

Name _____

Date _____

Nature of Light and Color

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Access: Google “PhET simulations.” Click on **Light & Radiation**. Launch the **Color Vision** Simulation.

Part I – Use the RGB Bulbs Tab

- 1) Each light has a color gradient. For the best results, slide the bar to the very top of each color. **Each color should be observed individually** for this first part. To stop the color, return the bar to the black location.
 - a) What color is seen when the red light is on?

 - b) What color is seen when the green light is on?

 - c) What color is seen when the blue light is on?

- 2) For the next part we will investigate the effects of mixing two colors. Before you begin each part **be sure to make a hypothesis**.
 - a) What color *do you think* the man will see when **red and green** are mixed together?

 - b) Turn on the red and green, both to the very top of the color scale. What does the man *actually see*?

 - c) Experiment with the degree of color. While doing this, make sure that both colors are in equal locations on the scale. What colors are observed? Do they still fit into the same color family as the color observed in ‘b’?

- 3) Keep the red light on (to the top red location), and turn off the green. We will be looking at red and blue next.
 - a) What color *do you think* the man will see when **red and blue** are mixed together?

 - b) Turn on the red and blue, both to the very top of the color scale. What does the man *actually see*?

 - c) Experiment with the degree of color. While doing this, make sure that both colors are in equal locations on the scale. What colors are observed? Do they still fit into the same color family as the color observed in ‘b’?

- 4) Keep the blue light on (to the top blue location), and turn off the red. We will be looking at green and blue next.
 - a) What color *do you think* the man will see when **green and blue** are mixed together?

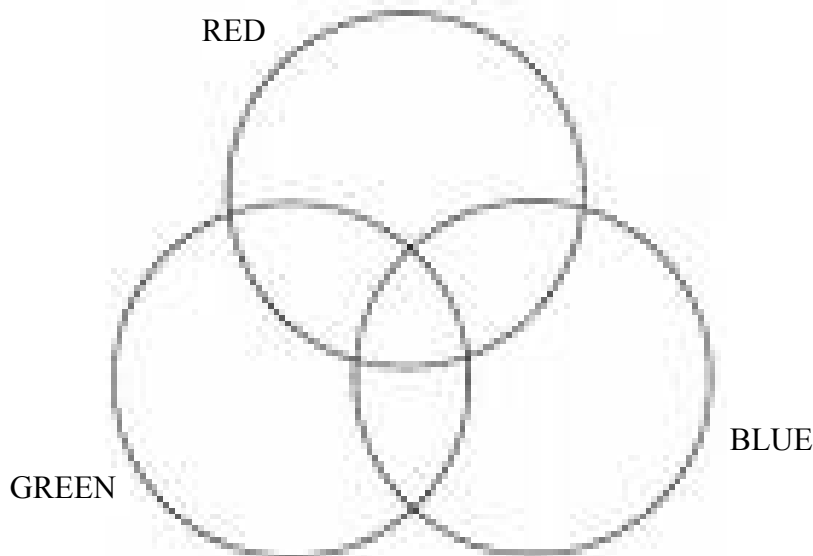
 - b) Turn on the green and blue, both to the very top of the color scale. What does the man *actually see*?

 - c) Experiment with the degree of color. While doing this, make sure that both colors are in equal locations on the scale. What colors are observed? Do they still fit into the same color family as the color observed in ‘b’?

- 5) Now we will be looking at mixing all three colors.
 - a. What color *do you think the man* will see when **red, green and blue** are all mixed together?

 - b. Turn on all three colors, all to the very top of the color scale. What does the man *actually see*?

- 6) Fill in the color diagram below. Provide the appropriate colors that you observed when each was mixed. You may use colored pencils if you wish.



Part II – Use the Single Bulb Tab

- 1) Set the simulation to the following: **bulb type** – ‘white’, **beam** – ‘photons’, and **filter color** – ‘off’.
 - a) What is coming out of the bulb?

 - b) What color light does the man see?

- 2) Set the simulation to the following: **bulb type** – ‘white’, **beam** – ‘solid’, and **filter color** – ‘off’.
 - a) What is coming out of the bulb?

 - b) What color light does the man see?

- 3) Set the simulation to the following: **bulb type** – ‘white’, **beam** – ‘photons’, and **filter color** – ‘on’.
 - a) Choose any filter color. Record the color _____.
 - b) What is coming out of the bulb before the filter (in the area just in front of the filter)?

 - c) What is coming out after the filter?

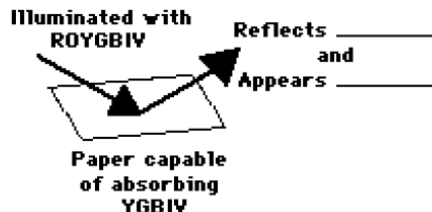
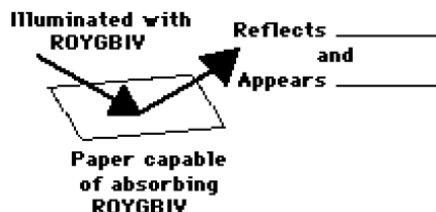
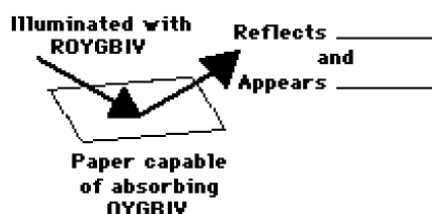
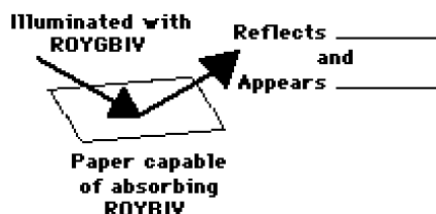
 - d) What color light does the man see?

 - e) Choose another filter color. Record the color _____.
 - f) Repeat questions b-d (above). Please record your observations as you answer the questions.

 - g) What is the filter doing?

- 4) Set the simulation to the following: **bulb type** – ‘white’, **beam** – ‘solid, and **filter color** – ‘on’.
- Choose any filter color. Record the color _____. Repeat questions b-d (from question 3 on the last page). Please record your observations as you answer the questions.
 - Choose another filter color. Record the color _____. Repeat questions b-d (from question 3 on the last page). Please record your observations as you answer the questions.
 - What are the differences between question 3 (photon setting) and question 4 (solid setting)?
 - What are the similarities between question 3 (photon setting) and question 4 (solid setting)?
- 5) Set the simulation to the following: **bulb type** – ‘monochromatic, **beam** – ‘solid, and **filter color** – ‘on’.
- Select a bulb color and a filter color that are **different**. Record the colors chosen below. What does the man see?
Bulb Color: _____
Filter Color: _____
Color seen by the man: _____
 - Select a bulb color and a filter color that are the **same**. Record the colors chosen below. What does the man see?
Bulb Color: _____
Filter Color: _____
Color seen by the man: _____
 - What is the filter doing?
- 6) In this activity light was represented in 2 ways – as a photon or as a solid. What explanation can you provide for the nature of light?

The color that an opaque object appears is dependent upon what color(s) of light incident upon the object and the color(s) of light reflected by the object. Express your understanding of this principle by filling in the blanks in the following diagrams.

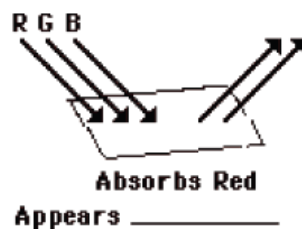
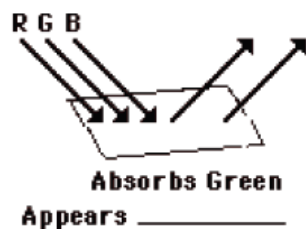
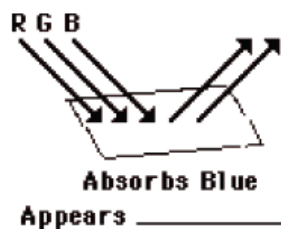


The Rule of Color Subtraction: An understanding of complementary colors assists in understanding the color appearance of objects when viewed under white light. Whenever an object subtracts a color from white light, it appears as the complementary color. If an object absorbs cyan light, then it will appear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

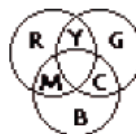
When viewed under white light (RGB), a ...

- ... 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.

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.



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)



- $R + G =$ _____
- $R + B =$ _____
- $G + B =$ _____
- $R + C =$ _____
- $G + M =$ _____
- $B + Y =$ _____
- $W - R =$ _____
- $W - G =$ _____
- $W - B =$ _____
- $W - C =$ _____
- $W - M =$ _____
- $W - Y =$ _____
- $W - R - C =$ _____
- $W - G - B =$ _____
- $W - M - G =$ _____