chapter 12

Light

section 2 Light and Color

Before You Read

Colors are important in everyday life. Name a time when seeing color is important.

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What You'll Learn

- how you see color
- the difference between light color and pigment color
- what happens when colors are mixed

Read to Learn

Mark the Text

Identify the Main Idea

After you read each paragraph, highlight the topic sentence, or the main idea, of the paragraph.

Colors

Why do some apples appear red, while others look green or yellow? You read that white light is made up of light of different wavelengths. Each wavelength is a different color. The color of an object, like an apple, depends on which wavelength(s) of light it reflects. For example, when white light hits a red apple, only the red wavelengths are reflected. This is why the apple appears to be red. The apple absorbs all other wavelengths of light.

Some objects reflect all wavelengths of visible light. Visible light is light that we can detect with our eyes. Objects that reflect all wavelengths of visible light appear to be white. What about black objects? Black is not a color of visible light. Black objects absorb all wavelengths of light. Since almost no light is reflected from these objects, they appear to be black.

How can colors be filtered?

Have you ever worn tinted glasses? Maybe you noticed that tinted glasses change the color of almost everything you see. Yellow glasses make everything look yellow. Red glasses make the world look red. If you put a see-through green plastic sheet over this page, the paper would look green. Tinted glasses and see-through plastic sheets are filters. A **filter** is a transparent material that lets one or more colors pass through, but absorbs the rest. The color of a filter is the color of light that it lets through.

What happens when you look through a colored filter?

When you look at a baseball field, you see green grass. But what would happen if you looked at it through a green filter? Since a green filter lets green light pass, the grass would still look green. Suppose you looked at the same field with a red filter. A red filter only allows red light to pass through. Green grass absorbs all colors, including red, except green. Since the grass absorbs the red and the filter blocks the green, the grass appears black.

Reading Check

1. **Infer** What color would green grass appear to be if you looked at it through a red filter?

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Seeing Color

As you approach an intersection the traffic light changes from green to yellow to red. What could happen at the intersection if you couldn't see the color changes? Your safety could depend on seeing colors. How do you see colors?

How does your eye detect light?

Look at the figure below. Light enters your eye through the lens. The lens focuses light onto the retina. The retina is an area on the inside of your eyeball. The retina has two types of cells that absorb light. When retina cells absorb light energy, chemical reactions happen inside the cells. The chemical reactions change light energy into nerve signals that go to your brain.

The two types of retina cells are cones and rods.

Think it Over

2. **Infer** Nocturnal animals are awake mostly at night. Which type of retina cells would nocturnal animals probably have the most of?

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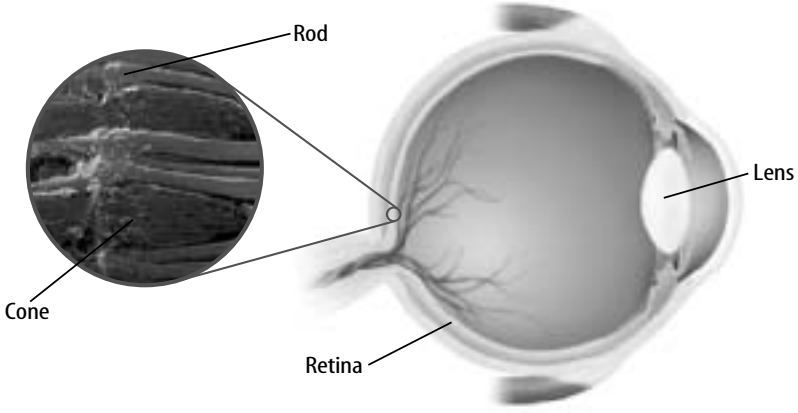
What are cones and rods?

Your retina has three types of cones. Cones are sensitive to color and bright light. Each type detects different wavelengths, or colors of light. Red cones detect mostly red and yellow light. Green cones detect mostly yellow and green light. Blue cones detect mostly blue and violet light.

The second type of retina cell is a rod. Rods are sensitive to dim light and aid night vision.

Picture This

3. **Use a Scientific Illustration** In the figure, underline the name of the kind of cell that allows you to see colors. Circle the name of the kind of cell that allows you to see in dim light.



How do you interpret color?

When you see a stop sign, how do you know it is red? Red light reflected by the stop sign enters your eye and is focused on the retina. Red cone cells send a signal to your brain. Your brain then understands the signal to mean "red."

What is color blindness?

If one or more sets of cones in your retinas did not work correctly, you would not be able to detect certain colors. This condition is called color blindness. About eight percent of men and one-half percent of women have a form of color blindness. Most people who have color blindness are not truly blind to colors. They have trouble telling the difference between some colors, usually between red and green. People learn to deal with color blindness in many ways. For example, the color of a traffic light can be identified by its position.

Applying Math

4. **Convert** What does "one-half percent" mean?

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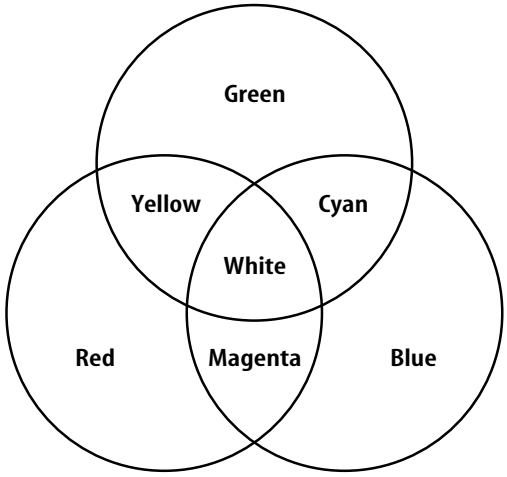
Mixing Colors

Have you ever noticed the hundreds of different paint colors customers can choose in a hardware store? You may even have mixed paints to make new colors in art class. It is possible to create different paint colors by mixing pigments. A **pigment** is a colored material that is used to change the color of other substances. A pigment's color depends on the wavelengths of light it reflects.

What happens when you mix colored light?

All the colors you see are made by mixtures of three colors of light—red, green, and blue, known as the primary colors of light. They correspond to the three different types of cones in the retina of your eye. Mixing them in different proportions produces all visible colors. As the figure shows, if red, green, and blue light are mixed equally, the result is white light.



Picture This

5. **Observe** What color appears when red and blue light are mixed?

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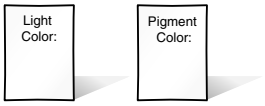
FOLDABLES

B Classify Make the following Foldable to help you organize information about light color and pigment color.



Think it Over

6. **Explain** A hardware store clerk uses green pigment to make green paint. Is green pigment a primary pigment, or is it made from a mixture of primary pigments? Why or why not?

Picture This

7. **Observe** What color appears when magenta and cyan pigments are mixed?

What are paint pigments?

Paints are made with pigments. Paint pigments are made from chemical compounds. Titanium dioxide is a bright white paint pigment. Lead chromate is a yellow pigment that is used to paint the yellow stripes on highways. If you mixed equal amounts of red, green, and blue paint, would you get white paint? No, because mixing paint is different from mixing colored light.

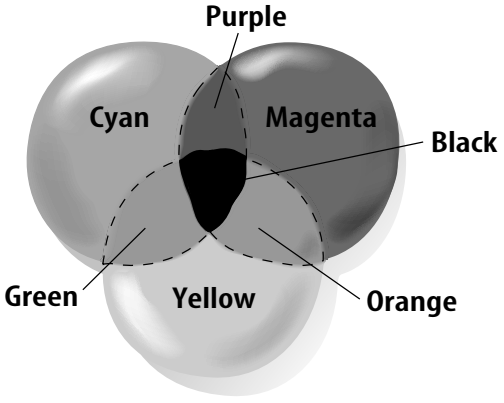
How is mixing pigments different from mixing light?

There are three primary colors of pigments, just as there are three primary colors of light. But the primary pigment colors are different. They are cyan, magenta, and yellow. Cyan is a greenish blue. Magenta is a bluish red. You may have seen these color names if you have ever put ink cartridges in a color printer. You can make any pigment color by mixing different amounts of the three primary pigment colors.

A primary pigment's color depends on the color of light it reflects. Pigments both absorb and reflect many colors. Your eyes and brain, however, see the range of light wavelengths as one color. For example, a yellow pigment appears yellow in white light because it reflects red, orange, yellow, and green light. It absorbs blue and violet light. So, the color of a mixture of primary pigments depends on the primary colors of light that the pigment reflects.

Is there a black pigment?

Recall that the three primary colors of light combine to produce white light. They are called additive colors. The opposite is true with pigments. When equal amounts of cyan, magenta, and yellow pigments are mixed, they produce black.



Look at the figure. The area where the three primary pigments overlap is black. The blended primary pigments absorb all colors of light. Because black is the result of no light being reflected, primary pigments are called subtractive colors.

After You Read

Mini Glossary

filter: a transparent material that lets one or more colors pass, but absorbs the rest

pigment: a colored material that is used to change the color of other substances

1. Review the term and its definition in the Mini Glossary. Write a sentence describing a product you have used that contains pigments.

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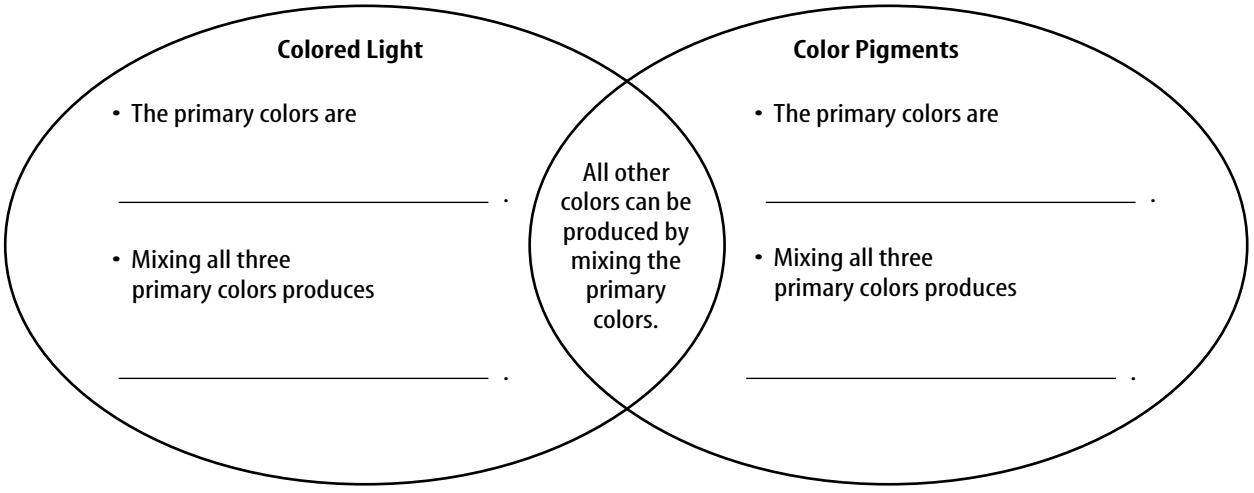
2. Complete the Venn diagram to organize the information you learned in this section about color.



3. Mark the Text Think about what you have learned. How did highlighting the main idea of each paragraph help you as you read the section?

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End of Section