

A WORKSHOP ON COLOR AND LIGHT  
Presented by  
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## 6. CYLINDRICAL LENSES

Why do letters printed in one color turn upside down while letters in another color do not? Try printing the following words on a sheet of paper. Print the normal letters in blue and the underlined letters in red.

BLUE + RED      DIOXIDE GLASS

If the cylindrical lens (pop bottle filled with water) is held close to the words, everything looks normal. However, when the cylindrical lens is held about 2 to 3 inches above the paper, the red letters turn upside down while the blue ones do not! Actually, the blue ones also turn upside down but because they are symmetrical they appear to read the same.

## 7. TYNDALL EFFECT

Different colors of light have different wavelengths. Red is long; Blue is short. (Actually they are all rather short, only about 5 ten thousandths of a millimeter, but red is longer than blue.) When encountering small objects, long wavelengths tend to bend around easiest while short wavelengths tend to reflect the easiest. When light travels through something with a number of small particles the red light tends to go on through but the blue light tends to be scattered to the side. Thus the sky is blue and the sun turns red at sunsets. This can be demonstrated using an overhead and a large beaker of water. As small amounts of coffee creamer are added to the beaker, the water in the beakers tends to become tinted blue and the light passing through to the wall becomes tinted red. Remember, pretty sunsets usually mean lots of pollution!

## 8. BUBBLES

Nearly everyone has played with bubbles and noticed the colors. The colors are produced as the water between the two surfaces of the bubble begins to settle to the bottom. As the thickness of the bubble changes at different places, light of different wavelengths (different colors) constructively interfere as they reflect from the inside and outside surfaces. Thus the color is an indication of the bubbles' thickness. The reflection of light from thin films is very important in the production of fine photography lenses.

## 9. GREEN, BLACK, AND ORANGE FLAG

Our eyes detect light when the light causes chemical reactions to occur in the cones of our eyes. Our eyes have three different kinds of cones to detect three different colors (RED, BLUE, GREEN). If you stare at a red picture for a few moments, the cones in our eyes that respond to red light are all actuated and it will take a short time before they are ready to detect red light again. If you then quickly look at a white background the red cones will not react but the blue and green detectors will and your brain will register a cyan color even though you are looking at a white background. The short time before the cones can again detect light after they have reacted is called persistence of vision. This also accounts for our seeing "moving pictures" even though they are just a series of still pictures projected on a screen.

## 10. SPINNING DISKS

Part A: Most students know that it is possible to mix colors to get other colors. However, most students (and teachers) do not really know the primary colors of light. If we are working with light the primary colors are RED, BLUE, and GREEN\*. Combinations of these three colors can make all the other colors we see. If you hold a magnifying glass up to a color TV you will see only small dots of red, blue and green. By coloring a cardboard disk these three colors and spinning it quickly you can produce white which is the combination of all colors.

(\*In art classes students usually do not work with colors of light but pigments of paint. Pigments absorb colors rather than emit colors. The primary pigments which can be mixed together to make other pigments are RED, BLUE, and YELLOW.)

Part B: Because of the way our eyes detect light we can trick them into thinking they are seeing colors. Because the persistence of vision is different for each of the three kinds of cones in our eyes, when we spin a black and white disk with different patterns we can begin to see some variation in color.

#### 11. COLORED BULBS

It is possible to buy "party bulbs" from the grocery store in all three primary colors. If only one bulb projects light upon a white screen then you will only see that color and a black shadow. If you shine any two bulbs on a white screen then they will add together to produce a new color of light (red + blue = magenta, red + green = yellow, blue + green = cyan), black shadows and shadows of the original two colors. It is very interesting to shine all three colors on a white screen. They will produce white light with black shadows and shadows of the three complementary colors.

#### 12. SOMEWHERE OVER THE BEAKERBOW

If a projector is aimed so that the beam just strikes the edge of a beaker full of water, a "beakerbow" can be formed. The light will internally reflect twice before leaving the beaker just like in a spherical raindrop. A number of properties of a rainbow can be studied in the classroom. Just like in a real rainbow the angle between the incident ray and the exiting ray is about 42 degrees. This indicates that the sun tends to always be at your back when you look at the top of the rainbow. Also, since, the angle between the incident ray and the red is slightly larger than the blue, when you look at a rainbow the red normally appears on top.

#### 13. OVERHEAD SPECTROSCOPE

One way to make a rainbow is to use a prism but anyone who has tried it in the classroom knows that it is not easy. The other way is to use a diffraction grating. Diffraction gratings spread the different colors of light by different amounts. The longer the wavelength, the more the color spreads. The inexpensive "rainbow glasses" that you can buy in carnivals use diffraction gratings. By using an overhead projector and a diffraction grating, an excellent rainbow can be made in the classroom. Put the grating in front of the overhead projector lens and use two file folders to make a narrow slit on the stage of the projector. Two rainbows will be projected on the screen. To observe how different filters absorb different colors try putting filters over the slit and observe the projected rainbows.

#### 14. ULTRAVIOLET BEADS

The light that we see is not the only kind of light that exists. Light that has a longer wavelength than red light is called infrared while light with a shorter wavelength than violet is called ultraviolet. Our eyes cannot