

# Light

## A Colorful Physics Module

### Objectives for Students Activities

- Review the physics concepts relating to the principles of light and color
- Identify the primary and secondary colors of light
  - Investigate the primary and secondary colors of pigments
- Create a color wheel
- Create a process to manufacture crayons (or pastels)

## Resources

### Printed Sources

Merrill, "Physics", Chapter 16 – Light

Holt, "Modern Physics", Chapter 14B – Dispersion

Hewitt, "Conceptual Physics", Chapter 26 – Color

"Filters for Color Mixing", Robert Williamson. The Physics Teacher, Vol. 36, January 1998

"Confusing Color Concepts Clarified", Lawrence Woolf. The Physics Teacher, Vol. 37, April 1999

### Websites

<http://webphysics.ph.msstate.edu/javamirror/colors/TabbedcolorBox.html>

<http://webphysics.ph.msstate.edu/javamirror/explrsci/dswmedia/coloradd.htm>

<http://webphysics.ph.msstate.edu/javamirror/ntnujava/shadow/shadow.html>

<http://www.colorado.edu/physics/2000/tv/colortv.html>

### Materials

- 3 Light fixtures (Wal-Mart sells single bulb plug-in fixtures)
- 3 aquarium light bulbs (red, blue, green)
- White poster, board, or wall as background
- Color Key or Color Separation Page from local printers
- Paper plates
- Food coloring
- Water
- Small cups or jars
- Pipettes or eyedroppers
- Color print from comic strip or newspaper
- Magnifying lens

- Color television
- Hot pot or hot plate (to create hot water bath)
- Beakers or empty cans
- Ice cube tray (plastic or metal)
- Hot pad
- Blocks of paraffin wax
- Dry tempura powder (cyan, magenta, yellow)

## Instructional Concepts

### Demonstrations

- Use red, green, and blue light bulbs to introduce the primary colors of light and how they mix.
- Obtain a “color key” or color separation page from a local printing industry to demonstrate how the primary colors of pigments mix

## Project Development

### Creating the Color Wheel

- Make pigments for the color wheel by adding a couple of drops of food coloring to water. Use blue, red, and yellow food coloring to create three pigments (cyan, yellow, and magenta). You may need to add a drop of blue food coloring to the red to create the magenta color.
- Use pipettes or eyedroppers to create a color wheel that mixes the pigments on paper plate. Example: Place 5, 4, 3, 2, 1 drops of cyan water in adjacent locations along the rim of the paper plate. Then put one drop of magenta over the 4 drops of cyan, 2 drops of magenta over the 3 drops of cyan, 3 drops of magenta over the 2 drops of cyan, 4 drops of magenta over the one-drop of cyan, and then 5 drops of magenta. Repeat the process for each pair of pigments.
- Let dry and observe the various shades of color.
- Prepare a spreadsheet that records the ratios of primary pigment colors to create each of the shades obtained by the color wheel.

### Observing Applications of Color Mixing

- Use a magnifying lens to observe the combination of colors in a color print from a comic strip or newspaper.
- Use the magnifying lens to observe the pixels of a color television screen.
- Research how graphic design and stencils are used in advertising and industries.

## **Manufacturing Crayons**

- a. Use a hot pot or plate and beakers for a hot water bath to melt the paraffin wax.
- b. Use the results of the color wheel to determine the ration of pigments needed to create a color for the crayon. Add the appropriate amounts of dry tempura powder in shades of cyan, magenta, or yellow to create the desired color.
- c. Mix the pigment powder with the wax. Pour the mixture into an ice cube tray to let cool. Gently stir or swirl the mixture while cooling to prevent settlement of the pigment.
- d. Use a paint or similar drawing application program to create and print labels for the crayons.

## **Alternatives**

Instead of crayons, pastels or sidewalk chalk can be made by mixing soap shavings with hot water, then add in calcium carbonate and the dry tempura powder pigments to form a “dough-like” mixture. Roll the mixture into “biscuits” and let dry.

## **Applications in the Workplace**

Businesses and industries rely on public relations to promote their products or services. It is the basic understanding of color and light principals that enable quality prints of products to be made. During our visit at an industry, we witnessed the printing of a color key. The color key allows the printers to determine the correct amount of each primary pigment color to use for each portion of a print to produce the desired picture. Other industries such as Valspar and Crayola depend on the their employees abilities to properly mix colors and to discover new color combinations. Color concepts are vital to the printing industry.

## **Integration Across the Curriculum**

Faculty from physics, chemistry, art, and computer studies could identify a part of the project relevant to their discipline and could contribute to the success of the project.