



## Islands in the Stream 2002: Exploring Underwater Oases

# Blinded by the Light

### Focus

Reflection, absorption, and scattering of light in the ocean

### Grade Level

9-12 (Physical Science)

### Focus Question

How is it possible for a fish to look one color in deep water and a different color above the water in bright sunlight?

### Learning Objectives

Students will recognize that the colors they see are a result of the reflection of light and that other colors of light are absorbed.

Students will predict what color an object will appear when light of different colors is shined upon it.

Students will predict what color(s) will be produced when different colors of light are mixed.  
Students will identify the three primary colors and three secondary colors of light.

### Additional Information for Teachers of Deaf Students

Words listed as key words have no formal signs in American Sign Language and many are difficult to lipread. The activity itself is very visual and should be very easy for deaf students to follow.

### Materials

- 1 piece of red color filter or plastic wrap

- 1 piece of blue color filter or plastic wrap
- 1 piece of green color filter or plastic wrap
- 1 piece of magenta\* filter
- 1 piece of cyan\* filter
- 1 piece of yellow\* filter
- 1 red marker
- 1 blue marker
- 1 green marker
- 1 yellow marker
- 8" x 11" white copy paper, 3 pieces per group of students
- 1 red apple
- 1 green apple
- 1 banana
- 1 blueberry
- 1 lime
- Any other colored fruit/object

\* If you do not have access to these filters in your physics laboratory, they can be purchased from Arbor Scientific, POB 2750, Ann Arbor, MI 48106-2750, 1.800.367.6695 (Product ID 33-0190, Category Light and Color, Color Filters Kit, \$12.00)

### A/V Materials

None

### Teaching Time

One 90-minute class period

### Seating Arrangement

Groups of 2-3 students, depending on available materials

### MAXIMUM NUMBER OF STUDENTS

Varies depending on available materials

### KEY WORDS

Wavelength  
Primary colors  
Secondary colors  
Reflection  
Absorption

### BACKGROUND INFORMATION

Many students will claim that an apple will appear red even in the absence of light. This is a common misconception. This activity is designed to help students fully understand why they see the colors they do. White light or light from the sun or a light bulb consists of all wavelengths or colors. Students may be familiar with ROYGBIV, which stands for red, orange, yellow, green, blue, indigo, and violet. However, students are not often familiar with the concept of primary and secondary colors of light. The primary colors of light are red, green, and blue. The secondary colors of light are yellow, magenta, and cyan. Secondary colors are produced by combining two primary colors. For example, to produce yellow, green and red are combined. To produce magenta, red and blue are combined and to produce cyan, green and blue are combined.

Objects appear certain colors because of the colors they either reflect or absorb. For example, a blue racquetball appears blue because it reflects blue wavelengths of light and absorbs all others (red and green). Objects that appear white appear so because they reflect all wavelengths of light and objects that appear black appear so because they absorb all wavelengths. This is why black is sometimes defined as the absence of color. Under blue light, an apple will appear black because it absorbs the blue light and has no red light to reflect. In contrast, if magenta light is shined on the apple, it will appear red because magenta light is comprised of red and blue light. The blue light will still be absorbed, but the red will be reflected.

### LEARNING PROCEDURE

1. Pose this question to students: "What color will an apple be in the dark? Some will most likely answer red! Ask students to consider why the apple appears that particular color. Lead a discussion of why we see colors and how pigments reflect and absorb colors.
2. Now, pose this question to students: "What color will an apple look under red light?" Discuss why the apple reflects red light. This is the reason it appears red.
3. Now, pose this question to students: "What color will an apple look under blue light?" Discuss why the apple absorbs all other colors than red. The apple should appear black.
4. Give each group of students three pieces of white copy paper. Have them cut each piece into 3 pieces so they have a total of nine smaller pieces of paper. On three of the smaller pieces they should write the word "Red" using the red marker. Remind them to be sure their letters are fairly large. Have them repeat this process with the blue and green markers.
5. Now students should take the red, green, and blue color filter or plastic wrap and place one red, blue, and green word from Step #4 under the red, green, and blue color filters. Students should now observe the colors they see. The words that match up with the color filter should appear that color. For example, the red filter should allow you to see the word red as red. However, the words blue and green under the red filter should appear black. Students may not immediately recognize this and you may need to point this out to them.
6. Students should now place each of the three colored words under the magenta, cyan, and yellow filters. Since these are secondary colors, two of the colored words should appear the color of the filter and one should appear black. For example, under magenta the red and blue words should appear the appropriate red and blue, but the green word should appear black.

7. Students should predict what color a word written in yellow (a secondary color) will appear under each of the colored filters. After they have predicted, they should test their predictions.
8. Now, have the students predict what color each of the fruits will appear under each of the six colored filters. It may help to place the fruits in a shoebox and then place the fruit in the box with the filter on top.
9. Have students discuss the answer to the Focus Question from Page 1 of this activity (How is it possible for a fish to look one color in deep water and a different color above the water in bright sunlight?). Give them the following example: A fish was recently discovered in deep water off the coast of South Carolina. Under water, the fish was white with black bands, however when the fish was brought to the surface, it was white with red bands. Ask students why the bands would appear black in deep water, but red on the surface. HINT: Red light has the lowest energy of all colors and is therefore absorbed by water near the surface. The light that has the highest energy is near the blue range and, therefore, penetrates much deeper. The red bands absorb the blue light that reaches them and are unable to reflect any red light because no red light reaches this particular depth in the ocean.

### THE BRIDGE CONNECTION

<http://www.vims.edu/bridge/chemistry>  
<http://www.vims.edu/bridge/physics>

### THE "ME" CONNECTION

Ask students to design a fish or marine organism that would look one color when found in deep water and another color at or near the surface of the water. Remind students that colors having low energy (red, orange, yellow) are absorbed by water first and that colors having high energies (violet, blue, indigo) penetrate much, much deeper into the water.

### CONNECTIONS TO OTHER SUBJECTS

Physics/Chemistry, Art

### EVALUATION

Provide students with one piece of paper having pictures or words of different colors (try to stick to primary and secondary colors). Ask them to predict what color(s) will be visible under each of the six color filters. Be sure to have them identify when a particular color is reflected and when one is absorbed.

### EXTENSIONS

Have students research how the eye is able to detect color and the intensity of light using rods and cones.

### RESOURCES

<http://www.oceanexplorer.noaa.gov>  
<http://www.biolum.org>  
<http://www.bioscience-explained.org>

### NATIONAL SCIENCE EDUCATION STANDARDS

#### Content Standard E: Science and Technology

- Abilities of technological design
- Understandings about science and technology

#### Content Standard B: Physical Science

- Structure and properties of matter
- Interactions of energy and matter

### FOR MORE INFORMATION

Paula Keener-Chavis, National Education  
Coordinator/Marine Biologist  
NOAA Office of Exploration  
Hollings Marine Laboratory  
331 Fort Johnson Road, Charleston SC 29412  
843.762.8818  
843.762.8737 (fax)  
[paula.keener-chavis@noaa.gov](mailto:paula.keener-chavis@noaa.gov)

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<http://oceanexplorer.noaa.gov>

**Student Handout**

## Data Sheet

Name \_\_\_\_\_

Fill in what color each appears under the particular filter. The pigments or words written by the marker appear on the left and the colored filters appear across the top.

	Red Filter	Blue Filter	Green Filter	Cyan Filter	Magenta Filter	Yellow Filter
Red Pigment						
Blue Pigment						
Green Pigment						
Yellow Pigment						

Fill in what color each fruit appears under the particular filter.  
The fruits are listed on the left and the filters across the top.

	Red Filter	Blue Filter	Green Filter	Cyan Filter	Magenta Filter	Yellow Filter
Red Apple						
Banana						
Green Apple						
Blueberries						
Lime						

## Student Handout

### Student Data Sheet Answers

Fill in what color each appears under the particular filter. The pigments or words written by the marker appear on the left and the colored filters appear across the top.

	Red Filter	Blue Filter	Green Filter	Cyan Filter blue + green	Magenta Filter red + blue	Yellow Filter green + red
Red Pigment	red	black	black	black	red	red
Blue Pigment	black	blue	black	blue	blue	black
Green Pigment	black	black	green	green	black	green
Yellow Pigment	red	black	green	green	red	yellow

Fill in what color each fruit appears under the particular filter.  
The fruits are listed on the left and the filters across the top.

	Red Filter	Blue Filter	Green Filter	Cyan Filter	Magenta Filter	Yellow Filter
Red Apple	red	black	black	black	red	red
Banana	red	black	green	green	red	yellow
Green Apple	black	black	green	green	black	green
Blueberries	black	blue	black	blue	blue	black
Lime	black	black	green	green	black	green

Add more rows as desired for additional fruits or objects.