MODULE m2

LIGHT AND LENSES

INTRODUCTION

Module 2, Light and Lenses, is made up of two activities that introduce students to types of lenses and how light is focused in different ways when they use different lenses.

Activity 4: Exploring with Lenses
Activity 5: Looking Through Lenses

In Activity 4, Exploring with Lenses, students will be encouraged to use each of the lenses supplied in the Science, Optics and You package. Students will look at different images, use flashlights to see how light reacts with each of the lenses, and will be asked to draw and write about what they are observing.

Activity 5, Looking Through Lenses, allows students to explore the surface of the lens, focal point, and images that lenses produce. This is a good introduction to concepts of focal point and focal length and allows students to experiment with lenses before moving onto more complex manipulations.

The following interactive web-based tutorials can be used to enhance this module, explain difficult concepts, and enrich the classroom experience: Optical Light Bench, Simple Magnification, Magnifying with a Bi-Convex Lens, http://micro.magnet.fsu.edu/optics/tutorials/index.html

ACTIVITY 4

Exploring with Lenses

Using the sets of lenses in your package, students will be looking at each of the lenses, observing their similarities and differences, and experimenting with light as it passes through each of the lenses. Allowing students to find out for themselves the characteristics of differently-shaped lenses will help them in Activity 5, Looking through Lenses, when they work with only the convex and concave lenses.

MATERIALS:

- ☐ Sets of lenses
- ☐ Science Notebooks
- ☐ Flashlights

WHAT WILL THE STUDENTS DO?

1. In pairs or small groups, students will look at various lenses.
2. In their Science Notebooks, students will write a description of what each lens looks like, what objects look like when viewed through the lens, and other information that they decide is necessary to enhance their understanding of how lenses change the way we look at objects.
3. Students will brainstorm with classmates about uses for the various lenses, answering the question, "How would a scientist use each lens?" and "What instruments can you think of that might use the lenses you looked at?"

EXTENSIONS:

Research. Have students use a variety of media to list scientific instruments and tools that use lenses. Students should list the types of lenses used in each and compare them to the lenses they looked at in this activity.

Research. There are hundreds of American women who kept the lamps burning in lighthouses. Most of these women served in the nineteenth century, when the keeper lit a number of lamps in the tower at dusk, replenished their fuel or replaced them at midnight, and every morning polished the lamps and lanterns to keep their lights shining brightly. Several of these women were commended for their courage in remaining at their posts through severe storms and hurricanes. A few went to the rescue of seamen when ships capsized or were wrecked. Their varied stories provide a unique picture of this profession in maritime history. Students can research and explore the lives of some of the more important women during this time, or excerpts from the book, *Women Who Kept the Lights: An Illustrated History of Female Lighthouse Keepers* by Mary Louise Clifford and Candace Clifford (ISBN: 0-963-64120-4) could be read to the students. After learning about these women, students could write a diary entry describing the daily life of a lighthouse keeper during this time.

Narrative writing. Use the following expository writing prompt.

> *Key West, Florida, has a Wreckers' Museum that tells about how early residents of Key West purposely tried to wreck ships.*
>
> *Think about reasons why someone who lived in an isolated area would want to wreck a ship.*
>
> *Now write a description of what you imagine life as a child of a "wrecker" would be like.*

Writing. Have students determine how life as a lighthouse keeper could be enhanced by technological developments of the last decade (for example, e-mail and the internet). How might life have been different for "wreckers?" Would lighthouse keeping be a more popular career choice if keepers had access to these technological advances?

HISTORICAL VIGNETTE: IDA LEWIS

Idawalley Zorada Lewis, called Ida, was born in Newport, Rhode Island, in 1842. Her father, Captain Hosea Lewis, was a coast pilot and became the first keeper of nearby Lime Rock beacon on a tiny island near Newport. Shortly after he started this job he had a stroke. Ida became responsible for the care of her father and of the light. She filled the lamp with oil at

sundown and again at midnight, trimmed the wick, polished the carbon off the reflectors, and extinguished the light at dawn. After her father died, she received official appointment as lighthouse keeper and continued at that post until she died in 1911.

Because of the many rescues for which she was responsible, Ida became the most famous lighthouse keeper of her day. During her 39 years on Lime Rock, Ida is credited with saving 18 lives, although unofficial reports suggests that the number may have been as high as 25. Many of the newspapers and magazines of the day wrote stories about some of her rescues. President Ulysses S. Grant and Vice President Schuyler Colvax even went to visit her in 1869.

Schuyler Colvax

In 1881 the Annual Report of the U.S. Life Saving Service reported that the highest medal awarded by the Life Saving Service had been presented to Mrs. Ida Lewis-Wilson. Her last recorded rescue occurred when she was 63 years old.

In 1924 the Rhode Island legislature officially changed the name of Lime Rock to Ida Lewis Rock. The lighthouse service changed the name of the Lime Rock Lighthouse to the Ida Lewis Lighthouse, the only such honor ever paid to a keeper.

Activity. Research lighthouses and, if possible, take a field trip to a nearby lighthouse. Have students record similarities and differences among lighthouses that are found in different areas. Lighthouses in southern coastal states can be compared with lighthouses on New England's rocky coast. European lighthouses can be compared with American ones..

ARTIST VIGNETTE: WINSLOW HOMER

Winslow Homer (1836-1910) was an American artist most remembered for his New England seascapes. Homer worked in a variety of media. He created oil paintings of rural early America, was a magazine illustrator of Civil War scenes, and used watercolors to produce his heroic scenes of the sea. He created hundreds of works that are admired for their beauty and depiction of rural American life. Lesser known than his seascapes is a series of tropical watercolors that reflected his winter stays in Florida, the Bahamas, and Cuba.

Homer had a robust sense of humor that is well documented. When visitors came to his studio, he often made his own illustrations the butt of his jokes. Once he put a tin tag on one of his sketches as a hog's nose; when his visitor was not looking, the "nose" became a setting sun. At the beginning of a path that led to one of Homer's favorite spots to paint, Cannon Rock, he place a sign that said "SNAKES! MICE!" so that he would not be disturbed.

Homer's scenes of the sea can serve as a complement for a study of lighthouses as is recommended in this Activity.

Activity. Recently Bill Gates, Chairman of Microsoft, paid a record $30 million for Winslow Homer's last seascape still in a private collection, *Lost on the Grand Banks.* The sale was a private one and was kept a secret until the deal was struck. Have students debate the issue of private versus public art collections and the value of each. You may wish to divide your class into two groups and have them brainstorm the points that they will make in order to defend their position.

ACTIVITY 4

Exploring with Lenses

Each of the lenses that you will use in this activity is different. Observe how each lens is different from the others.

MATERIALS:

- ☐ Sets of lenses
- ☐ Science Notebooks
- ☐ Flashlight

1. With a partner, examine each of the lenses in your package, one at a time.
2. Look at different things around you with each of the lenses. Shine the flashlight on each of the lenses. Compare how things look when you look through each lens.
3. In your Science Notebook list each lens. Then, as you make your observations, write about each of the lenses.

   How do things look through the lens?
   What happens to the light when you shine it through the lens?

4. Draw each of the lenses and label your drawing. Be sure to include a side (profile) view.
5. Write 5 sentences about lenses.
6. List any questions you have about lenses in your Science Notebook.

ACTIVITY 5

Looking through Lenses

A lens is a piece of transparent material with at least one curved surface. The curved surfaces refract, or bend, light rays coming from an object. There are two basic kinds of lenses: convex and concave. Lenses are important in optical devices that use light (including our eyes). Cameras, telescopes, binoculars, microscopes and projectors all use lenses.

Convex lenses are thicker in the middle than on the edges and cause light rays to converge or come together. Things look bigger through a convex lens. A convex lens will concentrate a beam of light on a surface causing it to appear brighter. Convex lenses can focus light and project an image. The point where light rays converge after passing through a lens is called the *focal point*. The distance from the lens to focal point is called the *focal length*.

Concave lenses are thicker on the edges than in the middle. They cave in toward the center. Things look smaller through a concave lens. Concave lenses make light rays bend outward or diverge. A concave lens will spread a beam of light on a surface.

MATERIALS:

- ☐ Plano-convex lens
- ☐ Plano-concave
- ☐ Flashlight
- ☐ White paper
- ☐ Science Notebook

WHAT WILL THE STUDENTS DO?

In this activity students will explore and discover the properties of the two basic types of lenses. Students can work individually, in pairs, or in small groups. This can be an activity guided by the teacher or students can work independently using the Student Page as a guide. After distributing the materials, allow students ample time to explore the materials freely.

Ask students to look closely at the lenses and describe how the lenses are shaped. Introduce the terms *convex* and *concave* for the two different types of lenses. As students discover new things about how we look at objects, have them write their discoveries in their Science Notebooks. Encourage students to do the following:

1. Look through the lenses at the pages of a book, a picture, their hands and other objects.

2. Shine a flashlight through the lenses onto a white piece of paper.

3. Repeat steps 1 and 2 above after combining the lenses.

Have students explain the differences in what they see. Introduce the terms *focus, converge,* and *diverge* for describing the properties of the lenses.

Students will demonstrate how a convex lens can focus light and project an image. Step #5 on the Student Page has students hold a convex lens between an upright piece of paper and the window in a darkened room with a sunlit window. Students place the lens close to the piece of paper and slowly move the lens away from the paper until a sharp inverted (upside down) image of the window appears on the paper. If a sunlit window is not available, students can use a flashlight and any object. Explain that the light causes the inversion of the image from the top of the object being bent and projected to the bottom of image and light from the bottom of the object being bent and projected to the top of the image.

Facilitate a discussion about the uses of lenses. Students should be able to identify a variety of uses including magnifying glasses, eyeglasses, microscopes, binoculars, telescopes, cameras and projectors.

Have students draw and label cross-sectional diagrams of the two types of lenses in their Science Notebooks. Have them describe in writing and with diagrams the projection of an image using a convex lens.

EXTENSIONS:

Research. Using a variety of print and electronic media students can research and write about the different types of lenses and why they have different effects on images that are seen through them. This could include answering the question, "Why do some people need to wear glasses?" and "What is the difference between being near-sighted and far-sighted?"

Activity. After researching how various optical devices work, students can make simple telescopes and microscopes using the lenses. Telescopes and microscopes can be made by using the convex and concave lenses, and cardboard tubes (an empty paper towel tube and a plastic wrap tube work well since one will fit inside the other). Rather than supplying step-by-step instructions, after students have completed this activity, see if they can design their own instruments. Books such as *The Optics Book* (ISBN 0-8069-9947-0) contain many activities that can be done using everyday items.

Activity. Students can study how the lenses of our eyes enable us to see. Students can be challenged to determine what causes near and far-sightedness. Invite an optician to be guest speaker so students can learn how lenses in eyeglasses are used to correct vision. Making a model of the eye and how it works would be an appropriate activity.

Expository writing. Use the following as an expository writing prompt.

> *Movie and slide projectors use lenses to project images on a screen. Think about your experiences with the lenses and how the shapes of lenses bend light in different ways. Now write a description of how lenses are used to project images on a screen.*

Narrative writing. Use the following as a narrative writing prompt.

Magnifying glasses and microscopes are sometimes used to investigate crime scenes. Pretend that an unknown thief has burglarized your classroom. Think of an unusual piece of evidence that could be discovered using a magnifying glass that would identify the thief. Now write a short mystery story about how the evidence helped catch the thief.

HISTORICAL VIGNETTE: AUGUSTIN FRESNEL

In 1822, a French scientist named Augustin Fresnel invented a lens that is now used in lighthouses around the world. The lens looks like a giant glass beehive with a lamp in the center. The lens is made out of rings of glass prisms above and below the lamp that bend and concentrate the light into a bright beam. The Fresnel lighthouse lens work so well that the light can be seen from a distance of 20 or more miles. Before Fresnel's invention, lighthouses used mirrors to reflect the light. These lights could be seen at only short distances and hardly at all during foggy or stormy days. Lighthouses with Fresnel's lenses have saved many ships from going aground or crashing into rocky coasts.

Activities. Lighthouses have always fascinated people. There are a number of books depicting the colorful history of lighthouses. Students can research the history of nearby lighthouses or historic lighthouses. Students can also research other uses of Fresnel lenses (for example, in stage lighting).

Reading. Students can read *Women of the Lights* by Candace Fleming (ISBN 0-8075-9165-3). This book is a compilation of the adventures of some of the 250 women who have served as lighthouse keepers in America.

Reading. Students will also enjoy *The Wreckers* by Iain Lawrence (ISBN 0-440-41545-4). This fast-paced adventure tells a story about shipwrecks, pirates, kidnapping, mystery and ghosts and courage. The story is historically based upon a community on the coast of Cornwall, England during the early 19th century. Wreckers used lights to lure ships to crash on their rocky shores and lived on the loot salvaged from the wreckage.

Florida History. Key West, Florida, was settled originally by "wreckers." A wreckers' museum exists there and there are many documented stories about how the area was settled. This is an opportunity to work Florida history and culture into your science curriculum.

ARTIST VIGNETTE: MICHAEL DAVIDSON

Microscapes: The Art of Photomicrography

Michael Davidson is a scientist at the National High Magnetic Field Laboratory in Tallahassee, Florida, who has developed techniques for creating art photographs by taking pictures through a microscope. This is called photomicrography. Using polarizers, multiple exposures, and other techniques, Davidson has created unusual and colorful pictures that look like dream landscapes or alien worlds. He calls his creations microscapes.

Davidson uses microscopic images of real moon rock slices, vitamin C recrystalized crystals, proteins, DNA and other substances to create his microscapes. He combines these images into artistic creations with titles such as Black Hole in Space, Crystal Forest, Macdonald's on Mars, Mount Meatloaf, and Star Wars. You can see Davidson's creations on the Internet at: http://micro.magnet.fsu.edu/micro/gallery/microscapes/microscapes.html

Activity. After viewing Davidson's microscapes on the Internet, students can create their own microscapes using school microscopes or convex magnifying lenses. Have students examine everyday items such as fingerprints, leaves, a basketball, bark, or food items through the lens. If available, students can view the items through polarizers or a diffraction grating. They can then draw and color various patterns and textures that they see using crayons, markers or paints. Encourage students to be creative in the use of color and names for their microscapes.

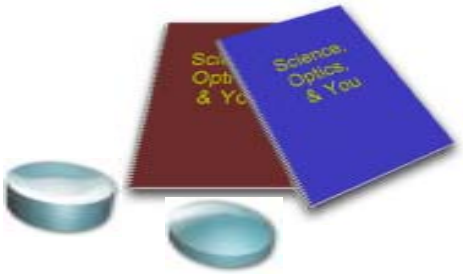
ACTIVITY 5

Looking through Lenses

A lens is a piece of transparent (see-through) material. Lenses are usually made out of glass or plastic and they have special characteristics some of which you explored in Activity 4, Exploring with Lenses. Now you will look at only two kinds of lenses and observe the similarities and differences.

MATERIALS:

- ☐ 2 Convex Lenses
- ☐ 2 Concave Lenses
- ☐ Flashlight
- ☐ White paper
- ☐ Science Notebook



1. Look closely at the lenses and answer these questions in your Science Notebook:

   How are they shaped?
   How are the lenses alike? How are the lenses different?

2. Look through the lenses at different things. Look at the pages of a book, your hands, a hair, and other things. Draw what you see in your Science Notebook and answer these questions. Label each picture with the type of lens with which you observed the object.

   How does a convex lens make things look?
   How does a concave lens make things look?

3. Lenses bend light in different directions. Shine a flashlight through the lenses onto a piece of white paper.

   In what direction do convex lenses bend light?
   In what direction do concave lenses bend light?

4. Shine the flashlight through different combinations of lenses: two convex lenses, two concave lenses, one concave and one convex lens. Draw a picture of what you see in your Science Notebook and answer these questions:

   What happens? Can you use two different lenses to make things far away appear closer?

5. If you can, darken the room and place a convex lens between a sunlit window and a white piece of paper. Place the lens close to the paper then slowly move the lens towards the window. Draw a picture of what you see in your Science Notebook.

6. Design an activity for a younger student that would help you explain to them the difference between a convex lens and a concave lens.

Student SELF-CHECK

MODULE 2: Light and Lenses

Now that you have completed Module 2, follow the directions below as a self-check to see if you need more practice.

1. A window is transparent. What does that mean?

2. Which type of lens has a surface that is curved outward?

3. Which type of lens has a surface that is curved inward?

4. Name three instruments that use lenses?

5. A magnifying lens is a convex lens; does it spread light out or bring light rays together to a point?

6. If you place a convex lens between a window and a white piece of paper, what happens to the image?

7. How do you bring an image into focus using a lens?