

# Simple Optics: Believing is Seeing

**Grade Level:** Third

**Presented by:** Dawn Stancil, Lincoln Avenue Academy, Lakeland, FL

**Length of Unit:** 7 Lessons

## I. ABSTRACT

Believing is Seeing guides students through the abstract world of light. The activities in this unit will provide students with opportunities to explore ways that visual light behaves. Students will recognize visible light as one form of radiant energy. This light energy travels at particular speeds. Light travels in straight lines and has predictable outcomes when it strikes transparent or opaque objects. Students will use a prism to demonstrate that white light is made up of a spectrum of colors, that various regions of the spectrum emit more heat than others, and may use gelatin lenses to magnify and refract light.

## II. OVERVIEW

A. Concept Objectives: Exploration of visual light

B. Core Knowledge Content: Simple Optics

Light travels at an amazingly fast speed

Light travels in straight lines: demonstrate by forming shadows

What happens when light strikes an object? It depends on whether the object is transparent or opaque.

Reflection: Mirrors - plane, concave, convex

The spectrum; use a prism to demonstrate that white light is made up of a spectrum of colors

Lenses; can be used for magnifying and bending light

C. Skills to be taught: Science skills used include predicting, observing, collecting data, organizing data, interpreting data, measuring, hypothesizing and communicating.

## III. BACKGROUND KNOWLEDGE

Asimov, Isaac. *Light*, Chicago: Follett, 1970

Asimov, Isaac. *Why do Some People Wear Glasses?*, Gareth Stevens, 1993

Brewer, A.C. *Exploring and Understanding Light*, Westchester, IL: Benefic Press, 1970

Cole, Joanna. *The Magic Schoolbus Makes a Rainbow*, New York: Scholastic, 1997

Epstein, Sam and Beryl. *Look in the Mirror*, New York: Holiday House, 1973

Gardner, Robert and David Webster. *Shadow Science*, New York: Doubleday, 1976

Kim, Hy. *Showy Science*, Glenview, IL: Scott Foresman, 1994

Peacock, Graham and Terry Hudson. *The Super Science Book of Light*, New York: Thompson Learning, 1993

Simon Seymour. *Mirror Magic*, Honesdale, PA: Boyds Mill, 1991

Taylor, Barbara. *Bouncing and Bending Light*, New York: Franklin Watts, 1990

## IV. LESSONS

### Lesson One

A. Lesson Objective

1. Lesson Content: Visible light is the portion of the electromagnetic spectrum that our eyes are sensitive to. Light travels in straight lines.

2. Concept Objectives:

Identify several luminous objects (objects that give off their own light)

Identify several nonluminous objects

Know that light can pass through some objects (opaque) and not others (transparent)

3. Skill Objectives: classification, labeling, writing conclusions

B. Materials

Overhead projector

A variety of objects, opaque and transparent, to be used to make shadows

Flashlights, one for each group of four

four index cards, a hole punch, four chalkboard erasers, a flashlight

C. Vocabulary: Ray of light, shadow

D. Procedure:

1. Show the students two flashlights, one lit and the other not. Have the students tell what is different. Explain that objects that give off their own light are called luminous. Ask the students to give examples of other luminous objects and objects that are not luminous. Make a T-chart using their suggestions. Ask the students to classify the variety of objects you have gathered into luminous or nonluminous categories. (10 minutes)

2. Ask the students to explain how nonluminous, opaque objects can help make a shadow (an object gets in the path of a light ray and blocks part of it). Pass out materials (a flashlight and an assortment of objects per group of four). Allow students to make shadows using the objects; encourage them to manipulate the objects to achieve more than one shaped shadow. Have students draw the shapes of the shadows and label the object. (20 minutes)

3. Students should recognize that opaque objects block light, while transparent objects allow light to pass through. Have students analyze the path that light travels. You may demonstrate that light travels in a straight line with a flashlight. Turn the lights off and shine the flashlight across the room. Students will see that the light travels in a straight ray. If it is difficult to see, you may have to create a light cloud of chalk by clapping two chalkboard erasers together. (5 minutes)

4. Punch a hole in the center of four index cards. Place the cards into a slit in the chalkboard eraser so that the cards stand up. Have the students place the cards so that the flashlight may shine directly through the holes in the cards. Turn the lights off and turn the flashlight on. Test the path to see if the light is traveling straight through the holes. Move one of the cards out of line.

E. Evaluation: Have the students write an explanation for why they may not see the light traveling through all four holes.

## **Lesson Two**

A. Lesson Objective

1. Lesson Content: When light strikes a surface, some of the light bounces off. This is reflection. The type of surface that the light strikes determines the type of reflection. When light strikes a smooth surface, the light bouncing off is called regular reflection. If the surface is rough or uneven, it is called diffuse reflection. One surface from which light is reflected is a mirror. Mirrors may be plane, concave or convex.

2. Concept Objective:

Explain reflection

Identify and compare regular and diffuse reflections

Identify plane, concave and convex mirrors

3. Skill Objectives: observation, describing

B. Materials

One spherical ball

Small plastic mirrors (one per group of two)

Metal spoons (one per group of two)

C. Key vocabulary: regular reflection, diffuse reflection, plane, concave, convex

D. Procedure:

1. Demonstrate the bounce of a ball. If you throw it straight down on a smooth surface, it will bounce straight up. If you throw it at an angle, it bounces up at the same angle, but in the opposite direction. If you throw the ball down on an uneven surface, there is no telling which direction the ball will bounce. Tell students that light behaves in the same way.

This bouncing of light is called reflection. When light reflects off of a smooth surface, we can predict where it will bounce. This is regular reflection. When light bounces off an uneven surface, we cannot predict where it will bounce. This is diffuse reflection. Have students make lists of objects that produce regular reflection and those that produce diffuse reflection. (15 minutes)

2. Students probably suggested mirrors produce regular reflection. Explain that a mirror with a flat surface is called a plane mirror. Pass out the small mirrors. Have students write their observations of images they can see in the mirror. They should note that the images are the same size, right side up, and appear as far into the mirror as they are in front of it. They should also note that the image is reversed: right is left and left is right. Tell students that the ray that strikes the mirror is called the incident ray, and the ray reflected is called the reflected ray. The law of reflection states that the angle of incident is equal to the angle of reflection.(10 minutes)

3. Explain that some mirrors are concave, or they curve inward. Demonstrate this by allowing the students to make observations of images reflected from the inside bowl of a spoon. If you turn the spoon around, the image is reflected from a convex mirror. Have students describe the contrast between concave and convex reflections. An example of a concave mirror is the reflective area behind the bulb in a flashlight or a headlight. The mirror allows the bulb's light rays to be thrown in one direction, a beam, instead of light rays going in every direction. An example of a convex mirror is the side mirror on a car or bus or the security mirror in a store. These curve outward, making images appear farther away than they are and the images cover a wider area. (10 minutes)

E. Evaluation/Assessment: Students will be able to describe or illustrate how light behaves when it strikes a surface.

### **Lesson Three**

A. Lesson Objective

1. Lesson Content: Light travels at an amazingly fast speed, 186,000 miles (300,000 kilometers) per second. Light travels at different speeds through different mediums; the more dense the medium, the slower light travels through it, and the less dense the medium, the faster light travels through it.
2. Concept Objective: Observe how light is refracted through different mediums
3. Skill Objective: hypothesize, observation

B. Materials:

One large, clear container (a quart jar works well) per group of four

Two cups water per group

One cup clear cooking oil per group

One twelve inch dowel per group

C. Key vocabulary: refraction, hypothesize

D. Procedure:

1. Distribute materials to students: each group will need one large jar, two cups water, one cup oil, and one twelve inch dowel. Direct one student in each group to observe and describe the dowel (it is a solid, straight stick). All students should record these observations. Ask if there are any other observations. Record these. Have one student measure two cups water and pour it into the jar. Have the next student place one end of the dowel into the water. Students may record their observations. Explain that this bending of the pencil is really refraction of the light being reflected off of the pencil. When light travels through air, it travels faster than it does when it travels through water. When the light slows down, it appears bent, this is refraction. Ask students to hypothesize what they think will happen when oil is added. Next, remove the dowel and have another student carefully add one cup of oil to the water, making sure not to mix the two substances. Place the dowel back into the jar with the oil and water combination. Students should record these observations. (45 minutes)

E. Evaluation/Assessment: Students should analyze their observations and write a conclusion about their investigation. Discuss their conclusions.

#### **Lesson 4**

##### A. Lesson Objective

1. Lesson Content: Lenses are used to bend or refract light rays.
2. Concept Objectives:
  - Know that light can pass through some objects and not others
  - Identify two types of lenses - concave and convex
  - Know that most things that emit light also emit heat
3. Skill Objectives: prediction

##### B. Materials:

Concave lenses  
Convex lenses  
Flashlight  
Hand lenses (magnifying lenses) one for each student

##### C. Key vocabulary: concave lens, convex lens, focal point

##### D. Procedure:

1. A lens is a curved glass or other transparent material. Lenses are used to bend light; light always bends toward the thickest part of the lens. There are two types of lens - concave and convex. Convex lens are thin on the ends and thick in the middle. Show students the convex lens. Demonstrate how light rays enter the lens in straight lines using a flashlight. If necessary, turn off the classroom lights enabling you to see the beam better. If you do this near a dark wall or chalkboard you may move the lens forward and backward until the light rays meet, converge, in a small spot. This is the focal point. Move the lens forward and backward watching the rays spread out, diverge. Distribute the hand lenses. Allow the students to explore, finding the focal point for a variety of objects. Take the students outside. Remind the students that you should never look directly into the sun. Using the light from the sun's rays, hold the hand lens over a dry leaf or a scrap of paper. Without blocking the sun's rays, move the lens forward and back until the rays converge and are focused on a small spot on the leaf or paper. Students will see that the leaf or paper will become scorched or burnt if held there long enough. Caution the students to never hold the leaf or paper in their hands while doing this. Ask the students what they think happened to the leaf or paper. Explain that the light rays converged making an intense spot. Most objects that give off light, also emit heat. Just as the light rays became strong, so did the heat, causing the leaf or paper to burn.

2. Show students the concave lens. Ask them to tell what is different from the convex lens. Seeing that they curve in opposite ways, have them predict what happens to light rays when they enter a concave lens. Demonstrate by shining the flashlight at the lens, what happens to the beam? Show the students what the beam looks like shining on the chalkboard without the concave lens and with the concave lens in the beam. Have them compare/contrast what happens to light shining through the convex and concave lens. Ask what happened to objects' images with the hand lens (convex lens). The images were magnified. Predict what will happen with the concave lens. Hold the concave lens between your eyes and an object. What happens? (30 minutes)

E. Evaluation: Have students examine a drop of water. Explain which type of lens the drop is, and what images will look like through the drop. (10 - 15 minutes)

### **Lesson 5**

#### A. Lesson Objective

1. Lesson Content: Lenses are used to bend or refract light rays.
2. Concept Objective:  
Observe how light is refracted through different lenses  
Identify two types of lenses - concave and convex
3. Skill Objective: prediction

#### B. Materials:

##### **If you are going to allow students to eat the lenses:**

One petri dish per student  
One watch glass per student  
Three packages of gelatin  
Three cups boiling water  
Mixing bowl and spoon  
Access to refrigerator

##### **If you are not going to allow students to eat the lenses:**

One petri dish per group of four students  
One watch glass per group  
One or two boxes gelatin  
One or two cups boiling water  
Mixing bowl and spoon  
Access to refrigerator

C. Key vocabulary: petri dish

#### D. Procedure:

1. One day before lenses will be needed, prepare gelatin. In a mixing bowl, combine gelatin and boiling water. Stir until gelatin is dissolved. Pour gelatin into petri dish. Place the watch glass carefully on top of the gelatin so that it floats. Chill overnight. This will make a concave lens. To make a convex lens, pour the gelatin directly into the watch glass and chill. The next day, you may use the lenses in the petri dish or watch glass, or you may use the lenses without them. To remove the gelatin from the container, run the dish under warm water to melt the surface of the gelatin and allow it to slide out. (These edible lenses may be used in the same manner as the lenses in the prior lesson.)

E. Evaluation/Assessment: Students will differentiate between convex and concave lenses.

### **Lesson Six**

#### A. Lesson Objective

1. Lesson Content: Light as we see it is white. White light is a combination of colors; red, having the lowest frequency, appears at one end and violet, having the highest frequency, appears at the other end. A prism is a piece of clear glass or plastic that forms the spectrum.
  2. Concept Objectives: Observe how a prism refracts light to form a spectrum
  3. Skill Objectives: compare and contrast
- B. Materials:
- Light source
  - One prism per group
  - One sheet of white poster board
  - One large sheet of white construction paper per group
  - Markers (red, orange, yellow, green, blue, and violet)
  - One large bottle of Bubbles, use pipe cleaners or straws to blow bubbles
- C. Key vocabulary: dispersion
- D. Procedure:
1. Hold a prism in the path of sunlight or a bright light. Manipulate the prism until you have a rainbow appearing a flat surface in the classroom. Have a students tape a piece of white poster board over the rainbow, then locate and identify the spectrum. Pass out the prisms, white construction paper, and markers. Have each group make a rainbow on their construction paper. Compare each groups rainbow. The colors of the rainbow will always appear in the same order, this is called dispersion. If you want to combine the colors to make white light again, you may with the use of a hand lens, or magnifying glass. Holding the hand lens between the prism and the construction paper, move it back and forth until the spectrum has been converted back to white light. (20 minutes)
- E. Evaluation/Assessment: 2. Take the students outside and allow them to blow bubbles. Students should be able to see rainbows in the bubbles. (10 - 20 minutes)

### **Lesson Seven**

- A. Lesson Objective
1. Lesson Content: White light is made up of a spectrum of colors.
  2. Concept Objective:
    - Know that light can pass through some objects and not others
    - Know that most things that emit light also emit heat
    - Discover that various regions of the spectrum emit more heat than others
  3. Skill Objective: analyzing data, writing conclusions
- B. Materials:
- Prisms (one per group of four)
  - Thermometers (three per group)
  - Large white construction paper (one per group)
- C. Key vocabulary:
- D. Procedures:
1. On a sunny day, take students outside. Place the construction paper on the ground. Have students manipulate the prism until they have a rainbow on their paper. They may be able to stand the prism on its end on the paper or they may have to hold it in one spot until data is collected. Place a thermometer in the red light, one in the green light and one in the violet light. Check and record the temperature of each thermometer at the beginning and again after five minutes.
- E. Evaluation/Assessment: Analyze the data and write a conclusion.

## **VI. CULMINATING ACTIVITY**

## **VII. HANDOUTS/WORKSHEETS**

Appendix A: Ray Model of Light

## **VIII. BIBLIOGRAPHY**

Asimov, Isaac. *Light*, Chicago: Follett, 1970

Asimov, Isaac. *Why do Some People Wear Glasses?*, Gareth Stevens, 1993

Brewer, A.C. *EXPLORING and Understanding Light*, Westchester, IL: Benefic Press, 1970

Cole, Joanna. *The Magic Schoolbus Makes a Rainbow*, New York: Scholastic, 1997

Epstein, Sam and Beryl. *Look in the Mirror*, New York: Holiday House, 1973

Gardner, Robert and David Webster. *Shadow Science*, New York: Doubleday, 1976

Kim, Hy. *Showy Science*, Glenview, IL: Scott Foresman, 1994

Peacock, Graham and Terry Hudson. *The Super Science Book of Light*, New York: Thompson Learning, 1993

Simon Seymour. *Mirror Magic*, Honesdale, PA: Boyds Mill, 1991

Taylor, Barbara. *Bouncing and Bending Light*, New York: Franklin Watts, 1990