resource. The information that you learned from careful observation can then be used to understand larger topics, and how new information fits together with old information.

TIME

- 20–30 minutes

RECOMMENDED AGE GROUP

This activity will work best for children in kindergarten through 4th grade.

CHALLENGE WORDS

- canal:** a human-made waterway dug across land
- Fresnel:** the last name of an inventor (pronounced “Fray-nell”). The lens he invented is called a Fresnel lens.
- lens:** a piece of see-through material (like glass) that focuses rays of light
- lighthouse:** a structure, often a tower on land or in the water, with a powerful light that gives a signal to guide seafarers
- magnifier:** a lens or combination of lenses that makes something appear larger
- maritime:** of, relating to, or bordering a body of water
- observation:** an act of recognizing and noting a fact, sometimes involving measurement
- order:** level, rank or category
- refraction:** a change in direction that happens when a light ray passes from one material (like air) into another (like glass) in which its speed is different
- seafarer:** a person who operates or assists in operating a ship

More information at <http://americanhistory.si.edu/ourstory/activities/water/>



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GET READY

Read *Keep the Lights Burning, Abbie* together. *Keep the Lights Burning, Abbie* is a work of historical fiction about a teenager who saves the day by running her father's lighthouse during a storm. For tips on reading this book together, check out the Guided Reading Activity (http://americanhistory.si.edu/ourstory/pdf/water/water_reading.pdf).

YOU NEED

- Directions sheets (*attached*)
- Background sheet (*attached*)
- Thinkabout sheet (*attached*)
- How Things Work: The Fresnel Lens presentation (*downloadable from <http://americanhistory.si.edu/ourstory/activities/water/>*)
- Digital presentation software such as Microsoft PowerPoint (*Open Office Impress is available for free download at <http://download.openoffice.org/index.html>.*)
- One computer or more
- Art supplies
- Sheet magnifier, overhead projector, or car headlight (*optional, see Directions step 3*)



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Background Information

For more information, visit the National Museum of American History Web site <http://americanhistory.si.edu/ourstory/activities/water.html>.

For hundreds of years, seacoasts, rivers, lakes, and **canals** have had a big impact on the ways America has changed as a country. Even Americans who have never seen an ocean are still very connected to water. Eating fish for dinner, playing at the beach, ordering goods made overseas, and other **maritime** activities continue to play an important role in our lives.



Image of Point Bolivar Lighthouse in Texas.

Life and work on the water—for **seafarers**, fishers, passengers, and many others—have included many big challenges and successes, and even some disasters. On shore, many other jobs are connected to **maritime** activities, like moving cargo carried by boats, making fishing nets, and running **lighthouses**.



Lens from Point Bolivar Lighthouse in Texas

In fog or deep night, a **lighthouse's** beam warns ships away from dangers such as shorelines, shallow waters, and underwater rocks. Because the exact locations of **lighthouses** are marked on charts, the lights help **seafarers** figure out where they are. In the past, **lighthouse** keepers lived in **lighthouses** to make sure the lights were shining every night. Today, many **lighthouses** are run by computers.

For more information, visit the *On the Water* online exhibition at <http://americanhistory.si.edu/onthewater>.

What kinds of lights can you see right now? A computer screen? The sun? A lamp? Are they bright lights? How far away do you think you could be and still see that light?

Look closely at a lighthouse lens from the National Museum of American History to see how it works!

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Directions, page 1 of 1

For adults and kids to follow together.

1. Together, explore the presentation *How Things Work: The **Fresnel Lens***.

2. Talk about what you learned about the **Fresnel lens** from the National Museum of American History.

3. Look for a **Fresnel lens** near you.
 - If possible, find or buy a sheet **magnifier** or a “pocket **Fresnel lens**.” These come in several sizes, from the size of a business card to a whole sheet of paper. Experiment with using the **magnifier** on different objects at different distances. Turn it sideways and look closely to see the tiny plastic parts that make up the whole **lens**.
 - If you are outside, look at a parked car nearby. Examine the headlights to see if they include any **Fresnel lenses**.
 - If you are in a classroom with an overhead projector, take a look at the lenses to figure out if they are **Fresnel lenses**.

4. Now that you have learned how **Fresnel lenses** work and looked for one in real life, think of a new way you could use a **Fresnel lens**. **Fresnel lenses** can magnify words or images that are close by, or send light very far into the distance. What invention could you make that would use a **Fresnel lens**?

5. Use the Thinkabout sheet to develop your new invention!

Tip *You can use the pictures from the presentation or the online exhibition (<http://americanhistory.si.edu/onthewater/>) to make your picture very accurate.*

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ThinkAbout

Fresnel lenses turn the light from a small source (like a lamp or a light bulb) into a strong, solid beam that can be seen from far away. August **Fresnel** invented the **lenses** to use in **lighthouses**, so that boats could see the **lighthouses** from far away.

Think it! What new invention could you make, starting with a **Fresnel lens**? What problems can you think of that could be solved with a strong beam of light? Maybe think about problems you face everyday or problems you think might exist in the world of the future.

Explore It! How does the Fresnel lens you saw in real life (in car headlights, sheet or pocket magnifiers, or overhead projectors) inspire you? Are there any lessons you could learn from that Fresnel invention?

Sketch It! On the back of this page, draw a picture of how your invention might look.

These are just the first steps of the invention process. To finish the process, you would need to create a model, test the invention, tweak the ideas, and sell the real thing to people who might buy it. For more on invention, visit <http://sparklab.si.edu>.



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Script for the Presentation, page 1 of 3

For adults and kids to explore together.

Slide 1: How Things Work: The Fresnel Lens (*Image of lens*)

Slide 2: Look at page 27 in *Keep the Lights Burning, Abbie* and compare it to this picture of a **Fresnel lens**. Do the **lighthouse** lamps from the book look like the **Fresnel lens**? (*Images of **Fresnel lens** and book illustration*)

Slide 3: Many sources of light, like the oil lamps in Abbie's lighthouse, send light out that moves in different directions. But sometimes, we don't want the light to go in different directions—we want it to go in just one direction, like how **lighthouse** beams only light up one place at a time. (*Image of candle with light going in many directions*)

Slide 4: A man named August **Fresnel** came up with a way to do that using a **lens**. A lens is a piece of see-through material (like glass) that focuses rays of light. Say it! **FRESNEL** sounds like "Fray-nell." The first part rhymes with "spray" and the second part rhymes with "shell." (*Images of a spray can and a shell, audio recording of pronunciation*)

Slide 5: Many **lenses** are made out of glass or plastic. Looking at this part of a **lens** from the National Museum of American History, do you think it is made out of glass or plastic? Hint: It is very heavy and could break! The **lens** is made out of glass and is held together by a metal called brass. (*Image of **Fresnel lens** with materials labeled*)

Slide 6: The **Fresnel lens** has many parts that have different shapes. Each glass part curves just a little bit. Can you count the different pieces of glass in this close-up picture of a **Fresnel lens**? (*Image of **Fresnel lens** with separate parts numbered*)

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Slide 7: The parts of the **Fresnel lens** bend the light so a lot of it points in the same direction. The bending is called “**refraction**” and happens because light moves differently in air than in the glass of the **lens**. **Refraction** also happens in water. Take a look at this animation from Science Net Links

(<http://www.physicsclassroom.com/mmedia/optics/bp.cfm>) and try it yourself at home! Can you “break” a pencil using only a glass of water? (*Rough animation of **Fresnel lens** operation*)

Slide 8: About a year after Abbie saved the day, the Matinicus Rock **lighthouse** (where she lived) was repaired and **Fresnel lenses** were added to the towers. The **lenses** added to the Matinicus Rock **lighthouse** were “third **order**,” or the third-largest size of **Fresnel lenses** made for **lighthouses**. Look at the chart. How tall were the Matinicus Rock **Fresnel lenses**? Great! Each one was 4’8” tall. Is that taller or shorter than you are? (*Chart of **Fresnel lens orders***)

Slide 9: The National Museum of American History has a **Fresnel lens** in its new exhibition *On the Water*. This lens is 4’ 8” tall. What **order** is it? Great! It’s a third **order lens**. (*Chart of **Fresnel lens orders***)

Slide 10: The **lens** on display at the National Museum of American History was used at Bolivar Point **lighthouse**, in Galveston, Texas. In 1915, there was a big storm and some of the people from the town of Galveston went to the **lighthouse** to get protection from the storm. During the storm, the machine part that rotated the lighthouse lens broke. To warn ships at sea, the assistant keeper turned the huge **lens** by hand for nearly an hour. For more information about this **lens**, check out the *On the Water* online exhibition at

http://americanhistory.si.edu/onthewater/collection/TR_335567.html. For more activities and information about *Keep the Lights Burning*, Abbie and America’s activities on the water, visit <http://americanhistory.si.edu/ourstory/activities/water>. (*Image of Bolivar Point **Lighthouse***)

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Script for the Presentation, page 3 of 3

Slide 11: For more information about **lighthouses**: Explore the history of **lighthouses** with a **Lighthouse** Preservation Society Web site (<http://www.lighthousepreservation.org/beacons.php>). Learn more about the **Fresnel lens** and it's use in American **lighthouses** at the National Park Service Web site (<http://www.nps.gov/caha/historyculture/fresnellens.htm>)

Slide 12: Copyright: "Keep the Lights Burning, Abbie" by Peter and Connie Roop and illustrated by Peter E. Hanson. Illustrations copyright © 1985 by Carolrhoda Books. Reprinted with the permission of Carolrhoda Books, a division of Lerner Publishing Group, Inc. All rights reserved. No part of this excerpt may be used or reproduced in any manner whatsoever without the prior written permission of Lerner Publishing Group, Inc. (<http://lernerbooks.com>)



Lenses and Lighthouses

Teacher Guide, page 1 of 4

Read the Directions sheets for step-by-step instructions.

SUMMARY

In this activity, students will examine a lighthouse lens to develop an understanding of how some lighthouse lenses work in the context of a specific example. Students will then apply their knowledge of the lighthouse lens technology to imagine a new invention using a lighthouse lens to complete a different task.

RATIONALE

Careful observation is critical to everyday life and academic research in any field because it allows individuals to gather all of the information that is available from a resource. The information gathered from observation can then be used in higher-level thinking processes, such as application, analysis, synthesis, and evaluation.

OBJECTIVES

The students will be better able to:

- Describe how a Fresnel lens works.
- Observe carefully and describe in detail.

TIME

- 30–40 minutes

AGE GROUP: K–4

TARGET VOCABULARY:

- **canal:** a human-made waterway dug across land
- **Fresnel:** the last name of an inventor (pronounced “Fray-nell”). The lens he invented is called a Fresnel lens.
- **lens:** a piece of see-through material (like glass) that focuses rays of light
- **lighthouse:** a structure, often a tower on land or in the water, with a powerful light that gives a signal to guide seafarers
- **magnifier:** a lens or combination of lenses that makes something appear larger
- **maritime:** of, relating to, or bordering a body of water

More information at <http://americanhistory.si.edu/ourstory/activities/water/>



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- **observation:** an act of recognizing and noting a fact, sometimes involving measurement
- **order:** level, rank or category
- **refraction:** a change in direction that happens when a light ray passes from one material (like air) into another (like glass) in which its speed is different
- **seafarer:** a person who operates or assists in operating a ship

MATERIALS

- Directions sheets (*attached*)
- Background sheet (*attached*)
- Thinkabout sheet (*attached*)
- How Things Work: The Fresnel Lens presentation (*downloadable from <http://americanhistory.si.edu/ourstory/activities/water/>*)
- Digital presentation software such as Microsoft PowerPoint (*Open Office Impress is available for free download at <http://download.openoffice.org/index.html>.*)
- One computer or more
- Art supplies
- Sheet magnifier, overhead projector, or car headlight (*optional, see Directions step 3*)

PREPARATION

Read *Keep the Lights Burning, Abbie* together. *Keep the Lights Burning, Abbie* is a work of historical fiction about a teenager who saves the day by running her father's lighthouse during a storm. For tips on reading this book together, check out the Guided Reading Activity (http://americanhistory.si.edu/ourstory/pdf/water/water_reading.pdf).

STUDENT PERFORMANCE CRITERIA

- Describes a Fresnel lens.
- Uses careful observation to describe an object.
- Applies knowledge of Fresnel lens to development of a new invention.

STANDARDS

NCHS History Standards

K-4 Historical Thinking Standards

2H: Draw upon the visual data presented in photographs, paintings, cartoons, and architectural drawings.

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K-4 Historical Content Standards

- 2A. The student understands the history of his or her local community.
- 8B. The student understands changes in transportation and their effects.

IRA/NCTE Language Arts Standards

1. Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.
7. Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and nonprint texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.
8. Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

21st-Century Skills

Learning and Innovation Skills

- Critical Thinking and Problem Solving

Information, Media, and Technology Skills

- Media Literacy
- ICT (Information, Communications, and Technology) Literacy



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ISTE Education Technology Standards for Students (NETS.S)

Creativity and Innovation

- C. Use models and simulations to explore complex systems and issues.

Technology Operations and Concepts

- A. Understand and use technology systems.
- B. Select and use applications effectively and productively.

Benchmarks for Science Literacy

Grades K-2

- 3-C-1: People, alone or in groups, are always inventing new ways to solve problems and get work done.
- 4-F-1: Things move in many different ways, such as straight, zigzag, round and round, back and forth, and fast and slow.
- 11-A-3: When parts are put together, they can do things that they couldn't do by themselves.
- 11-C-3: Things can change in different ways, such as in size, weight, color, and movement.

Grades 3-5

- 3-A-1: Throughout all history, people everywhere have invented and used tools.
- 3-A-4: Technology extends the ability of people to change the world: to cut, shape, or put together materials; to move things from one place to another; and to reach farther with their hands, voices, sense, and minds.
- 3-C-4: Scientific laws, engineering principles, properties of materials, and construction techniques must be taken into account in designing engineering solutions to problems.
- 4-F-2: How fast things move differs greatly.
- 11-A-1: In something that consists of many parts, the parts usually influence one another.

