Name: _Key_

Color Addition and Subtraction

Read from **Lesson 2** of the **Light Waves and Color** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/light/u12l2d.html
http://www.physicsclassroom.com/Class/light/u12l2e.html

MOP Connection: Light and Color: sublevels 3 and 4

1.   White light is observed when light of __all__ wavelengths strike the retina.

2.   Primary colors of light are three colors of light which when mixed together produce white light. There are many different sets of primary light colors. Interestingly enough, the eye contains three types of color sensors (nerve cells) that sense the entire span of the visible light spectrum. Each of the three types of cells senses a range of colors; yet they are most sensitive to a specific light color. The most common set of three primary light colors are those that correspond to the three colors that the nerve cells are most sensitive to. What are these three primary colors?

3.   By combining pairs of these three **primary colors** in equal intensity, one can produce the secondary colors of light. State the pairs and the secondary colors they produce. Then fill in the color wheel to the right.

Green & _blue_ make _cyan_.
Red & _green_ make _yellow_
red & _blue_ make _magenta_
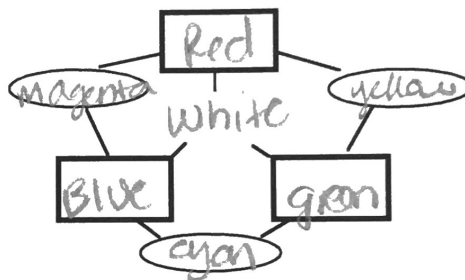
4.   Two lights are arranged above a white sheet of paper. When the lights are turned on they illuminate the entire sheet of paper (as seen in the diagram at the right). Each light bulb emits a primary color of light - red (**R**), green (**G**), and blue (**B**). Depending on which primary color of light is used, the paper will appear a different color. Express your understanding of color addition by determining the color that the sheet of paper will appear in the diagrams below.

R   G

Paper appears
yellow

R   B

Paper appears
Magenta

B   G

Paper appears
cyan
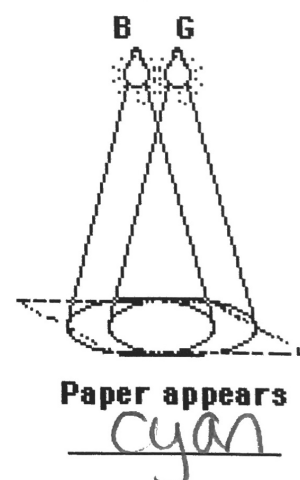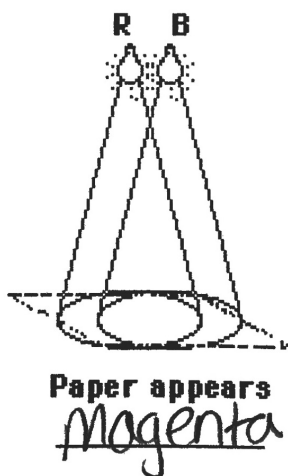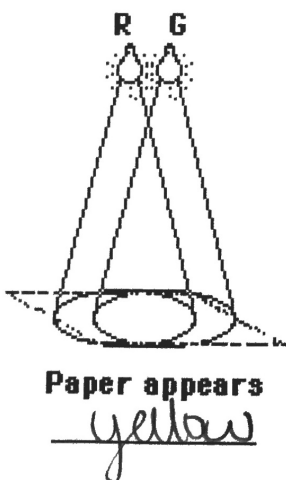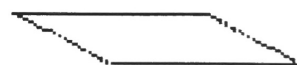
5. **Complementary colors of light** are combinations of two light colors that can be mixed together in equal intensities to produce white light. Thus, the complementary color of …

   a. … red light is ___cyan___ light.

   b. … green light is ___magenta___ light.

   c. … blue light is ___yellow___ light.

6. **The Rule of Color Subtraction:** An understanding of complementary colors assists in understanding the color appearance of objects when viewed under white light. Whenever an object subtracts a color from white light, it appears as the complementary color. If an object absorbs cyan light, then it will appear as red. Conversely, an object that appears as red is an object that absorbs cyan light. Use these ideas to complete the following statements.

   When viewed under white light (RGB), a …

   a. … red shirt will absorb ___cyan___ light and reflect ___red___ light.

   b. … green shirt will absorb ___magenta___ light and reflect ___green___ light.

   c. … blue shirt will absorb ___yellow___ light and reflect ___blue___ light.

   d. … cyan shirt will absorb ___Red___ light and reflect ___cyan___ light.

   e. … magenta shirt will absorb ___green___ light and reflect ___magenta___ light.

   f. … yellow shirt will absorb ___blue___ light and reflect ___yellow___ light.

   g. … black shirt will absorb ___white___ light and reflect ___black___ light.

7. Express your understanding of complementary colors and the rule of color subtraction by completing the following three diagrams. White light (red-green-blue) is shown incident on a sheet of paper that is painted with a pigment that absorbs one of the primary colors of light. For each diagram, label the color of the two reflected colors and label the color that the paper appears.
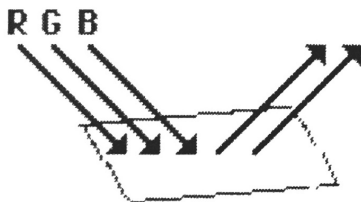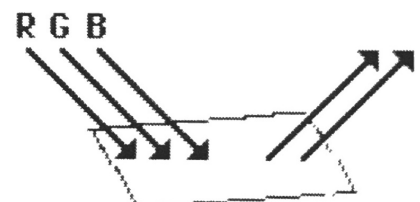

Absorbs Blue   Absorbs Green   Absorbs Red
Appears ___yellow___   Appears ___magenta___   Appears ___cyan___

8. The **mathematics of color** has little to do with numbers and much to do with the addition and subtraction of colors. The addition of two colors of light results in a new color. Use the *color wheel* at the right and the concept of complementary colors to complete the following *color equations*. (W = white; R = red; G = green; B = blue; C = cyan; M = magenta; Y = yellow)
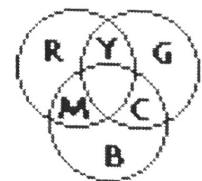
   a. R + G = ___Y___   b. R + B = ___M___   c. G + B = ___C___

   d. R + C = ___W___   e. G + M = ___W___   f. B + Y = ___W___

   g. W - R = ___C___   h. W - G = ___M___   i. W - B = ___Y___

   j. W - C = ___R___   k. W - M = ___G___   l. W - Y = ___B___

   m. W - R - C = ___Black___   n. W - G - B = ___R___   o. W - M - G = ___Black___