LESSON 12

# Colored Light

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*On a visit to a theater you may see lights like these. What is their function and how do they work?*

## INTRODUCTION

Imagine you're at the theater, an opera, or a musical. The lights of the theater darken for the performance. A hush descends over the audience as the curtains slide open. The stage looks dark. Suddenly there is a blaze of color as the star of the performance makes her entrance bathed in colored light. Where is this light coming from? Above, and to either side of the stage, you locate the source of this light. Large numbers of spotlights—some fixed to gantries, a few directed by hand—point at the stage. A few emit white light, but most shine a beam of colored light onto the stage. How is this colored light produced? How are the different colors used to set the scene on the stage combined? What happens when colored lights are mixed? How do these colors affect the appearance of the props and costumes? In Lesson 11, you determined that colored objects look colored because they absorb—or subtract—some of the colors from the light that falls on them and reflect other colors. Objects appear to be the color of the colors they reflect. What name did we give to this type of color mixing? In this lesson, you will investigate another type of color mixing. This color mixing process takes place when the colors from colored lights are added together. Can you guess the name that is given to this type of color mixing?

### OBJECTIVES FOR THIS LESSON

**Investigate what happens when lights of different colors are mixed together.**

**Discuss how this type of color mixing is used.**

## Getting Started

1. Imagine you are in charge of lighting the stage for a concert or play. You have red, green, and blue spotlights. With your group, predict which colors you could make by combining the colors of the spotlights.

2. Record your predictions in the Predictions section of Table 1 on Student Sheet 12.1: Mixing Colored Lights. Be prepared to share your predictions with the class.

# Inquiry 12.1
# Mixing Colored Lights

### PROCEDURE

1. One member of your group should collect the plastic box of materials.

2. Working with your group, come up with a procedure to use the materials available to test the predictions you made in "Getting Started." Record the materials you use and your procedure in Table 1. Use diagrams where appropriate.

3. Devise a data table in Table 1 for your results.

4. Test your predictions and record your results.

5. In the Conclusions section of Table 1, write a paragraph explaining what you can conclude from your inquiry.

### MATERIALS FOR LESSON 12

**For you**

- 1 copy of Student Sheet 12.1: Mixing Colored Lights
- 1 copy of Student Sheet 12.2: Assessment Review—Part 1
- 1 copy of Student Sheet 12.3: Sample Assessment Questions for Part 1

**For your group**

- 3 flashlights
- 6 D-cell batteries
- 1 red filter
- 1 green filter
- 1 blue filter

## REFLECTING ON WHAT YOU'VE DONE

**1.** The type of mixing you explored in Inquiry 12.1 is called additive color mixing. In additive color mixing, red, green, and blue are the primary colors. Discuss A and B with your group and then record your answers on Student Sheet 12.1.

A. Why is the term "primary colors" used to describe red, green, and blue colors in additive color mixing?

B. Why do you think this type of mixing is called additive color mixing?

**2.** In Lesson 11, you learned about color mixing that subtracts color—subtractive color mixing.

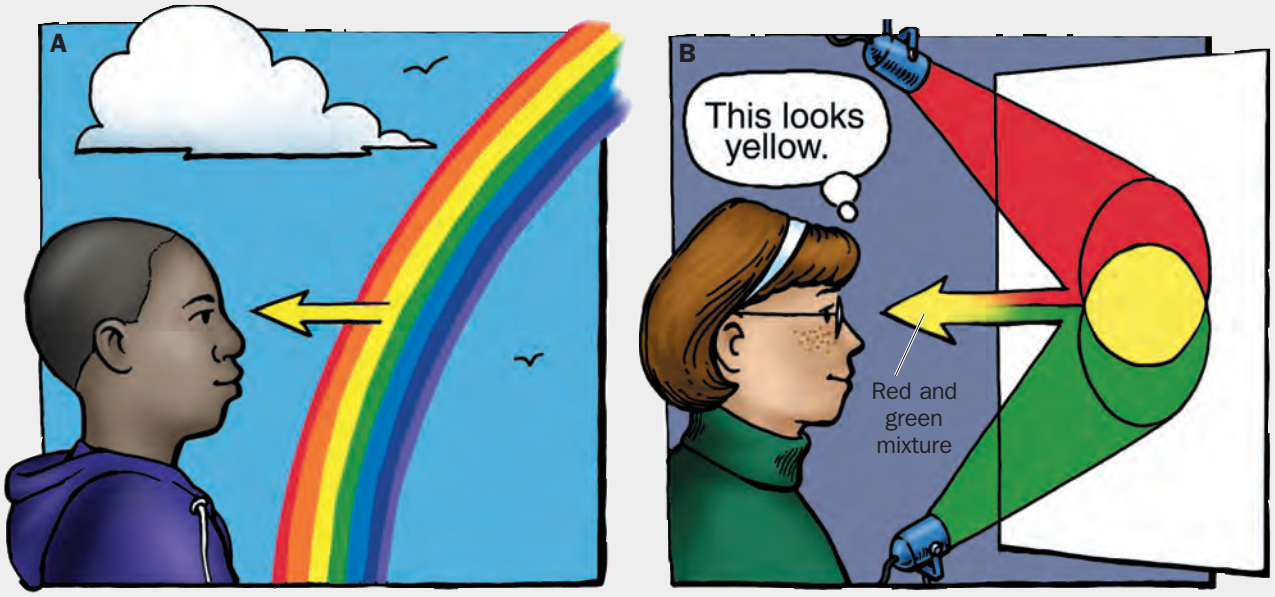
C. Write a short paragraph that describes how additive color mixing differs from subtractive color mixing.

**3.** Read "About Color Vision and Color Mixing."

## About Color Vision and Color Mixing

When you used a prism or your spectroscope to split white light into its different wavelengths, the colors you observed were different wavelengths of light. Yellow, for example, was a small range of wavelengths that looked yellow.

Because of the way our eyes detect color, we perceive mixtures of colors as one color. For example, you already know that white is a mixture of colors. The yellow you made with your flashlights is another example of this. It was not one wavelength of light. It was made from a mixture of two other colors—red and green—that your eyes detected and your brain perceived as being yellow. So the brain perceives yellow in two ways: pure yellow wavelengths or mixtures of red and green wavelengths.




*A. The yellow from a rainbow, prism, or spectroscope is a pure color consisting of "yellow wavelengths."*
*B. This yellow is produced differently. It comes from the yellow we see when red and green lights are mixed. No wavelengths corresponding to yellow light are reaching the eye.*

# Red, Green, and Blue Entertainment

Although the visible spectrum contains a continuous range of colors from red to violet, our eyes can be tricked into seeing all these colors by mixing only three of them: red, green, and blue. In fact, we allow TV to use this trick every time we watch it.

Turn on a color TV. Look closely at the screen. If you have a magnifying glass, use it to study the picture on the screen. What do you see? If you look very closely at the screen, you will find the picture the TV produces on the screen is made up of thousands of dots. Each dot is a red, green, or blue light. Where do these dots come from? How do they light up? How do they make a moving color picture?

Here's how it works. The inside of the front of your TV screen is made up of thousands of dots, or pixels, arranged in groups of three.

*Imagine watching a TV like this one. The picture was only in black and white. Why do you think it was easier and cheaper to make a black-and-white TV?*

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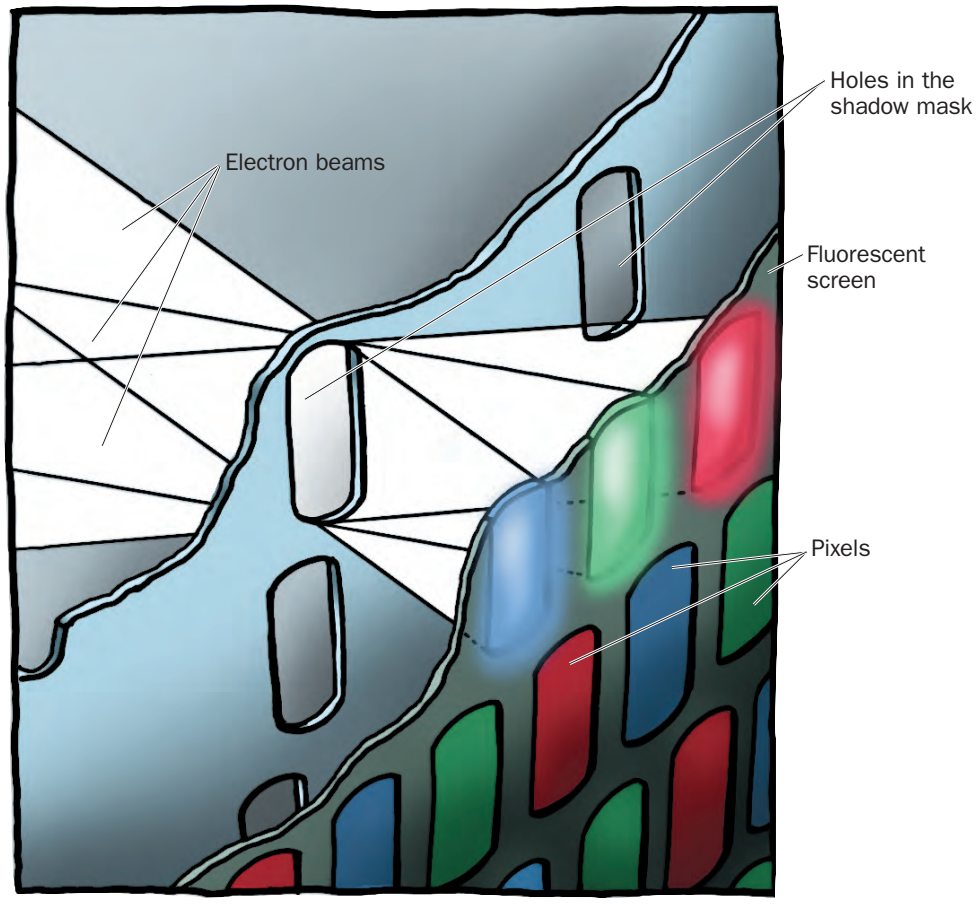
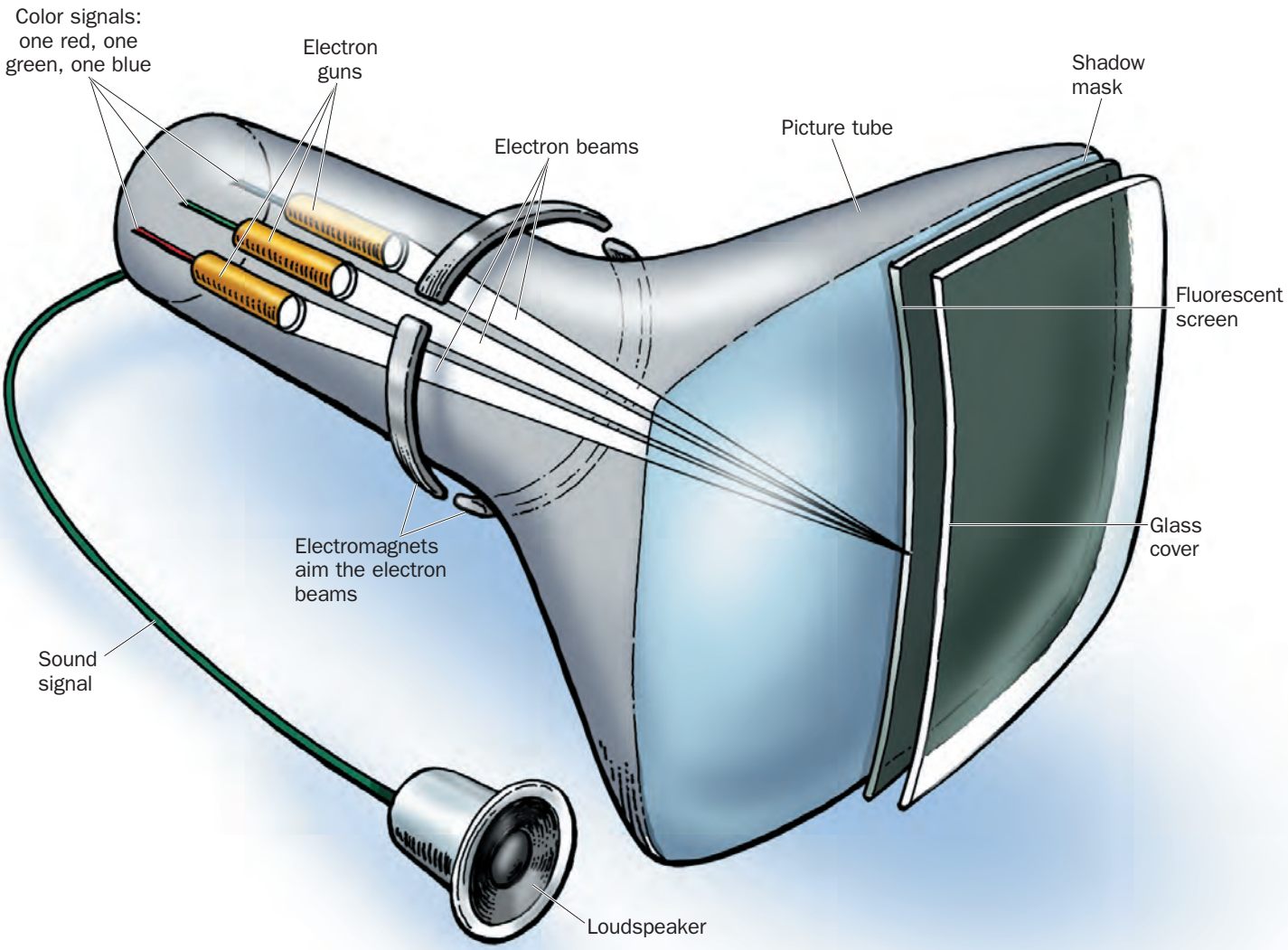
Each group contains one red, one green, and one blue pixel. Three beams of electrons (one for making each color) race across the screen targeting certain pixels through thousands of tiny holes positioned just behind the screen (in what is called the shadow mask). If a beam hits a pixel, the pixel glows. The beams use these pixels to draw a different picture about 30 times every second! As these pictures flash on the screen, they appear to our eyes as a moving image.

### From Signal to a Video Picture

Where do these pictures come from? A TV receives signals, either as radio wave signals through its antenna or satellite receiver or as signals via cable. It converts the signals to sound (audio) and pictures (video). The video part of the signal is further decoded into signals for red, green, and blue. These signals are used to control the electron beams that light up the appropriate colored pixels on the screen. By lighting different pixels in a group, the beams trick the eye into seeing different colors—through additive color mixing. If the red and green pixels in one group are lit, your eyes see yellow. If the beam lights up all three in the group (red, green, and blue), your eyes see white. (This is the same type of color mixing you observed when you shined the flashlights through the colored filters.) By changing the combination and brightness of each of colored pixels, the TV can create thousands of colors. □




*A TV picture is made up of thousands of dots, or pixels. Each pixel is red, green, or blue. They are so small that you can not see them individually, so they are able to appear as a solid color picture.*




*Inside a TV set, there are three electron guns, one for each color. These guns fire beams of electrons that make the red, green, or blue pixels glow to form a picture of many colors by using additive color mixing. The guns scan alternate lines of pixels that make up each picture. Each picture is therefore scanned onto the screen twice—60 scans or 30 complete pictures each second.*