



HSCAPA

Showing Students the Light

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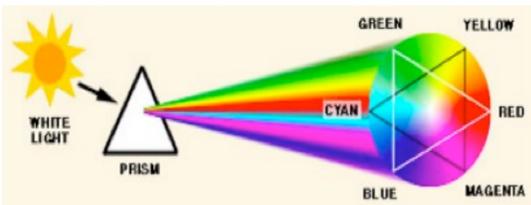
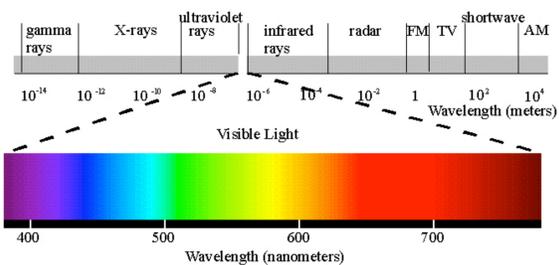
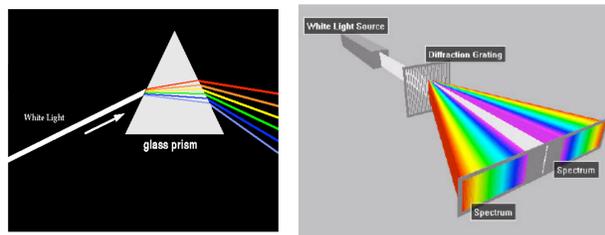
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Imaging Lab: Out of Sight

Color images are created by an ingenious technology. Our **goal** is to have HS students understand how Cathode Ray Tubes (CRT), Liquid Crystal Displays (LCD) and plasma monitors produce the millions of colors that we see.

What's in White Light?

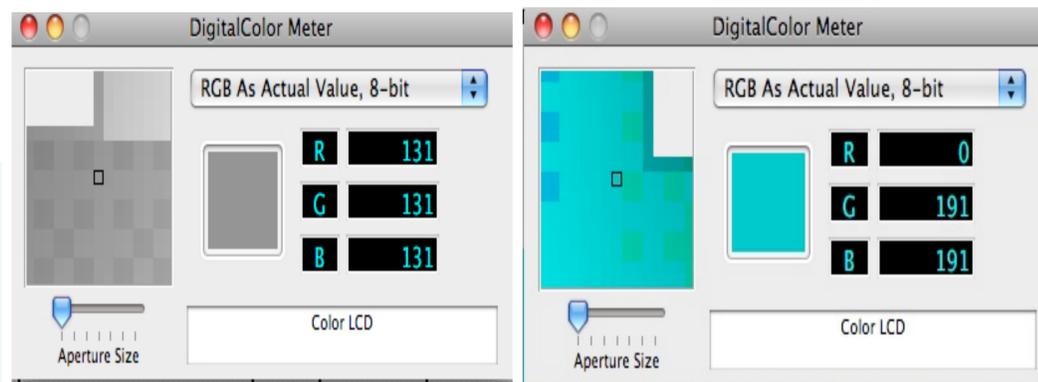
If white light is passed through a prism or diffraction grating, then the colors of the rainbow are dispersed, as shown.



If the visible portion of the light spectrum were divided into thirds, the predominant colors would be red, green, and blue (RGB). These colors are considered to be the primary colors. If white light is passed through a prism and arranged in a circle (the Color Wheel), the primary colors would form a large triangle. The colors in between the primary colors namely, cyan, magenta and yellow (CMY) form another triangle, called secondary colors. How are the primary and secondary colors related?

ACTIVITY 1: Using the Mac DigitalColor Meter Application to view the RGB Channels

1. Open up the DigitalColor Meter on the **Mac** which is in Applications > Utilities folder. (See <http://www.thinkmac.net/blog/archives/mac-tips-daily-129-digital-color-meter.html> for some background on the meter.)
2. Once you have the DigitalColor Meter opened up, paste this link for the spectrum shown at left into the web browser <http://ahsastronomy.pbwiki.com/The+Spectrum>.
3. From the drop down menu, select RGB As Actual Value, 8-bit. [This gives values from no color (=0) to full intensity (= 255)].
4. Move the mouse to a part of the screen that is white. Notice the Red, Green and Blue values. What are these values?
5. Move the mouse to a part of the screen that is black. Notice the Red, Green and Blue values. What are these values?
6. Mouse over the pure **yellow** portion of the spectrum (left of 600 nm). What proportions of RGB give yellow?
7. The color portion to the left of 500 nm on the spectrum above is **cyan**. Mouse over there. What proportions of RGB give cyan?
8. The color very far to the left is **magenta**. Mouse over there. What proportions of RGB give magenta? {A bit to the right of this is violet. Here the Red value is about half the Blue value. Mouse over this region to see the difference between magenta and violet. Describe how this difference appears to you.}
9. Find orange (in between yellow and red). Predict what proportions of RGB give you orange and then verify it with the DigitalColor Meter. What proportions to you see?



Some DigitalColor Meter Results:

Yellow (at maximum intensity) = (R,G,B) = (255,255,0)

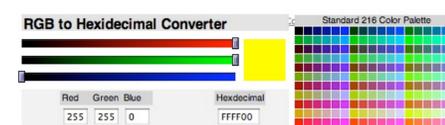
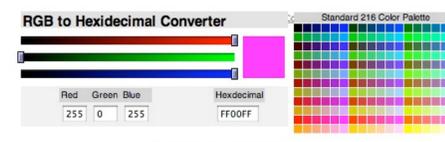
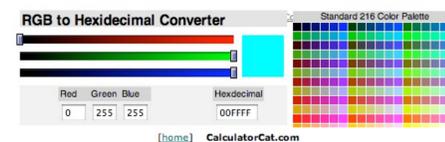
Cyan (at maximum intensity) = (R,G,B) = (0,255,255)

Magenta (at maximum intensity) = (R,G,B) = (255,0,255)

ACTIVITY 2: Using a RGB Graphical User Interface to produce different shades of color:

- (1) Click on the following hyperlink (works with Safari): <http://www.calculatorcat.com> Click on [Color Slider \(RGB to hex\)](#) at the lower right side.
 - (i) CONTINUOUS CHANGE: Move **R** fully to the right (other sliders left). Move **G** slowly to the right and note how the color changes. Now move **R** slowly to the left. Move **B** slowly to the right and then move **G** slowly left. Finally, move **R** slowly right, then **B** left.
- (2) MULTIPLE SLIDERS: In turn, move each possible pair of sliders to the right keeping the other slider to the left. **Predict** what would happen if you slowly move the third slider to the right. Do it. What do you notice about the color?
- (3) In all cases above relate the results you observe to the Color Wheel and spectrum.

SLIDER RESULTS (below):
RGB produces CMY.
Primary colors produce secondary colors



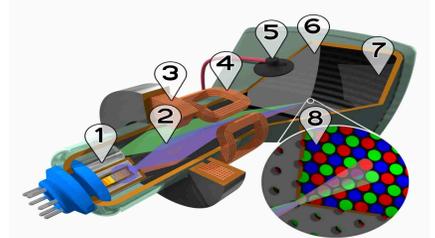
Major Findings

If Red and Green light of **equal intensities** are mixed, the resulting color is (the secondary color) yellow at maximum, with similar results for the other primary colors. If R and G light of **unequal intensities** are mixed, the resulting color is between R and G and is closer to the color of greater intensity, with similar results for the other primary colors.

This explains how a color picture can be represented on a CRT or LCD monitor. Every picture element (pixel) is specified as an element of a five dimension matrix of numbers, where the first two numbers designate the row and column and the last three numbers indicate the RGB values (from 0 -> 255). If the pixel at (200,200) is to be cyan at half intensity, then its coordinates are (200,200,0,127,127). Below is an example of brown. How could we produce a brighter brown, a darker brown?



CRT or TV Tube



PA Standards

The full Drexel Imaging Lab (see the *RET/2008 webpage for additional content not shown above*) addresses Standard 3.1 because students use the concept of a model and apply **mathematical models**. (3.1.10.B) In Standard 3.4 students describe **light effects**. (3.4.10.C) In Standard 3.6 students apply knowledge of **information technologies of encoding**, transmitting, storing and retrieving and decoding. (3.6.10.B)