

Color Addition and Subtraction

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

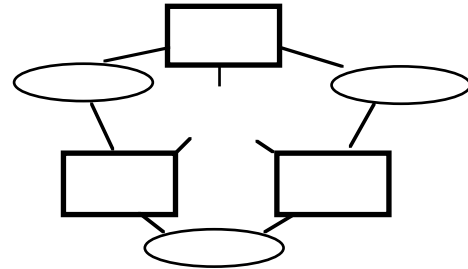
<http://www.physicsclassroom.com/Class/light/u12l2d.html>

<http://www.physicsclassroom.com/Class/light/u12l2e.html>

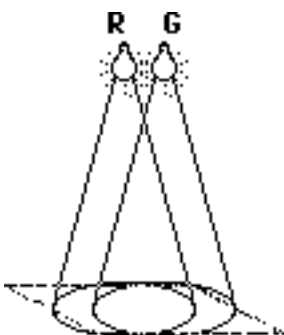
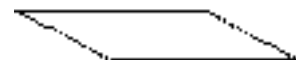
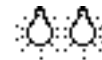
MOP Connection: Light and Color: sublevels 3 and 4

- White light is observed when light of _____ wavelengths strike the retina.
- 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?
- 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.

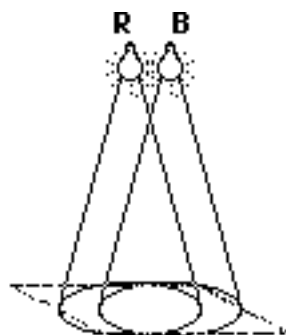
_____ & _____ make _____ .
 _____ & _____ make _____ .
 _____ & _____ make _____ .



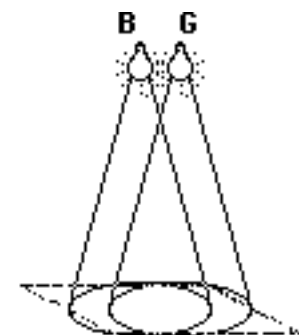
- Two lights are arranged above a white sheet of paper. When the lights are turned on they illuminate the entire sheet of paper (as seen in the diagram at the right). Each light bulb emits a primary color of light - red (**R**), green (**G**), and blue (**B**). Depending on which primary color of light 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.



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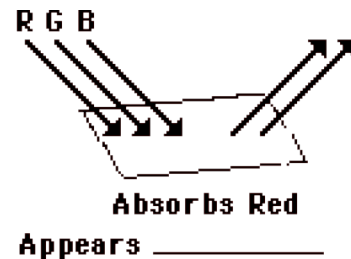
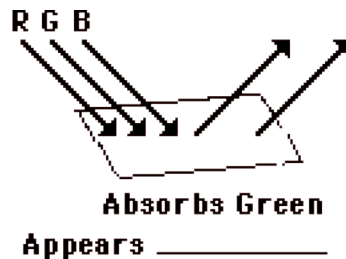
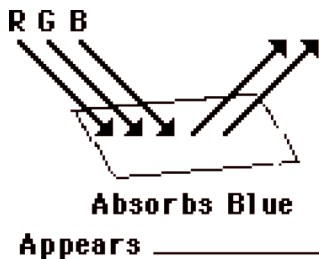
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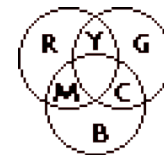
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Sound and Music

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 ...
- ... red light is _____ light.
 - ... green light is _____ light.
 - ... blue light is _____ 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 ...
- ... red shirt will absorb _____ light and reflect _____ light.
 - ... green shirt will absorb _____ light and reflect _____ light.
 - ... blue shirt will absorb _____ light and reflect _____ light.
 - ... cyan shirt will absorb _____ light and reflect _____ light.
 - ... magenta shirt will absorb _____ light and reflect _____ light.
 - ... yellow shirt will absorb _____ light and reflect _____ light.
 - ... black shirt will absorb _____ light and reflect _____ 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.



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. $R + G =$ _____ | b. $R + B =$ _____ | c. $G + B =$ _____ |
| d. $R + C =$ _____ | e. $G + M =$ _____ | f. $B + Y =$ _____ |
| g. $W - R =$ _____ | h. $W - G =$ _____ | i. $W - B =$ _____ |
| j. $W - C =$ _____ | k. $W - M =$ _____ | l. $W - Y =$ _____ |
| m. $W - R - C =$ _____ | n. $W - G - B =$ _____ | o. $W - M - G =$ _____ |