

Make a Rainbow

Strand	Force, Motion, and Energy
Topic	Investigating light
Primary SOL	5.3 The student will investigate and understand basic characteristics of visible light and how it behaves. Key concepts include b) the visible spectrum; e) refraction of light through water and prisms.
Related SOL	5.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which g) data are collected, recorded, analyzed, and communicated using proper graphical representations and metric measurements.

Background Information

Visible light is made up of different wavelengths, and each color has its own unique wavelength. As light hits an object, some light is absorbed and some is reflected. The color of an object is the color of the light it reflects. Grass looks green because when light hits it, the blades of grass absorb all the colors of the light except green, which it reflects. Objects that appear white reflect all colors of light waves, while black objects absorb all colors of light waves.

A rainbow is an example of both refraction and reflection. Sunlight is first refracted when it enters the surface of a spherical raindrop. It is then reflected off the back of the raindrop, and once again refracted as it leaves the raindrop.

The sun is always behind you when you face a rainbow, and the center of the circular arc of the rainbow is in the direction opposite to that of the sun. The rain is in the direction of the rainbow.

A rainbow is made by light bouncing back to you from the inside of raindrops. The raindrops act like a prism. The colors can also be separated when a bright white light is shone through a prism at an angle. Ordinary light, like that from a light bulb or from the sun, is called white light. White light is actually a mixture of six colors.

Light bends when it passes through water. Each color bends a different amount. Short wavelengths, such as blue and violet, are bent more than longer wavelengths, like red, so the colors always separate and appear in the same order or sequence. When white light enters a raindrop, the colors get separated. The white light splits into six colors that you can see. These six colors always appear in the same order: red, orange, yellow, green, blue, and violet (purple). These six colors make the visible light spectrum (“ROY G. BV”). (Most scientists no longer include the color indigo, which used to be included between blue and violet.)

The three primary colors of light are red, green, and blue (R. G. B.: “Roy G. BV’s” initials), which are different from the three primary colors of pigment — magenta (red), yellow, cyan (blue). Light of any color can be made from these three primary light colors, and combining all three primary colors of light produces white light. When colored filters are used, only certain wavelengths pass through, and the others are absorbed. For example, when a red filter is used

over a light, only red light passes through, and objects appear to be either shades of red or black.

Materials

- A glass of water (about three quarters full)
- White paper
- A sunny day or an overhead projector
- Assorted prisms
- Copies of “Rainbow” worksheet
- Watercolors
- Paintbrushes
- Copies of “Refraction” Worksheet

Vocabulary

rainbow, visible spectrum, white light, reflection, refraction, electromagnetic spectrum

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Ask the students what they know about rainbows. After students respond, explain that “Rainbows appear when the sun is shining and it's raining at the same time. That doesn't happen very often. But you don't have to wait to see rainbows—you can make them yourself.”
2. Model the following experiment:
 - a. Take the glass of water and paper to a part of the room with sunlight, or if it is not a sunny day, use an overhead projector or bright light. (*Note: If the windows have UV film on them, this experiment will need to be conducted with an overhead projector or other bright light.*)
 - b. Hold the glass of water (being careful not to spill it) above the paper and watch. As sunlight passes through the glass of water, it refracts (bends) and forms a rainbow of colors on your sheet of paper.
 - c. Try holding the glass of water at different heights and angles to see if it has a different effect. Ask the students to explain what they think is happening. (*Rainbows form in the sky when sunlight refracts (bends) as it passes through raindrops. It acts in the same way when it passes through your glass of water. The sunlight refracts, separating it into the colors red, orange, yellow, green, blue, and violet.*)
3. Ask students to brainstorm other situations you might find a rainbow other than when it is raining. (e.g., waterfall, sprinkler, or water fountain)

Procedure

1. Have students complete the same activity the teacher has just modeled in small groups of two or three and complete the Rainbow Activity Worksheet independently. Students will also need to use the watercolors and paintbrushes to complete this activity.
2. When students have completed the Rainbow Activity Worksheet, distribute copies of the Refraction Activity Worksheet.

3. Allow students to experiment with the effect of prisms on light as they try different ways to cause the light to bend and make rainbows.
4. Instruct students to draw at least three discoveries on their worksheet. Have them write at least three sentences beside each drawing explaining what they discovered about how light is bent. Students will complete the Refraction Activity Worksheet independently.

Conclusion

1. When both activities are completed, have students find a partner with whom to go over their answers. If students have different answers, allow them to add the other students' observations to their worksheets.

Assessment

- **Questions**
 - What observations did you make when creating a rainbow using a glass and water?
 - What observations did you make when creating rainbows using a prism?
 - How is light bent?
 - What is refraction?
- **Journal/writing prompts**
 - Have the students write two to three paragraphs about what they have learned about light from making rainbows.
 - Have the students create a graphic organizer that displays what they know about light and color.
- **Other**
 - Use the completed worksheets to assess student understanding.

Extensions and Connections (for all students)

- Give each student an 8-inch circle made from white poster board, and have students use rulers to mark several pie-shaped sections on them. The sections do not have to be equal in size. Then have each student color the sections differently so their circle is not like anyone else's. Next, have the students predict whether their "color wheels" will appear (reflect) white or black when spun around at high speed. After they have written their predictions, tape each wheel to the end of one beater of a hand mixer, and spin the wheel. Have the students compare the colors they see with their predictions and explain the results.
- Have students use fine-tipped markers in red, yellow, and blue to make a pointillist painting — i.e., they may use only small dots of these colors to create their picture, but they may apply different colors over the top of each other (e.g., make green by applying yellow and blue dots on top of each other).
- Have students use a magnifying glass to look closely at a television picture to see the lines of very small red, green, and blue dots.
- Set up a hose with a spray nozzle outside and put a fine mist of water in the air to create a rainbow for students to identify the colors in the rainbow.

Strategies for Differentiation

- For students needing an additional challenge, have them explain why the sunset is orange and red and the water is blue using the principles of refraction. What properties of visual light make that possible?
- Create a drawing of ROY G BV. He will have red hair, an orange head, a yellow neck, green arms, blue shirt, violet pants, and small white shoes. Try to exaggerate big at the top, small at the bottom.
- Have students use spray bottles to produce a mist of water outside at different times during a sunny day and record their observations.
- Challenge the students to capture a rainbow on film by producing a rainbow at home or observing one in the sky.

Rainbow Activity Worksheet

Name: _____ Date: _____

Write at least three sentences explaining why rainbows happen. You must include a list of the colors of the rainbow in the order they appear from top to bottom.

Look at the refraction of the water through the glass, and draw the colors you see.

How is this similar to a rainbow?

Using only red, yellow, and blue watercolors, paint a rainbow below with the correct colors in the correct order.

Refraction Activity Worksheet

Name: _____ Date: _____

Experiment using various prisms to bend a strong light. Draw in detail and explain beside each drawing three discoveries you made when using the prisms.






