Middle School Science Experiment

Color Theory

The human eye distinguishes colors using light sensitive cells in the retina. These sensors are rods and cones. The rods give us our night vision and can function in low intensities of light, but cannot distinguish color. The cones let us see color and can resolve sharp images. The light we see, such as the light from the sun, is made up of a mixture of several colors. You will learn more about light as well as about primary and secondary colors in this experiment.

Objectives

In this experiment, you will:

- Gain an understanding of primary and secondary colors
- Learn about how a mixture of colors makes up white light
- Experiment with the mixing of paint that uses pigments, not light
- Take pictures of various colors and compare them when they are mixed and separated

Materials

- Power Macintosh G3 or better
- ProScope Digital USB Microscope and software
- Red, blue, and green cellophane or plastic filters
- Three flashlights
- Red, yellow, and blue watercolor paint
- Paintbrush
- Water

Procedure

The first activities involve light and primary colors:

1. Cover one flashlight with red cellophane, one with blue cellophane, and one with green cellophane. (You can use red, blue, and green plastic filters instead of the cellophane.) Darken the room and set up the ProScope USB microscope on the tripod pointing at a piece of white unlined paper.
2. Shine the green flashlight at the white paper. Take a picture of this image using the m0W lens. Next, shine the red flashlight on the same spot so that the colors in the two images overlap about halfway. Take a picture of this. What new color is made where the colors overlap?
3. Shine the red light on the paper. Take a picture. Shine the blue light on the red light so the two overlap. Take a picture of this image. What new color is formed due to the overlap?

4. Repeat this process using the green light and the blue light. What color is formed now?

5. Using all three flashlights, try to make a white light. Explain what you did to try to accomplish this. Were you successful in your attempt?

   The next activities involve mixing paint to form secondary colors. You will need red, yellow, and blue paint.

6. Draw a circle with six equal sections. This drawing represents a color wheel. Using the three watercolor paints, color the top section red, skip a section and color the third section yellow, skip another section and color the fifth section blue. You should now have every other section colored. Take a picture of your color wheel using the ProScope USB microscope.

7. On an extra piece of paper, mix the colors to get orange. Fill in the blank space between the red and yellow colors. Mix the paint to get green. Fill in the blank space between the yellow and the blue colors. Mix the paint to get violet. Fill in the last blank space between the blue and the red colors. Take a picture of the completed color wheel using the ProScope USB microscope.

8. What colors did you use to create the orange color? Violet? Green? What color did you get when you mixed all of the primary colors?

9. What color do you think you would get if you mixed different amounts of blue and yellow? Start with the yellow color first and add the blue color a little at a time. With the microscope, take a picture of your result. Next, start with the blue color and add the yellow color a little at a time. Did you notice a difference in the results of the combinations?

10. The colors in the color wheel that are directly opposite of each other are called "complementary colors." These colors are the hues that are as different as they can be from each other. What are the three sets of "complementary colors"? Complementary colors can be used to change the brightness of other colors. If you add blue to orange, it will still be orange, but not as bright. Using the ProScope USB microscope, take before and after pictures of the complementary colors as you mix them. Compare the resulting colors from both your paints and the pictures.

Data/Processing the data

Keep a journal or record of all of your observations and pictures taken with the ProScope USB microscope. Include answers to the questions asked in each section of the experiment. The conclusion should summarize the information on color. Compose a diagram to show your results of the cellophane flashlight activities.

Extensions

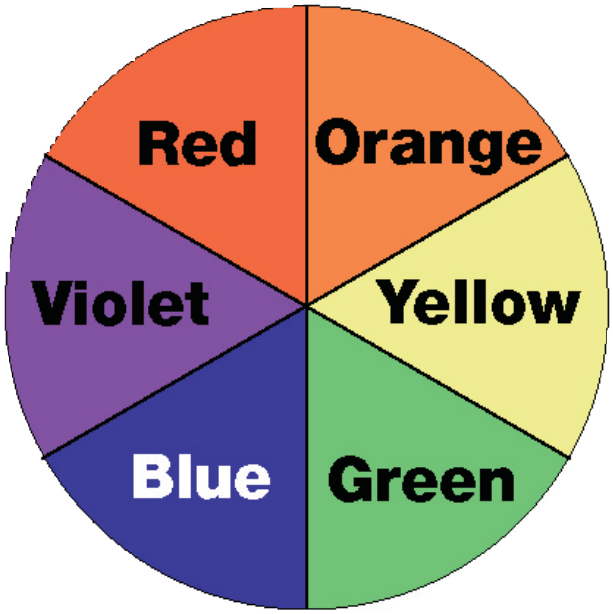
- For further study on colors, visit the following website: http://www.members.cox.net/mrsparker2/index.htm. This site provides specific information and activities on colors.
- There are also many optical illusions that you can investigate when you study light and color. An Internet search will provide you with many good websites on optical illusions.

Teacher information

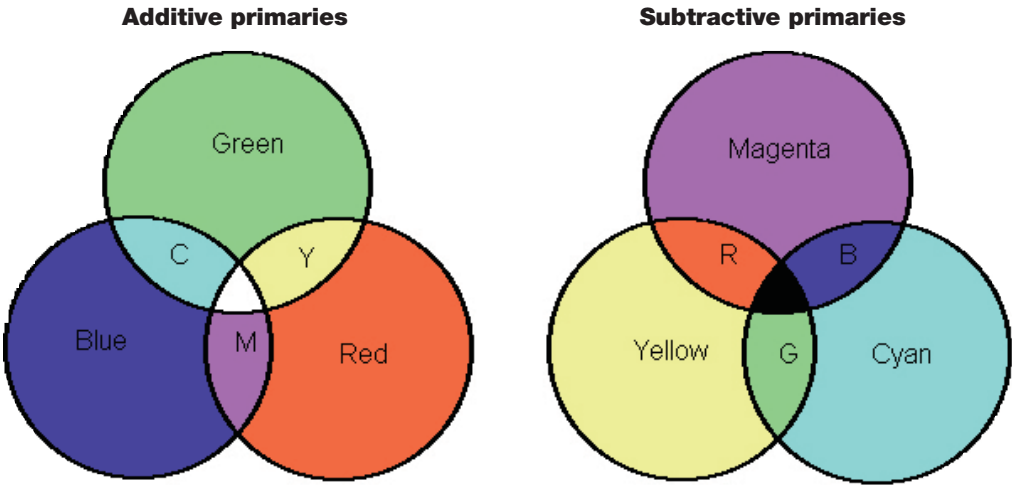
- When we look around, the thing we notice most about light is color. We see color because of the way it is either reflected or absorbed. We see the color green because all of the other colors are absorbed and green is reflected. Our eyes see the reflected color green.
- Color comes from the visible spectrum of light. White light can be separated into the colors of the spectrum, which are red, orange, yellow, green, blue, indigo, and violet. (You can remember the order of light separation from a prism or in a rainbow by "ROY G. BIV.") The primary colors are red, yellow, and blue. These colors cannot be mixed from any of the other colors. From these three primary colors, every other color of light can be made. The secondary colors are orange, green, and violet.

The color wheel shows the primary and secondary colors.

It is laid out so that any two primary colors (red, yellow, and blue) are separated by the secondary colors (orange, violet, and green), and secondary colors are separated by the primary colors.



- Printers and artists have different definitions for primary and secondary colors because paint mixes differently than light. The color mixing of paints is done by pigments in the paint, not by light.
- The activity using the cellophane is done with the additive primary colors. These colors, red, blue, and green, form white light when they all overlap.



The colors formed where the two light beams overlap are called the "subtractive colors." They are yellow (red + green), magenta (red + blue), and cyan (blue + green). These colors are often used to form photographs or ink dyes. Colored cellophane works as a filter on the light to block or absorb some colors and allow others to pass.

Answers to questions

The answers to all of the questions can be found on the color wheel or on the additive primaries diagram.

In the cellophane activity:

Green + Red = Yellow

Red + Blue = Magenta

Blue + Green = Cyan

In the paint activities:

The color wheel shows the colors in the correct order. Mixing the blue and the yellow should produce varieties of both color combinations. The complementary colors produce shades of the colors.

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