| **CONCEPTUAL PHYSICS** | **Tech Lab/Activity** |

Color: Mixing Colored Light   Color Mixing in Digital Displays

Pixel Peeping

Purpose
To use a magnifier to examine the pixels of a computer display and see how the display's colors are created

Apparatus
__computer with display (monitor or screen)
__PhET sim, "Color Vision" (available at http://phet.colorado.edu)
__overhead transparency sheet (or equivalent)
__small magnifier (30x or 60x-100x, for example)

Discussion
The term, "pixel peeper," is used among digital photographers to describe someone more interested in the technical specifications of camera gear than in photography, itself. But in this activity, we will literally examine ("peep") at the individual picture elements ("pixels") of a computer display to see how colors are created. The results might surprise you!

Procedure
Step 1: Place the transparency over the screen to protect it during this activity. With laptops, the transparency should rest in place without any further need to secure it. Ask your instructor for assistance if there is difficulty with the transparency sheet.

Step 2: Launch PhET sim, "Color Vision."

Step 3: While in the RGB Bulbs tab, use the on-screen slide control to increase the red light to maximum.

Step 4: Place the small magnifier onto the on-screen character's "perception bubble" to see what red looks like up close. (Recommendation: 60x is plenty of magnification; place the magnifier on the transparency on the section of screen to be examined and focus it there.) Describe what you see using words and pictures.

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_____

_____

Step 5: Slide the red control back to zero and increase the green to maximum. Use the magnifier to see what green looks like up close. Describe what you see using words and pictures.

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Step 6: Slide the green control back to zero and increase the blue to maximum. Use the magnifier to see what blue looks like up close. Describe what you see using words and pictures.

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_____

Step 7: Switch to the Single Bulb tab. Switch the filter to "Off." Use the magnifier to see what white looks like up close. Describe what you see using words and pictures.

_____

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_____

Step 8: Switch the color filter to "On." Set the Filter Color to as pure a yellow as you can (this may be the default color that the filter is set to when switched on).
a. Prediction. What will yellow look like up close?

_____

_____

_____

b. Observation. What does yellow look like up close? Describe what you see using words and pictures.

_____

_____

_____

Step 9: Try watching through the magnifier while the Filter Color is adjusted from one extreme to another. What do you see through the magnifier at each of the spectral colors?

Red

_____

_____

Orange

_____

_____

Yellow

_____

_____

Green

_____

_____

Blue

_____

_____

Violet

_____

_____

Step 10: Return the sim to the RGB Bulbs tab. Knowing what you know about yellow, how can you make the "perception bubble" bright yellow?

_____

_____

_____

Summing Up
1. The term "pixel" is short for "picture element." A computer screen is an array of pixels. Standard Definition is 640 x 480 pixels, High Definition is 1280 x 720 pixels, Full HD is 1920 x 1080 pixels, 4K UHD is 3840 x 2160 pixels, and 8K UHD is 7680 x 4320 pixels. Each pixel is made of phosphors. A single phosphor emits one color of light. How many phosphors (tiny color lights) are there in each pixel?

_____

2. Which colors correspond to the individual phosphors within a pixel? Note: some of the color names listed below may be unfamiliar to you. If the computer you're using is connected to the Internet, you might search the name of the color, then refine your search to produce images (rather than web links).

__blue   __brown   __chartreuse   __cyan   __gray   __green

__magenta   __mint   __orange   __periwinkle __red   __turquoise

__violet   __white   __yellow

3. Arrange the following and describe the resulting color (in one word, if possible: use the list above as a guide). Note: 1.0R means red at 100% intensity; 0.5G means green at 50% intensity.

a. 1.0R + 1.0G + 1.0B = _____   b. 1.0R + 1.0G = _____

c. 1.0R + 1.0B = _____   d. 1.0G + 1.0B = _____

e. 1.0R + 0.5G = _____   f. 0.5R + 1.0G = _____

g. 1.0R + 0.5B = _____   h. 0.5R + 1.0B = _____

i. 1.0G + 0.5B = _____   j. 0.5G + 1.0B = _____

k. 0.5R + 0.5G + 0.5B = _____

Going Further

Examine the pixel structure of other items (e. g., smart phones, plasma TVs, tablet computers, etc.). Are they all the same, or do they differ? What—if anything—do they have in common? Describe using words and pictures.

Device: _____

Pixel structure: _____

_____

_____

Device: _____

Pixel structure: _____

_____

_____

Device: _____

Pixel structure: _____

_____

_____