Activity Description & Estimated Class Time

This lesson consists of one 50-minute session. Students mix colored light to produce white light and investigate how light combines to make colors. Students investigate our perception of color and its relationship to the electromagnetic spectrum.

Correlations to NC Science Standards

PS.6.3.2 Carry out investigations to conclude the relationship between the electromagnetic spectrum (including visible light) and sight.

Learning Target

Students will demonstrate knowledge and understanding of the following ideas and content:

- visible light is a section of the electromagnetic spectrum that human eyes can see.
- A quality of electromagnetic waves that distinguishes one from another is the speed at which it vibrates.
- The electromagnetic waves we cannot see are vibrating too slow or too fast for our eyes to register.
- Ordinary light is usually composed of multiple waves vibrating at different rates, and white light is composed of all of the wavelengths in the visible range.

Students demonstrate this knowledge and understanding by using three color filters and flashlights to make many different colors. They also use their own words to describe colors in terms of the colors that do (and do not) make them up.

Brief Science Background

Electromagnetic waves are made of fluctuating electrical and magnetic energy. With our senses, we cannot perceive them as waves, such as a wave on the water. In fact, most electromagnetic waves are invisible altogether. A quality of electromagnetic waves that distinguishes one from another is the speed at which they vibrate. The electromagnetic waves that vibrate too slowly to see include radio waves and radiant heat. Those that vibrate too rapidly to see include ultraviolet light and x-rays. Only a narrow band in the middle of the spectrum is visible to human eyes. Ordinary light is usually composed of many different waves vibrating at different rates. White light is composed of all of the wavelengths in the visible range. Our eyes have receptors for only three colors: red, green, and blue, which span all of the wavelengths in the visible range. Our brains combine the signals from these three receptors to make all of the colors that we see.

Mixed Colored Light and Shadows

Materials

Materials for three students

- 3 flashlights
- 1 piece of black construction paper in which to cut a 2-inch circle
- 1 set of 3 pieces of transparent colored plastic: red, green, blue
- 3 rubber bands
- 1 3-inch paper plate
- 1 toothpick

Materials cont.

- 1 cotton swab
- 1 copy of Student Instructions (SD 1)
- Light and the Electromagnetic Spectrum Student Activity Sheet (SD 2), 1 per student
- scissors (to be supplied by teacher)

Preparation

Make the light dim but not completely dark.

Procedure

1. Have each student try each flashlight and record what they see on SD 2.
2. Ask students what they think they will see when they turn on a flaslight covered with a red filter? blue filter? green filter?. They will document their answers and reasonings on SD 2.
3. Have students follow the directions 1-4 on SD 1. Students will cover the lenses of three flashlights each with a different colored piece of colored plastic. They will hold the plastic in place with rubber bands. They will also cut a 2-inch hole out of the center of a piece of black paper, poke a hole in the center of a paper plate, place the paper plate face down, then center the hole in the black paper over the plate.
4. Have students predict what they will see. After they do this, dim the lights, and ask students to follow direction 5 on SD 1. Each team member (3 per team) will shine a colored light on the circle in the black paper, evenly spreading the flashlights around the circle. Afterward, turn on the room lights and ask each student to record what they saw on SD 2.
   Most but not all will record seeing white light in the circle. They should record whatever they see.
5. After recording what they have seen, ask students to follow direction 6 on SD 1. Students will push the cotton swab into the hole in the plate so that the swab stands straight up. They will place the black paper back over the plate in the same position.
6. Have students discuss how this set up is different. What might be the same? What could be different?
7. Dim the room lights and have students follow directions 7-8. Students will shine the three colored lights on the white circle and record the colors of the three shadows and their locations relative to the positions of the three colors of flashlights.
   Most students will be surprised by a cyan, magenta, and yellow shadow. Yellow will be opposite the blue light. Magenta will be opposite the green light. Cyan will be opposite the red light.
8. Finally, students are challenged to make yellow, cyan, and magenta light on the paper plate without using the cotton swab to make a shadow. Be sure each student records the colors they used to do this.
9. Have groups answer questions 8 and 9 on SD 2 and discuss as a class.

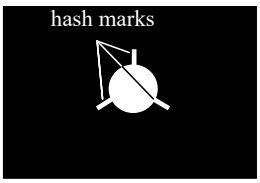
Content Connection

1. What were the colors of the shadows? Why do you think they were those colors? Cyan, magenta, and yellow. In each shadow, only 2 of the colors are blended, and the 3rd color is blocked out. Ask students which color is blocked for each color of shadow.
2. To make the three other colors, how did you decide which color flashlights to use? Ask each team to describe the cyan, magenta, and yellow light in terms combinations of red, green, and blue light.
3. Ask each team to come up with an argument from this evidence that white light is composed of a combination of colors.

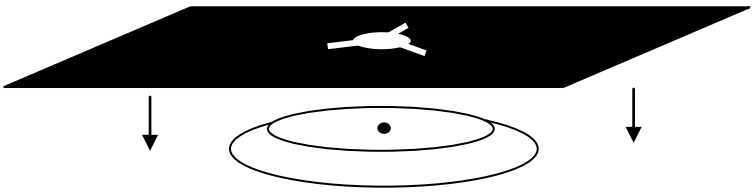
SD 1
pg. 1 of 2

Student Instructions

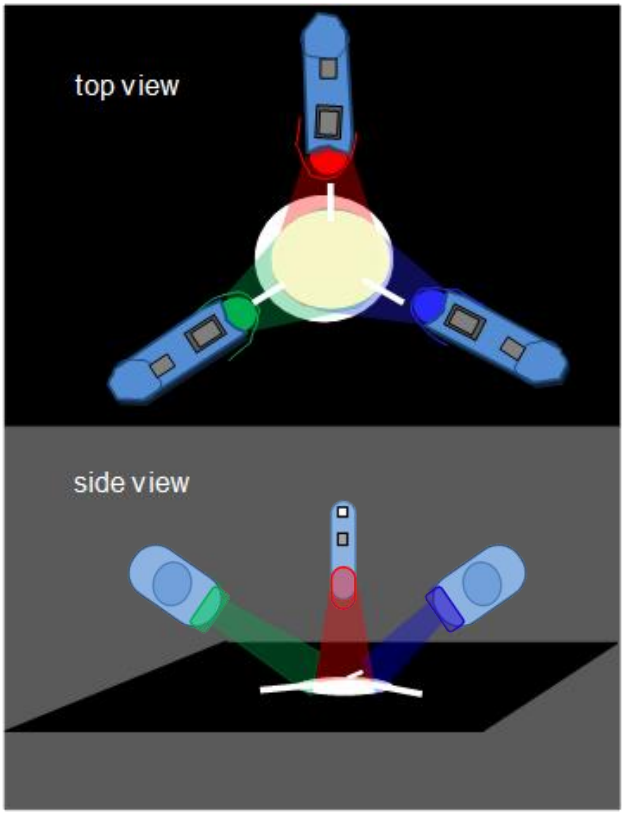
1. Cover a flashlight lens with the red filter and hold it in place with a rubber band. Do the same with another flashlight and the green filter, and a third flashlight and the blue filter.
2. Cut a 2-inch hole in the center of the black paper sheet and divide the circle into even thirds with white hash marks about 120° apart.



3. Poke a small hole in the center of the paper plate with a toothpick.
4. Place the paper plate face down on your workspace so that everyone on the team can reach it. Put the black paper over the plate with the hole centered over the plate.



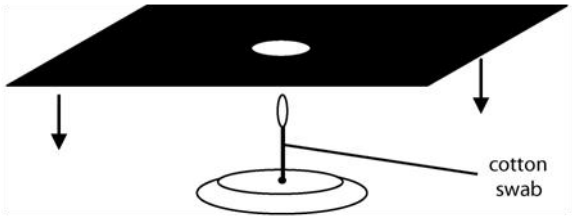
5) Hold each of the three flashlights above a hash mark on the setup as shown, 6 inches above the table. Angle the light to shine on the circle in the black paper. Try to get all flashlights at the same distance and angle. Record what you see on your activity sheet.

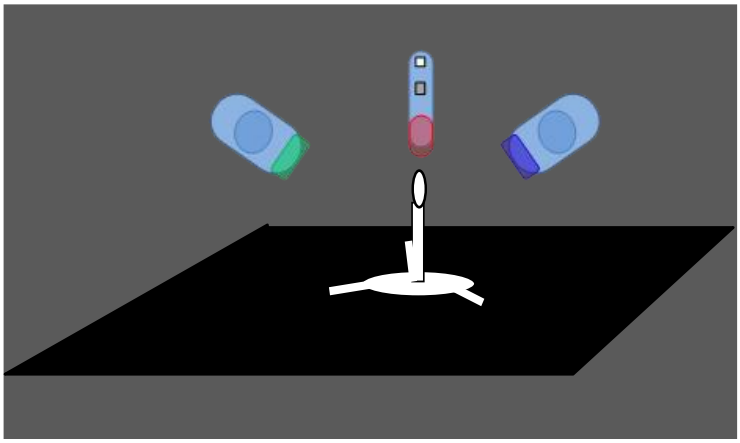


SD 1
pg. 2 of 2

Student Instructions

6) Turn off the flashlights. Uncover the paper plate. Push the cotton swab into the hole in the plate so that the swab stands straight up. Place the black paper over the plate in the same position as before as shown below:





7. When the teacher dims the lights, shine the three colors on the circle in the paper the same way you did before, with the flashlights over the hashmarks so that white light appears on the plate. On your activity sheet, record the colors of the three shadows and their locations relative to the positions of the three colors of flashlights.
8. Use what you have learned to make yellow light appear on the paper. Try it, and record how you did it. Do the same to make cyan and magenta, and record the colors you used.

SD 2

Light and the Electromagnetic Spectrum
Student Activity Sheet

Name:

1. Try each flashlight and record what you see.

2. What do you think you will see when you turn on a flashlight covered with a red filter? Blue filter? Green filter? Why?

3. Follow your teacher's directions for covering the flashlights, and assembling the set up for the experiment. Before beginning the experiment, predict what you will see this time.

4. Record your observations. Why do you think this occurred?

5. Follow your teacher's directions to assemble the set up for the second experiment. How is this set up different? What might be the same? What could be different?

6. Record your observations. Why do you think this occurred?

7. Remember that light travels as a wave. What things did the light waves interact with in these experiments?

8. How do you think the waves of different colors are the same and different?