



Name: _____

Date: _____

Student Exploration: Subtractive Colors

[NOTE TO TEACHERS AND STUDENTS: This lesson was designed as a follow-up to the Additive Colors Gizmo. We recommend you complete that activity before this one.]

Vocabulary: absorb, CMY value, complementary color, cyan, magenta, primary colors, reflect, RGB value, secondary color, subtractive color, transmit

Prior Knowledge Questions

(Do these BEFORE using the Gizmo.)

A color printer can print any color by mixing three **primary colors** of ink: **cyan** (light blue), **magenta** (bright pink), and yellow.

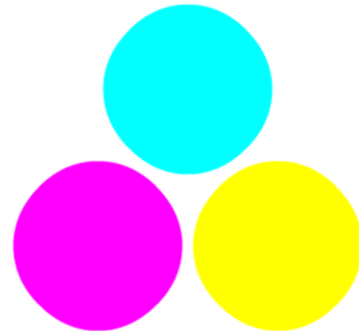


1. What color do you think you would get if you mixed cyan and magenta? _____
2. What color do you think you would get if you mixed cyan and yellow? _____
3. What color do you think you would get if you mixed magenta and yellow? _____

Gizmo Warm-up


We see objects when light from that object enters our eyes. Some objects produce their own light, while others **transmit** or **reflect** light. The *Subtractive Colors* Gizmo allows you to explore how light is **absorbed** and reflected by colored pigments such as paint.

Three primary colors of light—red, green, and blue—combine to make white light. Turn on **Show RGB values at the mouse location** to see how much red, green, and blue is in each color.



1. Move the cursor over a white area. What is the **RGB value** of white? _____
2. Move the cursor over the cyan circle. What is the RGB value of cyan? _____
3. Assume the cyan circle is a painted spot that is illuminated by white light. Some of the white light is absorbed by the cyan pigment, and some is reflected into your eyes.
 - A. What colors of light are reflected by the cyan spot? _____
 - B. What color of light is absorbed by the cyan spot? _____



Activity A: Mixing primary colors	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Turn on the Cyan, Magenta, and Yellow circles. • Check that each color value is set to 255. 	
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Question: What happens when cyan, magenta, and yellow pigment are combined?

1. Gather data: Move the cursor over the magenta and yellow spots. Record the RGB value of each pigment, and then state which colors are absorbed and reflected by each pigment.

Pigment	RGB value	Reflected colors	Absorbed color
Cyan	0, 255, 255	Green, blue	Red
Magenta			
Yellow			

2. Observe: **Secondary colors** are created when two primary colors are mixed together. Which colors result from each of the following pigment combinations?

Cyan and magenta: _____ Magenta and yellow: _____

Cyan and yellow: _____ Cyan, magenta, and yellow: _____

3. Analyze: Consider the combination of cyan and magenta.

A. What color of light does both cyan and magenta reflect? _____

B. What color results from mixing cyan and magenta pigment? _____

C. What colors of light are absorbed by the combination of cyan and magenta pigment?
 _____ and _____

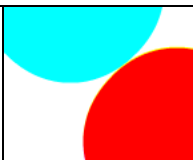
4. Summarize: Explain the result of each color combination based on the colors that each pigment absorbs and reflects.

Cyan and yellow: _____

Magenta and yellow: _____

Cyan, magenta, and yellow: _____



Activity B: Creating colors	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Check that the Cyan, Magenta, and Yellow values are 255. • Check that Show RGB values is on. 	
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Introduction: When more light is added to a mixture, the resulting color becomes lighter. When more pigment is added to a mix, the resulting color becomes darker. For this reason, colors formed by mixtures of pigment are called **subtractive colors**.

Question: How is the RGB value of a pigment mixture determined?

1. **Observe:** Overlap the magenta and yellow circles to make a circle of red. Then move the cyan circle over the red circle. What is the result of combining red and cyan pigment?

2. **Investigate:** Because they combine to make black, red and cyan are called **complementary colors**. Use the Gizmo to determine the complementary colors of magenta and yellow.

3. **Gather data:** Move the three circles so they completely overlap each other. Use the sliders to create each of the described colors in the table below. Record the resulting RGB value.

Color	Cyan	Magenta	Yellow	R	G	B
Dark green	255	180	255			
Tan	45	75	115			
Blue-gray	80	60	45			

4. **Analyze:** For each color in the table above, compare the cyan, magenta, and yellow values (**CMY values**) to the RGB values.

A. What is the relationship between the cyan value and the red value? _____

B. What is the relationship between the magenta value and the green value? _____

C. What is the relationship between the yellow value and the blue value? _____

(Activity B continued on next page)



Activity B (continued from previous page)

5. Calculate: What is the RGB value of a color with a CMY value of 30, 100, 0? _____

Use the Gizmo to check your answer.

6. Summarize: In general, if you are given the CMY value of a color, how can you calculate the RGB value of the color? _____

7. Explore: Use the Gizmo to create a color matching each description. List the CMY value and RGB value of each color. Describe your own object and color in the last line of the table.

Description	CMY value	RGB value
A dark blue night sky		
A gray cloud		
An orange pumpkin		
A green olive		
A red brick		

