PhET Simulation – Color Vision

Name ________________________

Date _________________________

INTRODUCTION:

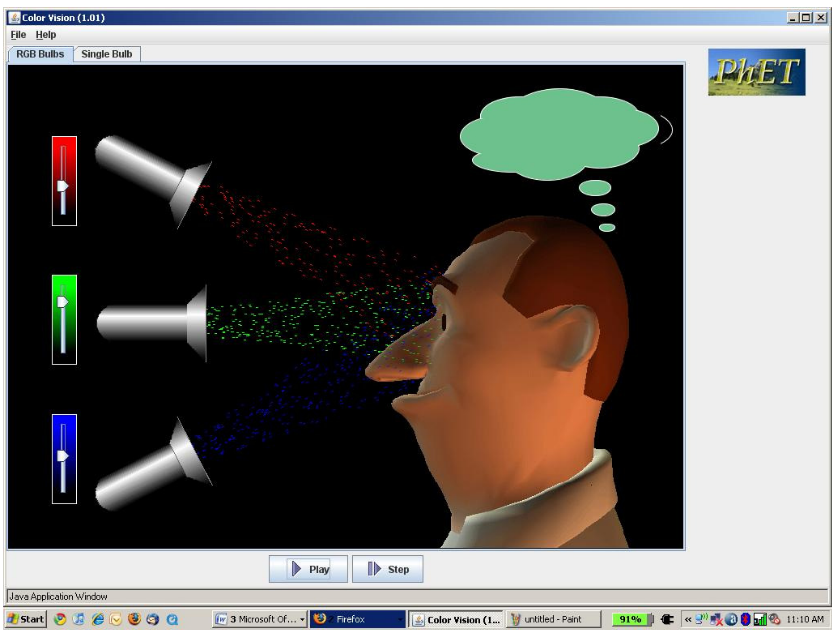
•Why does normal white light (like sunlight) contain all the colors of the rainbow?
•Why is an object a certain color?
•How does a television screen project colored images?

It all is based in the way we see colored **LIGHT**—called ***additive color mixing***.

Don't confuse this with what your elementary school art teacher told you—that if you mix all of the colors of the rainbow you end up with a dark, muddy brown mess. Your teacher was talking about **PAINT**, which is not the same thing as light! The way we make differently colored paint can be explained by something called ***subtractive color mixing***.

MODEL & ACTIVITY:

Access: Google "PhET simulations." Click on **Light & Radiation.** Launch the **Color Vision** Simulation. The following simulation is what you should **Run Now**.



Part 1. Playing and examining model. Play with the simulation for a few minutes. (Not more than 5.)

1. What do you think the moving, colored dots represent?

   Photons.

2. What do you think the colored cloud above the man's head represents?

   The color he perceives.

Part 2. Color intensity or brightness.

3. What color does the man perceive when the red light is turned up to full intensity? Red.

4. What color does the man perceive if the light is turned up to just ¼ of full intensity? Maroon (or dark red).

5. Form a hypothesis to explain these two results:

The perceived brightness of a color is based on the number of photons of that color.

6. Attempt to confirm your idea. Explain how you attempted this:

Change the tab of the red light from 0 to 100% intensity and note if the brightness corresponds.

Part 3. Additive mixing of colored light.
For the next part we will investigate the effects of mixing two colored lights. Before you begin each part **be sure to make a hypothesis.**

RED & GREEN.

7. What color *do you think* the man will see when **red and green** are mixed together? ????

8. Turn on the red and green, both to the very top of the color scale. What does the man *actually see*? Yellow.
9. 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? Brown, ochre, etc. yellow
   •Do they still fit into the same color family as the color observed in the previous question 8? Yes, just different shades.

RED & BLUE.
Keep the red light on (to the top red location), and turn off the green. We will be looking at red and blue next.

10. What color *do you think* the man will see when **red and blue** are mixed together? ????

11. Turn on the red and blue, both to the very top of the color scale. What does the man *actually see*? Magenta (Pink/ Purple).
12. 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? Deep purple, deep pink, etc. magenta.
    •Do they still fit into the same color family as the color observed in the previous question 11? Yes, just different shades.

BLUE & GREEN.
Keep the blue light on (to the top blue location), and turn off the red. We will be looking at green and blue next.

13. What color *do you think* the man will see when **green and blue** are mixed together? ?????

14. Turn on the green and blue, both to the very top of the color scale. What does the man *actually see*? Aqua/ Cyan.

15. 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? Aquamarine, teal, etc. aqua.
    •Do they still fit into the same color family as the color observed in the previous question 14? Yes, just different shades.

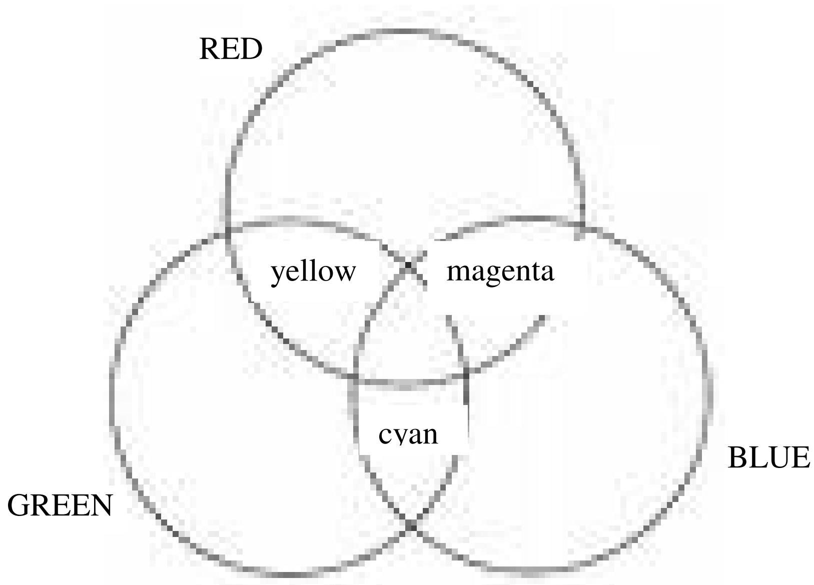
RED, GREEN, & BLUE.
Now we will be looking at mixing all three colors.

16. What color *do you think the man* will see when **red, green and blue** are all mixed together? ????

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

SUMMARIZE.

18. 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.



APPLICATION.

Television and computer monitors.
Red, green, and blue are commonly referred to as the primary additive colors and are used in TV screens and computer monitors. Addition of varying amounts of these primary additive colors generate the enormous variety of colors that can be displayed.

19. Approximately how much of each color should be mixed to generate brown? (dark yellow)
    red 20% green 10% blue 0%
20. Approximately how much of each color should be mixed to generate purple? (dark magenta)
    red 10% green 0% blue 10%
21. Approximately how much of each color should be mixed to generate orange? (medium yellow)
    red 100% green 40% blue 0%

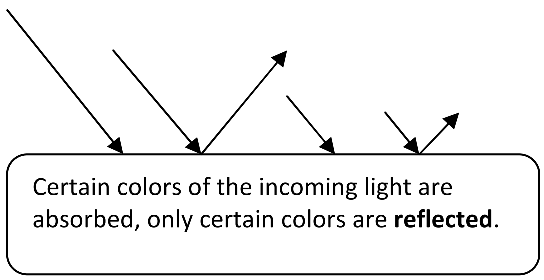
(There are other color combinations)

Colored objects

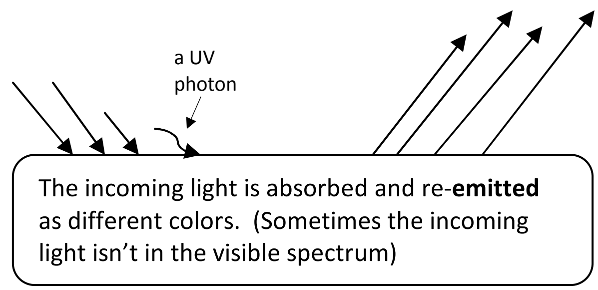
We see objects as a certain color either based on the light that they **reflect** , the light that they **emit**, or some combination of reflected and emitted light.

In the following, light color is related to the length of the arrow.

Ex. ⟶ is a red photon → is a violet photon



Model 1. Reflected Light



Model 2. Emitted Light

Model 1. Reflected light (How you see the color of flowers).

22. In Model 1, is all the light reflected? No.
23. When it is reflected, what do you notice about the color of the incoming and reflected light?
    They are the same.

24. •If an object absorbs a lot of light and doesn't reflect much, will it be dark or bright (not the actual color but the intensity)? dark
    •Give an example of an object like that. Dark fabric/ felt.

25. •If an object does not absorb much light, but rather reflects most of it, will it be dark or bright (not the actual color but the intensity)? bright
    •Give an example of an object like that. White paper.

Model 2. Emitted light (How you see your TV screen).

26. In Model 2, is all the incoming light in the visible spectrum? No.
27. Would **you** be able to see a UV photon? No.
28. What do you notice about the color of the incoming light and the color of the emitted light?
    The emitted light is a different color from the incoming light.

Summarize.

29. What is the difference between color based on reflected light and emitted light?

Reflected light is the light that is not absorbed, but just bounced off. A good analogy is like a person against a wall catching a ball—the balls that are caught and not thrown back are like photons that are absorbed. When light is reflected, its' as if the balls were thrown against the wall—they return without being altered.

Emitted light is light that is given off after the initial light is absorbed. Going back to the analogy in the previous paragraph. It's as if the person against the wall caught the ball and then threw it back in a different way. Sometimes emitted light is the same color as the incoming light, but sometimes the emitted light is a different color from the incoming light.