Lab 8. LIGHT AND COLOR

I. Equipment

1. diffraction grating, power supply, gas discharge tubes, colored pencils
2. diffraction grating, incandescent bulb, socket, variable transformer, colored pencils
3. computer with internet, color monitor, magnifier
4. color projector, spectroscope
5. translucent color filters
6. printed color gradient sheets, magnifier
7. diffraction grating, sodium lamp, numbered colored cards, didymium glasses
8. prism, white beam source, colored pencils

II. Activities

This lab consists of several stations. You may do them in any order.

Many of the activities involve using a spectroscope. A spectroscope consists of a housing containing a slit to admit the light being observed, a diffraction grating to separate the light into its component wavelengths, and an illuminated scale labeling the wavelengths of the spectrum. (When the ambient light is dim, as in this lab, you probably won't be able to see the scale.)

To use the spectroscope, point the slit on the wide end of the wedge at the light source being studied. Position your eye at the eyepiece so that you don't see the source light, but you do see the much dimmer spectrum spread out to the side.

1. Gas discharge lamps

In these lamps, a high voltage across a low-pressure gas causes the gas to ionize and conduct electricity (dielectric breakdown). The light emitted depends on the gas.

If you need to replace a discharge tube, take care because they are fragile, and because a tube that has recently been used may be hot. To remove a tube from the power supply,

- Turn off the power supply.
- Handle the tube with a pad if it is too hot to touch.
- Push down on the tube so that the top contact of the tube is lower than its bracket.
- Pull the top of the tube forward away from the power supply.

- Lift the tube up so that it comes free of the lower bracket. If it catches in the mounting spring, gently move the tube around to release the spring.

To mount a tube in the power supply,

- Make sure the power supply is turned off.
- Place one end of the tube in the bottom bracket of the source and push down until the top of the tube is below its bracket.
- Position the top of the tube to align with its bracket.
- Allow the spring in the bottom bracket to push the tube up to the contact in the top bracket.

Look through the spectroscope at the spectrum from the different gas discharge tubes. Tubes should include hydrogen and helium. (I hope to get more in the future.) Sketch the spectra you see from each.

2. Incandescent light

1. Set up a vertical-filament incandescent light. Adjust the voltage to give a white light. Look at the white light through your spectroscope or grating. Describe and sketch the spectrum you see.

2. Reduce the voltage so that the filament glows orange. Look at the filament through your spectroscope or grating. Describe and sketch the spectrum you see.

3. Computer monitor

1. Display the color gradients page (accessible from the welcome page on the course web site at barransclass.com) on the monitor. Each bar is a continuous change in some

primary light intensity left to right. The percentages list the intensities of red (R), green (G), and blue (B) intensity at the right and left.

2. Use the hand magnifier to observe the individual pixels in the bars. Note what colors the pixels are individually, and what color they appear to be in combination. Also note what changes from left to right in each of the bars.

3. Draw a single white pixel.

4. Color projector

This apparatus comprises three separate light sources projecting onto a screen. Each source can be adjusted individually.

1. Look at each color in turn with your spectroscope. Describe the spectra you see.
   - red:
   - green:
   - blue:

2. Turn on the lights in pairs. Look at the region where the light from the red and green sources overlap. What color do you see there? Do the same for the other combinations of two of the three primary colors.
   - red and green:
   - red and blue:
   - green and blue:

3. Now observe where all three sources illuminate the same location. What color do you see where all three overlap?

5. Translucent color filters

1. Hold a filter disk up to the light and look through it. Overlap two and three filters of different colors and look through both, or all three, together.
2. What colors do the individual filters transmit?

3. What colors do the combinations transmit?

4. Does it matter which filter is in front and which is in back?

6. Printed color gradients

1. These are printed paper sheets. The numbers to the left and right of the color-gradient bars identify the densities of the cyan (C), magenta (M), and yellow (Y) inks making up the colors. The densities vary continuously across each bar. Under magnification, try to observe the changes in ink coverage from left to right.
2. Can you see the individual dots of ink? What colors are they?

3. Do you observe the ink densities changing across the bars??

7. Sodium vapor lamp

Spectrum

First, look through the spectroscope at the spectrum from the sodium light. Describe the spectrum.

Colors

Place the numbered colored cards so that they are illuminated by the sodium vapor lamp. Record what color each card appears.

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

6. _____ 7. _____ 8. _____ 9. _____ 10. _____

Didymium glasses

Place the numbered colored cards so that they are illuminated by the sodium vapor lamp. Observe them through the didymium glasses, which obscure the most intense yellow emission from the sodium vapor lamp. Record what color each card appears.

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

6. _____ 7. _____ 8. _____ 9. _____ 10. _____

Natural light

Bring the numbered colored cards to a place illuminated by natural light. Record what color each card appears.

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

6. _____ 7. _____ 8. _____ 9. _____ 10. _____

8. Dispersion

Purpose

In this activity you will learn why a prism separates a beam of white light into colors.

Overview

Prisms bend light because light travels more slowly through glass and plastic than through air. However, all light is not alike! Different colors of light have different speeds in glass and other materials. This difference produces effects that are sometimes beautiful and sometimes annoying.

Procedure

Place a glass or plastic prism in a beam of white light so that the light passes through a corner and is broken into different colors.

1. Which color bends the most from its original path (from the source)?

2. Which color bends the least?

3. Sketch below the path of the beam of light into and out of the prism, including the colors of the light.

III. Lab report

Show your observations that are recorded on these pages to your instructor for check-off.