

Main Topic	Light & Color
Subtopic	Color
Learning Level	Middle
Technology Level	Low
Activity Type	Student

Description: A hands-on experiment in which students combine colored beams of light and develop color addition rules.

Required Equipment	Light Box and Optical Set
Optional Equipment	

This lab is excerpted from *Light and Color Teacher's Guide* (Arbor Scientific P2-9560). The diagrams allow students to use the Light Box and Optical Set (Arbor Scientific P2-9561) directly on their lab pages.

Color—AB2—Color Addition

Teacher's Notes

Educational Objectives

- To learn the primary additive colors and how they add.
- To learn the complementary colors.

Key Questions

- How do the primary additive colors combine?
- How do complementary colors combine?

Concept Overview

The spectrum formed in the previous lab showed many colors, but there are specific regions of interest. Figure 1 shows the colors, the regions of interest, and the overlap of the regions.

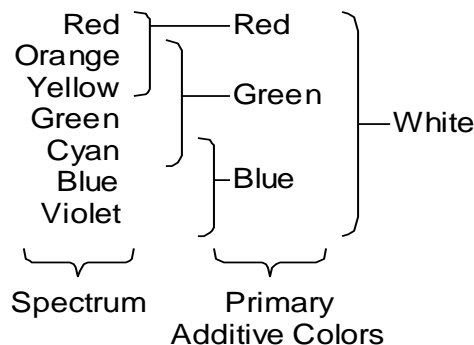
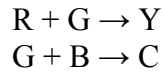


Figure 1

This figure suggests that white light is made up of red, green, and blue light and that other colors are the result of mixing various amounts of these colors.

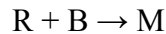
Primary Additive Colors

From the figure, you can see that red and green overlap to form yellow or orange. Green and blue overlap to form cyan. We can write this in short hand notation simply as



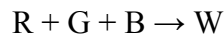
Orange is also made by combining red and green, but with a higher proportion of red to green.

Notice that the red and blue regions of the spectrum do not overlap. The red is at one end (long wavelength) of the visible spectrum, and the blue is at the other end (short wavelength) of the visible spectrum. If we add these two colors, the result is a color that does not appear in the spectrum, magenta (hot pink).



Violet light is.....

The three primary additive colors comprise the entire spectrum. If we add all three colors, the result is white.



The combinations of the primary additive colors can be summarized with the following diagram:

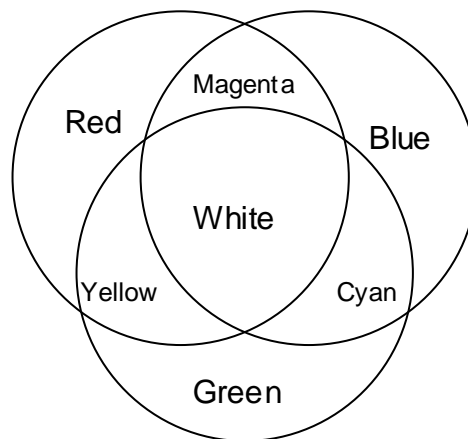


Figure 2

Complementary Colors

Complementary colors are two light colors that add together to produce white. Cyan is made of green and blue, so if red is added to cyan the result should be white. Cyan and red are complementary colors since they add to give white. The complementary colors are summarized below:

$$\begin{array}{lll} G + B \rightarrow C & C + R = (G + B) + R \rightarrow W & C \text{ and } R \text{ are complementary.} \\ R + G \rightarrow Y & Y + B = (R + G) + B \rightarrow W & Y \text{ and } B \text{ are complementary.} \\ R + B \rightarrow M & M + G = (R + B) + G \rightarrow W & M \text{ and } G \text{ are complementary.} \end{array}$$

Notice that in the addition of light summary figure (Figure 2), R and C are opposite each other with W between. Each color in the figure is directly opposite its complement, with white between.

Your students will use the light box and color slides to check the addition of complementary colors.

Techniques

A darkened room will make observations easier.

Use the end of the light box with the mirrored doors. Color filters are inserted in the three slots so that one color is projected out the end of the box, and one color is reflected in each mirror.

Color filters vary in quality. The filter that is placed in the end of the box (without the mirror) will be projected slightly stronger than the others. For instance, a strong red filter placed in the center slot may yield, instead of white light, a slightly red light. You may want to try different arrangements of filters to see which gives the best results.

You may want to show students the color filters and have them learn the names of the colors before beginning this activity. Magenta and cyan will be important, and they may not be familiar with these colors.

Color Addition

Goals

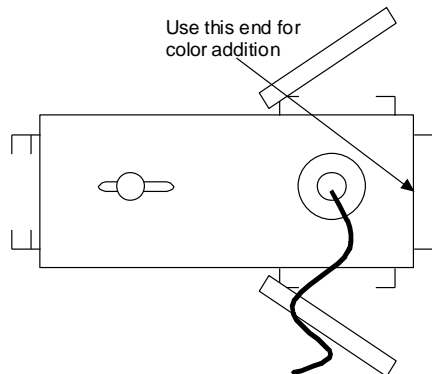
- To learn the primary additive colors and how they add.
- To learn the complementary colors.

Materials

- Light box
- Power supply
- Color filters (Red, Green, Blue, Yellow, Cyan, Magenta)
- Mask
- White index card (or other type of small screen)

Procedure

1. Plug the light box into the power supply. For this experiment, you will use the end of the light box *with* the swinging doors.



2. Insert the red, green, and blue filters in the slots at the end of the light box, one on each side. You can turn off a side light by closing the door, and you can turn off the front light by inserting a mask.
3. Turn on the power supply. Beams of colored light should be projected from the light box.
4. Support your index card (or other screen) so that the colors can be projected onto it.

Color Addition

Name: _____

Class: _____

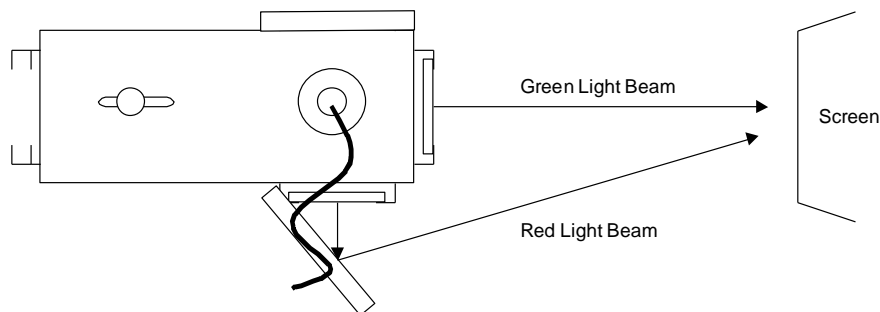


Figure 3: Example Setup for Question 5

- Project the colors two at a time on the screen. Record the color that you see where they overlap.
 - Red + Green →
 - Green + Blue →
 - Red + Blue →
- Now add all three lights and record the color that forms where they all overlap.
 - Red + Green + Blue →
- Now add the following combination and record the color that forms.
 - Blue + Yellow →
- Explain the result of the last question. (Hint: What colors combine to produce yellow light?)
- Predict what will form with each of the following combinations. After you have made a prediction, use the color filters to try each combination and record the result.

	Prediction	Actual Result
Red + Cyan →		
Green + Magenta →		

Questions

10. The three primary additive colors are _____. They are called primary additive colors because they add up to give _____ light.

11. Complementary colors are two colors that add up to give white light. List three pairs of complementary colors.

12. Complete each of the following light additions:

- a. Red + Green →
- b. Green + Blue →
- c. Red + Blue →
- d. Red + Green + Blue →
- e. Blue + Yellow →
- f. Red + Cyan →
- g. Green + Magenta →

13. Make a prediction about each of the following light additions. Hint: Write the primary additive colors that make up each color in the equation.

- a. Red + Green + Cyan →
- b. Blue + Green + Yellow →
- c. Red + Blue + Yellow →
- d. Red + Yellow →