

What Are The Primary Colors?

NOT Red, Blue, and Yellow! The Real Physics of Color

DaNel Hogan

Fabiana Estrella coauthor and Illustrator Why do we learn the primary colors are red, blue, and yellow? This is wrong! If you ask a <u>physicist</u> what the primary colors are, she would ask you...

"Are you talking about pigment (paint) or light?"



So, what ARE the primary colors of light and pigment?

Let's find out!



This explains why mixing yellow and cyan paint creates green paint. The yellow paint absorbs blue light, and the cyan paint absorbs red light.

BUT, they both reflect green!

Yellow and cyan paint mixed together create green paint.





Light! So brilliant!

The light coming from the sun is <u>white light</u>.

Using a crystal prism, we can <u>refract</u> or split white light into the colors of the visible spectrum.



Red, Orange, Yellow, Green, Blue, Indigo, and Violet!

NOTE: There are not just seven colors in a rainbow but rather an infinite spectrum of colors.

Our eyes have <u>cones</u> to detect colored light. The cones are sensitive to either red, green, or blue light.



Our eyes perceive red, green, and blue light mixed together as white light.

Man Color

So, instead of thinking of white light as the colors of the rainbow, we can explain it easier by just thinking of white light as a combination of red, green, and blue light added together.

This means red, green, and blue light are the primary colors of light used in <u>color addition</u>!



This explains why mixing yellow and magenta paint creates red paint. The yellow paint absorbs blue light, and the magenta paint absorbs green light.

BUT, they both reflect red!





When we mix paints together, it is called <u>color subtraction</u>.

But, why?

Cyan Paint

Our eye sees the color cyan when blue and green light enter to it at the same time.



You are seeing the cyan above because the paint is reflecting blue and green. What color did the cyan paint absorb from the white light?

Meet the authors¹

DaNel Hogan is a professional STEM (Science, Technology, Engineering, and Mathematics) educator. She taught physics for nine years at the middle and high school levels. As the Director of The STEMAZing Project at the Office of the Pima County School Superintendent in Tucson, Arizona, she currently finds herself teaching educators how to better engage students using STEM content. DaNel finds her creativity and imagination focused on #STEMontheCheap hacks - using inexpensive materials to teach STEM lessons.

Fabiana Estrella is a Bilingual Education major and Spanish minor student at the University of Arizona. She has been working for more than three years in the Supplemental Instruction Think Tank Tutoring Department in the areas of Biology and Spanish. Fabiana believes art, creativity, and games can be great tools for kids to understand difficult concepts and subjects. Currently, Fabiana interns with DaNel at The STEMAZing Project.



Fabiana Estrella

Glossary

Color Addition: Starting with no light and adding colored light together to create new colors. All the colors combined create white light.

Color Subtraction: Starting with white light and subtracting out or absorbing colors using pigments or paints to create new colors. All primary colors of paint mixed together create black paint.

Cones: Cells in your eye which detect either red, green, or blue light.

Physicist: A person who studies physics.

Physics: The study of matter and energy including mechanics (how things move), light, sound, electricity, and magnetism.

Pigment: A substance that absorbs and reflects specific colors of light. Another name for paint.

Refract: A change in the direction of light as it enters a new material. The color or wavelength of light determines how much it changes direction. Blue light refracts or changes direction more than red light.

White Light: A combination of all the colors of light.



Yellow Paint





reflecting red and blue. What color did the magenta paint absorb from the white light?

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In other words, the primary colors are NOT red, blue and yellow.



They ARE cyan, yellow, and magenta





BUT, they both reflect blue!