This activity was designed for elementary school aged children. The students use food coloring in water to experiment with mixing different color pigments. They compare this to the mixing of different colors of light. It can easily be adapted for older students.

Mixing Colors

Objectives

This activity makes students aware of the difference between mixing pigments of different colors and the mixing of light of different colors. After this activity, students will be able to:

1. Tell which combinations of primary pigment colors are necessary to create particular secondary colors and hues.
2. Tell what colors are produced by particular combinations of colors of light.
3. Recognize that there is a difference between combining colors of pigments and combining colors of light.

Materials

For Each Pair of Students

- 4 plastic cups
- 1 plastic bowl
- 4 “Color Mixing” worksheets (master on p. 3)
- 1 set of crayons
- 2 stiff white cardboard squares (about 4"x4")
- 2 scissors
- 2 short pencils (sharpened)
- glue and/or tape
- 1 tack

For the Whole Class

- Food coloring (Red, Blue, & Yellow)
- 3 large beakers of water
- 3 white floodlights (75 watt) with clamp-on light sockets and metal reflectors or 3 bright flashlights
- 1 filter gel of each of the following colors (each large enough to cover the front of the lamp reflector or flashlight; gel material sold at theater supply stores)

  Medium Red - # 27

  Kelly Green - #94

  Medium Blue - #88

Before Class

1. Make three large beakers of colored water by adding several drops of food coloring to water in the beakers. Make one beaker of yellow, one of red, and one of blue.
2. Secure the color filters to their respective light sources.
3. Draw a 4" circle on each cardboard square.
4. Try making a color wheel top or two before class. Experiment with different color combinations so that you get a feel for what proportions work best.

Note

Younger students should use crayons to indicate the colors they see on the worksheets (master on page 3). Older students can write their results on a blank sheet of paper.

In Class

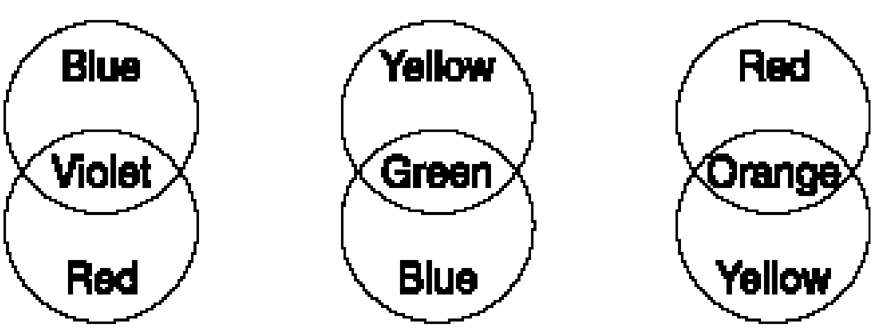
Part A: Mixing Pigment

Suppose we have only red, blue and yellow paint, but we want to paint our room green.

Is there any way we can make green paint from what we have?

Let's do some experiments to find out.

1. Students work in groups or pairs. Hand out four clear plastic cups and one plastic bowl to each pair of students.
2. Have students predict what color they will make with each combination of two colors. Use "Color Mixing" record sheets and crayons for recording predictions.
3. For each pair of students, pour one of each primary color water into plastic cups.
4. Let the children test their predictions and record the results on their color mixing sheets. Explain to your students that they should discard test results in the plastic "discard" bowl before attempting a new test.
5. Lead a class discussion and summarize the class results on the chalkboard by Venn diagrams of color mixing:



Experiment with PIGMENT or LIGHT (circle one)

Color Mixing

○ + ○ =

P Prediction

T Test Result

○ + ○ =

P Prediction

T Test Result

○ + ○ =

P Prediction

T Test Result

○ + ○ =

P Prediction

T Test Result

Your Name ______________________________

Part B: Mixing Colors of Light

Now let's see how colors mix when we use the light itself for mixing and not pigments. We have three light sources: red blue and green.

Darken the room. Demonstrate each light by shining it on a white screen or white wall (Off white is OK, too).

What color do you think we will get when we mix the red light and the green light together? The red light and the blue light? The blue light and the green light? Please indicate your guess by filling out another color mixing worksheet.

Allow time for students to record their guesses. You can shine the different color spotlights on a screen or wall, but be sure the beams of light don't overlap and mix until all students have recorded their guesses. When all students have recorded their guesses, mix the light beams in the three possible pair combinations, one at a time, and have students record the observed result on their worksheet. Finally mix all three light beams together.

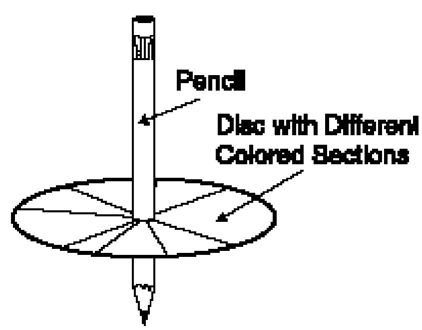
Ask the students: Why do the three colors appear white? (White is made up of all colors of light.) What colors of light do you think we will need to make black? (None. Black is the absence of light.)

For older students, ask if they can explain why we get different colors when mixing pigments compared with mixing lights. If they have seen the planetarium program Colors From Space, they may be able to figure out that when mixing two pigments, each separate pigment absorbs all but a few colors, so when they are mixed together, we see only the colors that are not absorbed by both pigments. However, when colored lights are added together, we see the combined colors of all of the lights that are being added.

Part C: Color Wheels

Now we will mix colors another way: on a spinning wheel!

1. Hand out cardboard and scissors. Have the students cut out the circles.
2. Have your students use crayons for making a design on their cardboard circles. The design that works the best is pie slices. What size should each pie slice be to produce the whitest color when you spin the disk? Experiment to see what works best. Hint: don't use too much red.
3. Show your students how to use a tack to start a small hole in center of the circle for a pencil to stick through. Secure a pencil in the hole with tape and/or glue. Make the paper disc fairly close to the tip end of the pencil (within an inch).



Now spin it. (It stays upright.) Look at the colors while the top is spinning fast.

What color do you see?

Is the color we see on the spinning top more like mixing pigments or more like adding colored lights? [More like adding colored lights because we are seeing the combined colors reflecting from all

the colored areas on the top.]

Summary

White is the combination of all colors of light. A rainbow is white light broken up into its component colors by little droplets of water in the air.

The distinction between colors of light and colors of pigments may be difficult for younger students to comprehend. **Light** can travel through space and illuminate pigmented objects that either **reflect** or **absorb** the light. **Pigment** in an object causes the object absorb all colors of light except the color of light for which the pigment is named. For example, red pigment (paint, crayon, etc.) absorbs all colors of light except for red light. In the absence of any light, all pigments appear black.

The absence of light appears to us as the color black. If you look through a hole in an otherwise closed box that has a white interior surface, the inside will appear dark. This demonstrates how the absence of light can make even a white surface appear black.

Going Further with Filters

1. We highly recommend the set of activities entitled ***Color Analyzers*** from the Great Explorations in Math and Science (GEMS) science curricula from Lawrence Hall of Science. The guide comes a class set of red and green colored filters and diffraction gratings.
2. If you are able to get a class set of filters, your students can find out more about how filters work. Have your students observe the effects of filters on various color images as well as finding out the effect of combining different color filters. Collect a number of large color pictures, posters, slides, and/or digital images of a variety of subjects. For each poster or image, have your students view the picture through each of their color filters. Lead a discussion about how the filters change the appearance of the picture and how filters can help resolve particular details in the picture. Have your students write down on paper which particular details of the picture show up best with a given filter.
3. Your students can experiment with all possible combinations of filters: red+green, red+blue, and blue+green. With extremely good filters, any combination of different colors will not let any light through, so everything appears black. Since real filters vary considerably in quality, different combinations will let more or less light through.
4. ***Which is the best filter?*** Try a variety of filters with a set of standard color lights. The challenge is to find a filter which makes all color lights look dark except the color light that matches the filter color. The other side of the coin is that any color light does not give off a perfectly pure color of light (single frequency). So even if you were able to get a "perfect" filter, it would probably let light through from an imperfect (not pure color) light source. The closest thing in existence to a pure color light source is a laser.