RADICAL RAYS

GRADES 3–6

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OVERVIEW:

This lesson focuses on the concept of refraction - the bending of light. Simple experiments using common objects will be employed by students to reinforce the phenomena of refraction through observation and hands-on activities.

ITV SERIES:

Dr. Dad's Ph^3: Optics

LEARNING OBJECTIVES:

The students will be able to

❖define the term refraction

❖explain what happens when light passes through materials of different densities

❖describe what happens when light passes through a lens

❖predict how lenses are used on some instruments

VOCABULARY

refraction
lens
convex lens
focal point

MATERIALS:

- flashlight
- aluminum foil
- clear, plastic food containers
- chalk
- chalkboard eraser
- water
- overhead projector
- magnifying glasses of varying circumferences
- straws
- newspaper picture
- index card
- scissors
- tape
- plastic wrap clear
- plastic glasses
- pencil
- paper

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BACKGROUND:

People first thought light was something that traveled from the eyes to an object and then back again. If the rays from the eyes were blocked then the object could not be seen. During the 1600's people began to understand light through the work of different scientists. Sir Isaac Newton discovered that white light is made up of many colors and theorized that light consists of tiny particles that travel in straight lines. About this same time Christian Huygens, a Dutch physicist, theorized that light consists of waves. Today the nature of light is still debated; but the quantum theory, which was advanced by Max Planck in 1900 and assumes that light has both particle and wave aspects, is most widely accepted.

Light travels in straight lines, but its direction changes when it passes from a medium of one density to another. The bending of light as it passes obliquely from one media to another is known as refraction. The apparent "twinkling" of stars (stars actually do not twinkle) is due to the bending of starlight as it passes though the different shifting layers of hot and cold air in the atmosphere.

Lenses are useful because they are effective light-benders. They are designed to refract light according to the purpose of the optical device in which they are used. The first lens used by man was the one he has in his own eye. The use of this lens has been extended with the aid of many others. Lenses in eyeglasses correct deficiencies in our eyes. Lenses in telescopes extend our view into space. Lenses in microscopes allow us to view minute matter. Lenses in cameras help us record the present for the future.

There are two main types of simple lenses. Convex (or converging) lenses are thicker in the middle than at the edges. Concave (or diverging) lenses are thinner in the middle than at the edges.

PRE-VIEWING ACTIVITIES:

Have students put a straw in a glass half-filled with water. Hold the straw straight up, then move it from side-to-side while observing through the side of the glass. Rest the straw on the lip of the glass. Sketch what is observed on a piece of paper.

Ask: Have you ever seen this occur anywhere else? (swimming pool - diving for coins; aquarium; fishing; dipping for crawfish).

FOCUS FOR VIEWING:

As the video is viewed students should look and listen for an explanation to the question: Why does the straw appear to be broken?

VIEWING ACTIVITIES:

Begin video. **Pause** when Kim says: "Wow! Cool! When the light hits the water it bends down." Review what was shown and what Kim said. Generate discussion on how this concept could explain why the straw appears to be broken. Write the explanation under the sketch that the students made: when light hits the water it bends causing the straw to appear to be broken. Tell students this bending of light is called refraction. **Stop** the video to conduct a hands-on activity.

Working in groups of three, allow students to investigate refraction. Give each group of flashlight, the illumination end of which is covered with aluminum foil which has a small slit; a plastic tray of water; chalk; and 2 chalkboard erasers. Rub the erasers with chalk. Tap them together gently (to simulate the fog in the experiment so the light will be easier to see). Shine the light into the container straight down and at varying angles.

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Students should note that the light beam does not bend when light enters water straight on. However, when light enters at an angle it bends, and it bends different amounts depending on the angle.

Pose the question: "How else can light be bent?" (Allow time for discussion.) Let's continue the video to find out.

Resume viewing the video. **Pause** when Dr. Dad says: "This is a wider glass and the curve on it is just a little bit flatter." Then say: "Let's investigate lenses." (**Stop** the video for another hands-on activity.)

Still in groups of three, hand out 2 magnifying glasses of different sizes per group. Re-define a lens as curved glass which bends light. Explain that a magnifying glass is a type of lens because it is curved glass which bends light.

Direct the students to determine the focal point of their magnifying glasses using the flashlight as the light source. Have students sketch and label their findings. Discuss how different size lenses have different focal pints.

With magnifying glasses and a piece of white paper, have students stand near a wall.

Opposite that wall, position an overhead projector. Using the overhead as a light source, (sunlight streaming through a window serves the same purpose) have two students hold the white paper against the wall, while the third moves the lens back and forth until a sharp image of the overhead (or window) is seen on the paper. The point at which the image is in focus is the focal point.

Students may take turns and try both magnifying glasses. Differences in focal point should be noticed. Looking at the image carefully, students should notice that it is upside down. The convex lens bends the light and causes it to form a small, inverted image.

Tell the students that the eye lens is a transparent disk, convex on both sides and about 1/3 of an inch in diameter. Its shape can be changed by the action of muscles attached to it. When the lens is thin and flat, it can focus on faraway objects. When it is fatter and rounder, it is adapted for closer vision. In some people the lens loses some of its ability to change its shape, and eyeglasses or contact lens are required to change the focal point for a clear image.

Resume viewing the video. **Stop** when Dr. Jong says, "Now we've got what prescription you need." Ask students how many of them have gone through a similar eye exam.

POST-VIEWING ACTIVITIES:

Review sketches of recorded activities. Add definition: (1) refraction (bending of light as it passes from one object to another) (2) lens (a curved glass which bends light) (3) convex lens (a lens which is thicker in the middle than at the edges) (4) focal point (the point at which bent light rays meet.)

Brainstorm to think of other objects besides your eyes which use lenses (ex: camera, telescope, microscope.) Record objects named. Add to this list as your unit on light progresses.

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ACTION PLAN:

Have the students make a magnifying lens.

Give each student an index card, scissors, tape, a newspaper picture, and clear plastic wrap. Cut a hole about the size of a dime in the index card. Cover the hole with plastic wrap. Stretch the wrap as smooth as you can and tape it down.

Put the index card on the newspaper. With the straw from your first activity, put one or two drops of water on the plastic wrap. Look at the newspaper picture. What do you notice? The picture is made up of tiny dots.

Raise the "lens." What do you notice? Invite an ophthalmologist to class to explain how an eye functions.

EXTENSIONS:

TECHNOLOGY:

Build a simple telescope. For the body of the telescope, make two cardboard or poster board tubes. One tube must fit snugly inside the other. Attach a magnifying glass to the open end of each tube with tape or glue. Look through the telescope and slide the tubes in or out until the object you are viewing comes into focus.

MATH:

Make a graph based on experimental data comparing the length of the focal point to the amount a lens curves. Fill five glasses (or jars) of varying circumferences half full of water. Measure and record the circumference of each glass. Rest a flashlight on a book one inch high. Place the smallest glass one inch from the flashlight. Turn on the flashlight. Using a ruler measure the distance from the glass to the focal point. Record that distance next to its circumference measurement. Follow the same procedure for each glass. Once data collection is completed, translate it into a bar or line graph.

LANGUAGE ARTS:

Compile a list of men and women who contributed to advancements in optics. Have students research and report on their lives or read a biography about that famous person and give a book report.

SOCIAL STUDIES:

Research the lives of men and women who contributed to the advancement of optics. Recognize the country of birth or discovery by labeling a world map with the person's name, discovery, and year of discovery.

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