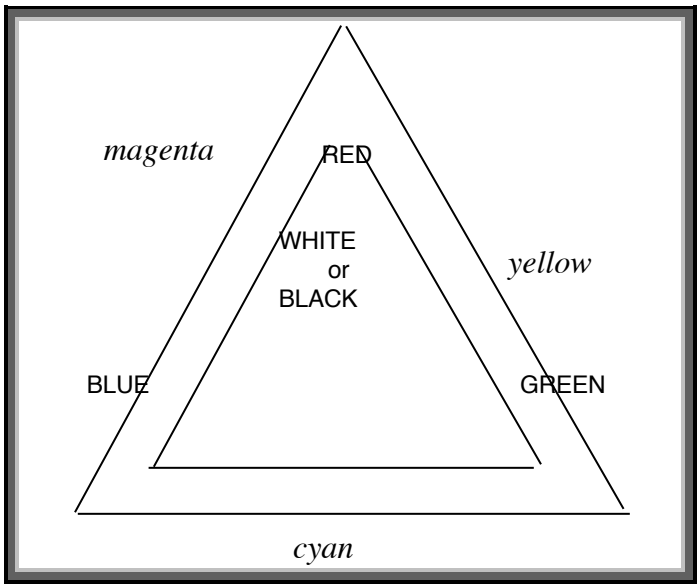
Experiment 17
COLOR MIXING

Equipment
3 Pieces of Wax Paper
White Cardboard
Colored Pencils
3 Rubber Bands
Set of Color Gels
3 Flashlights

INTRODUCTION
The purpose of this experiment is to investigate the processes of additive and subtractive color mixing.

Different frequencies of light are perceived as different colors. The color of a transparent object depends on the color of the light it transmits. For instance, a blue piece of glass appears blue because it transmits only blue and absorbs all the other colors composing white light. On the other hand, the color of an opaque object is determined by the light it reflects. For instance, a blue sheet of paper appears blue because it reflects only blue light while absorbing all other colors.

All the visible frequencies of light mixed together produce white light. White light can also result from equal mixing of red, green, and blue light. In fact, by adding various amount of red, green, and blue light, any color in the spectrum can be generated.
For this reason, red, green, and blue are called the *additive primary colors*.



The Color Triangle
Figure 19-1

However, if red, green, and blue paint are mixed, white paint is not the result. When red, green, and blue pigments are combined, every color in the white light that illuminates them is absorbed, and the mixture reflects no light and appears black. The mixture of paint pigments results in a subtraction of colors since the observer sees only the light reflected after the absorption has taken place.

By mixing magenta, cyan, and yellow pigments, the additive primaries - red, green, and blue - can be produced. Magenta, cyan, and yellow are known as the *subtractive primary colors*.

An aid in predicting the mixing of colors is the *color triangle* (Figure 19-1). The color triangle is an arrangement of the additive and subtractive primary colors. Red, green, and blue are located at the corners while magenta, cyan, and yellow are along the sides. The order of the colors is such that the sum of any two additive primaries at the corners gives the subtractive primary between them on the sides. The sum of all three additive primary colors produces white as shown in the center. The sum of any two subtractive primaries in the sides is the additive primary at the corner between them. The sum of all three subtractive primary colors produces black as shown. Colors opposite each other on the color triangle are called *complimentary colors*. The addition of two lights that are complimentary produces white light. The mixture of two complimentary paint pigments, however, produces black. For example, the mixing of a blue and yellow light produce white light, but the mixing of blue and yellow paint produces black paint.
In this experiment you will be provided with six color gels. Three gels represent the three primary additive colors: red, green, and blue. Three gels approximate the three primary subtractive colors: yellow, magenta, and cyan. These gels will be used to investigate the results of additive and subtractive color mixing.

PROCEDURE
A. Subtractive Color Mixing
1. Use the rubber bands to securely cover the flashlights with pieces of wax paper. These flashlights will be your light sources throughout this experiment.

2. Hold the yellow and magenta gels on top of the flashlight one over the other, and record the transmitted color you observe in the data chart.

Name_____ Time & day the lab meets_____

PHYS108

Modified Procedure for Color Mixing

Part A- Color mixing with paint

In this part of the lab, you will use a **subtractive color mixing website** to demonstrate the mixing of paint.

One way of obtaining various colors using paint is to start with a pure white paint base in which you will add additives that subtract primary colors one at a time to yield the subtractive primary colors (i.e., yellow, cyan and magenta). This is analogous to starting with white light and using a filter which absorbs one of the primary additive colors, (i.e., red, blue or green) to achieve one of the primary subtractive colors (i.e., yellow, cyan and magenta).

The method described above can be varied by using either different efficiency filters or additives to create an almost infinite palate of colors.

1. Using Foxfire browser open the website below:

"https://www.physics.wisc.edu/ingersollmuseum/exhibits/opticscolor/subcolormix/

It should be bookmarked on bookmark bar.

2. Scroll down to Subtractive Primaries. You will see a set of 3 filters that (which when combined to filter white light) will subtract all 3 primary additive colors and will result in a black portion where all 3 filters overlap. This is analogous to adding additives to white base (which subtract all 3 primary additive colors) and results in black paint.

3. Please note that a filter applied to white light behaves the same as a (subtractive) additive added to white paint.

4. Complete Table A using the 6 figures under the Subtractive Primaries.

Table A

colors mixed (or color of filter)	**color subtracted**	**resulting color**
yellow		**xxxxxxxx**
magenta		**xxxxxxxxx**
cyan		**xxxxxxxxx**
yellow + cyan		
yellow + magenta		
magenta +cyan		
Yellow+magenta+cyan		

Part B- Color mixing primary colors using light box.

5. Use small light box to mix the primary additives colors Red, Blue and Green. Be careful and do not over twist the knobs. Complete table B.

Table B

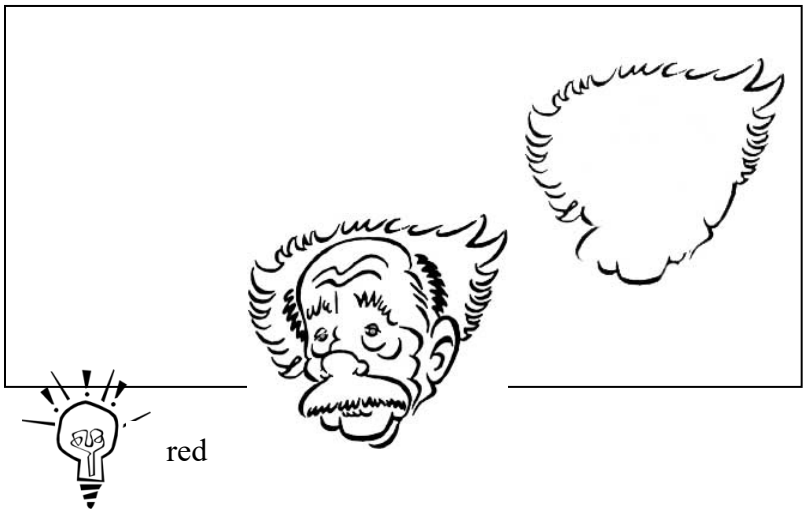
Colors Mixed	Resulting color

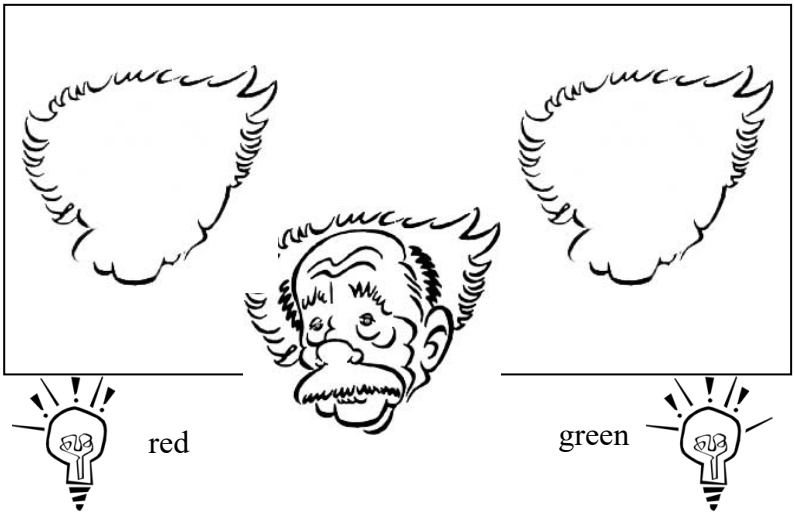
C. Light and Shadows

Complete figures on page 32 & 33 of your manual and turn in with this page.

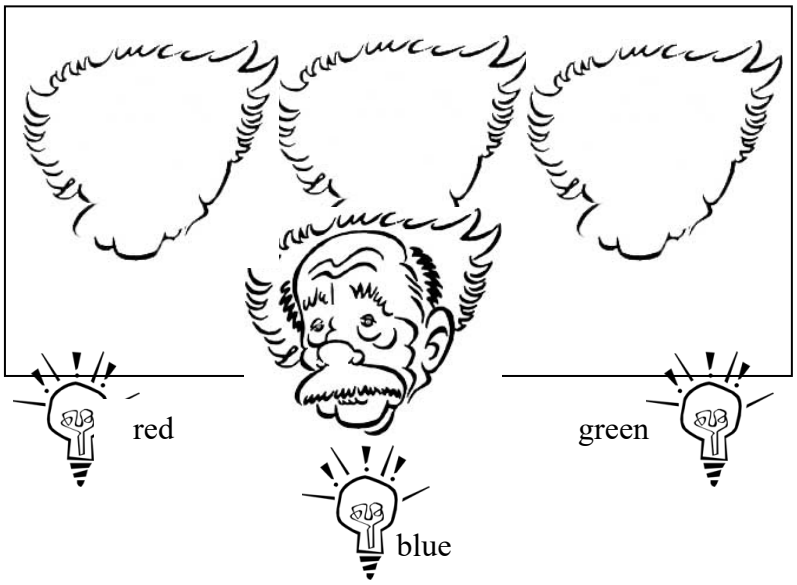
Data Sheets for
Color Mixing

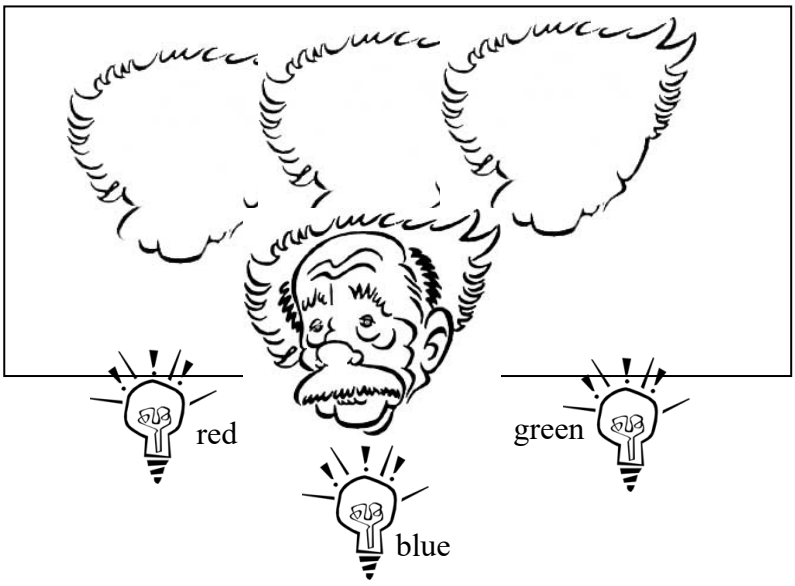
Part C
Figure 23-2





Data Sheets for
Color Mixing





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Modified Procedure for Color Mixing

Questions

1. Red light and green light produce _____ light.
2. Green light and blue light produce _____ light.
3. Cyan and yellow paint produce _____ paint.
4. The complimentary color of green is _____.
5. Magenta and green paint produce _____ paint.
6. Red light plus cyan light produce _____ light.
7. The color of water that we see in sunlight is based upon the absorption of infrared (& some visible red). Based upon this fact and what you observed in the paint mixing part of the lab what color would you expect water to be (particularly at depths greater than 30 meters)? Explain your answer.

8. If white light contains more than 3 colors (as evidenced by the colors of a rainbow) why are we mainly concerned with the addition of red, blue and green when studying color addition? It has to do with the human eye and how we perceive (i.e., measure) colors. See figures 27.7 and figure 27.8 of text for help.

9. Because water droplets are “considerably larger” than the individual molecules of water of which they are composed, they “primarily refract and reflect all colors about equally” which results in something we see in the sky often.

   What is a collection of water droplets in the sky called and what color would it be based upon the above description? Explain the color (of this collection of water droplets) in the context of what you observed in this experiment.