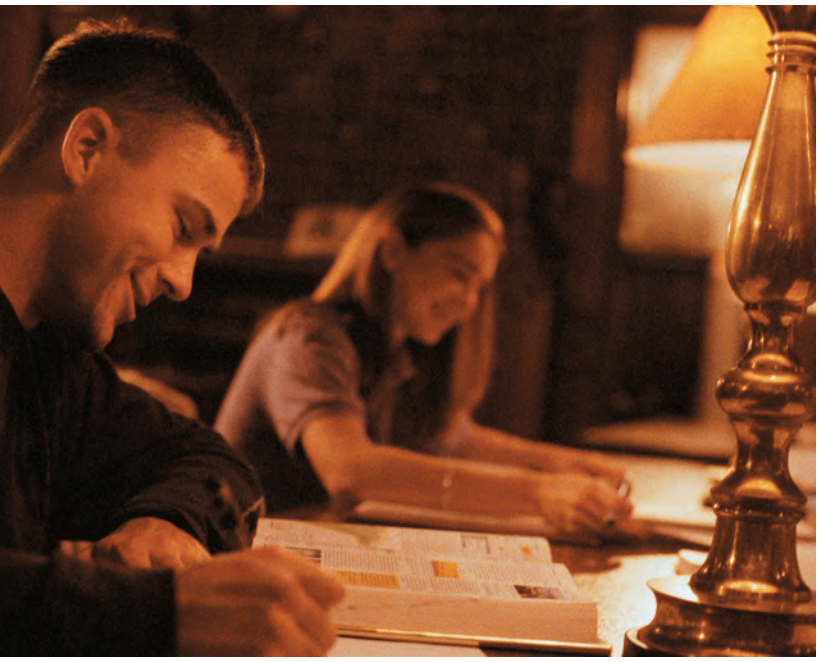
LESSON 2

Where Does Light Come From?



CORBIS/ROYALTY-FREE

We use artificial light sources to help us to see. How do light sources like lamps produce light? Where does light come from?

INTRODUCTION

Everyone knows that light exists. But what is light? Where does light come from, and how is it made? From your own observations, you know that some objects make light. The most important of these is the Sun. Do you know how the Sun and other objects make light? In this lesson, you will try to answer some of these questions. You will identify different sources of light and then conduct an inquiry to examine two of these sources—a flashlight and a lit candle—in more detail. You will discuss the nature of light and some processes by which it is made.

OBJECTIVES FOR THIS LESSON

Share your ideas on the nature of light.

Identify different sources of light.

Investigate some sources of light.

Discuss light as a form of energy.

Discuss a range of energy transformations.

Investigate and discuss the transformation of light into other forms of energy.

Getting Started

1. In your science notebook, record your own ideas about the following questions:

A. What do you think light is?

B. What do you think light is not?

C. Where does the light in the classroom come from?

2. Be prepared to share your ideas with the class.

MATERIALS FOR LESSON 2

For you

- 1 copy of Student Sheet 2.2: How Is Light Produced?
- 1 pair of safety goggles

For you and your lab partner

- 1 flashlight
- 2 D-cell batteries
- 1 petri dish (lid or base)
- 1 tea candle

Inquiry 2.1
Identifying Sources of Light

PROCEDURE

1. You have identified a source, or some sources, of light within your classroom. Working with your group, think of other sources of light. List those sources in your notebook.

2. Your teacher will ask you to contribute to a class brainstorm on different light sources. Your teacher will record the class's ideas on a concept map. As the concept map builds up, record it in your notebook.

Inquiry 2.2
How Is Light Produced?

PROCEDURE

1. One member of your group should collect a plastic box of materials. Divide the materials between the pairs in your group. Record your responses on Student Sheet 2.2: How Is Light Produced?

2. Working with your partner, examine the flashlight (see Figure 2.1). You may take it apart if you wish, but be careful not to break it. Do not dismantle the switch. As you examine the flashlight, answer the following questions. Use words and/or diagrams to record your results and ideas.

SAFETY TIP

Put on your safety goggles before proceeding with the inquiry.

Figure 2.1 *Try to find out how a flashlight produces light.*

A. Exactly where does the flashlight release its light?

B. Where does this light come from?

C. Where does the light go?

D. Is anything produced in addition to light?

E. Try to explain how the flashlight makes light.

3. Reassemble the flashlight. Check to see that it works.

4. Place the candle on the petri dish. Use a match (or ask your teacher) to ignite the candle. Observe what happens as the match is struck and ignites the candle.

5. Think about the following questions, and then answer them on the student sheet:

F. What was produced when you struck the match?

G. Where did what was produced when you struck the match come from?

H. How does the candle make light?

I. Is anything else produced in addition to light?

J. What happens to the candle as it makes light?

6. Extinguish your candle. Return all the materials to the plastic box.

SAFETY TIP

Your teacher may give you a book of matches to use to light the candle. Use caution when lighting the match. Always strike a match away from you and other students, and be very careful not to burn your fingers. Do not play with the matches. Avoid breathing in the fumes from the match.

REFLECTING ON WHAT YOU'VE DONE

1. Read "Transforming Energy."

2. Discuss A–C with your group. Record your responses on the student sheet.

A. Was light stored in any of the items you examined?

B. What had to happen for light to be produced?

C. Write down the energy transformations taking place in the flashlight and the candle.

3. Look at the scene shown in Figure 2.2. (This is the same scene as the "Where's the Energy?" picture on your student sheet.)

D. Work with the class to identify any forms of energy you see on the picture. Mark and write the names of these forms of energy on or around the edge of the picture on your student sheet.

E. Under the picture write down any examples of energy transformations you see happening in the picture (one example is provided under E on the student sheet). Can you identify those that involve light energy?

WHERE'S THE ENERGY?

Figure 2.2 *Identify the forms of energy you see in this scene. Mark and write the names of these forms of energy on or around the edge of the picture on your student sheet.*

4. If light is a form of energy, it should be possible to transform this energy into other forms. Watch as your teacher shows you two examples of such a transformation. Try to decide what energy transformations are taking place (see Figures 2.3 and 2.4).

F. Record your ideas on the student sheet.

G. Write a short paragraph outlining the evidence that light is a form of energy.

5. Look at the question bank cards the class generated in Lesson 1. Can you answer any of these using what you have discovered during this lesson?

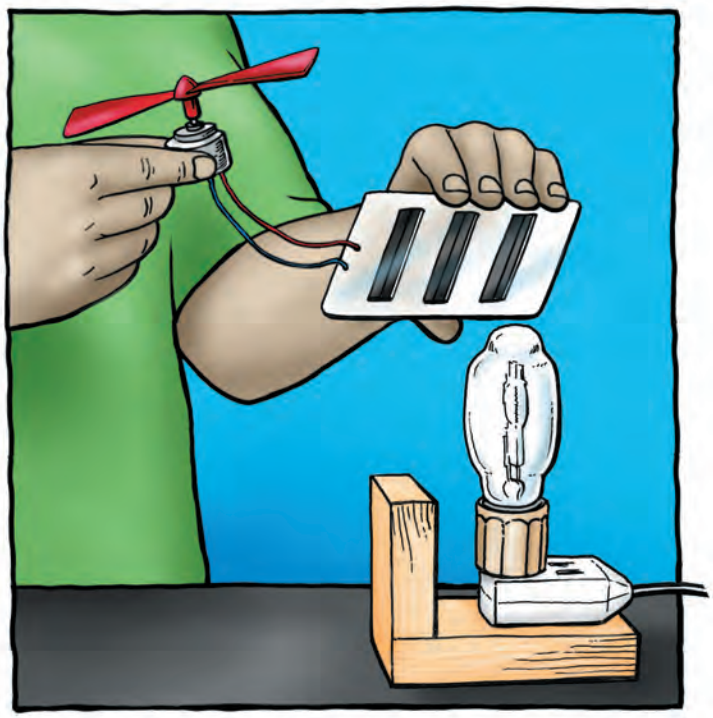


Figure 2.3 *What happens to the motor when light strikes the solar panel? What energy transformations are involved?*

Figure 2.4 *What happens when a flashlight is shone at the radiometer? What energy transformations are involved?*

TRANSFORMING ENERGY

Different light sources make light in different ways. But all light sources have something in common. They produce light as a result of energy transformations. Energy can take many forms. (Light is just one form of energy. Heat and electrical energy, movement energy, and chemical energy—stored in food or fuel—are also forms of energy. All forms of energy can do work—they can make things move.)

Energy can also be transformed from one form of energy into another form. For example, switching on the lights in your classroom allows electrical energy to enter the fluorescent tubes where some of this electrical energy is transformed into light.

When an energy transformation takes place, usually more than one form of energy is produced. Switching on the classroom lights releases light energy. But, if you touch the lit fluorescent tubes, you will also notice it is slightly warm. Heat is nearly always one of the forms of energy released during an energy transformation. The energy transformation occurring inside the tube could be expressed as follows:

Electrical energy → light and heat

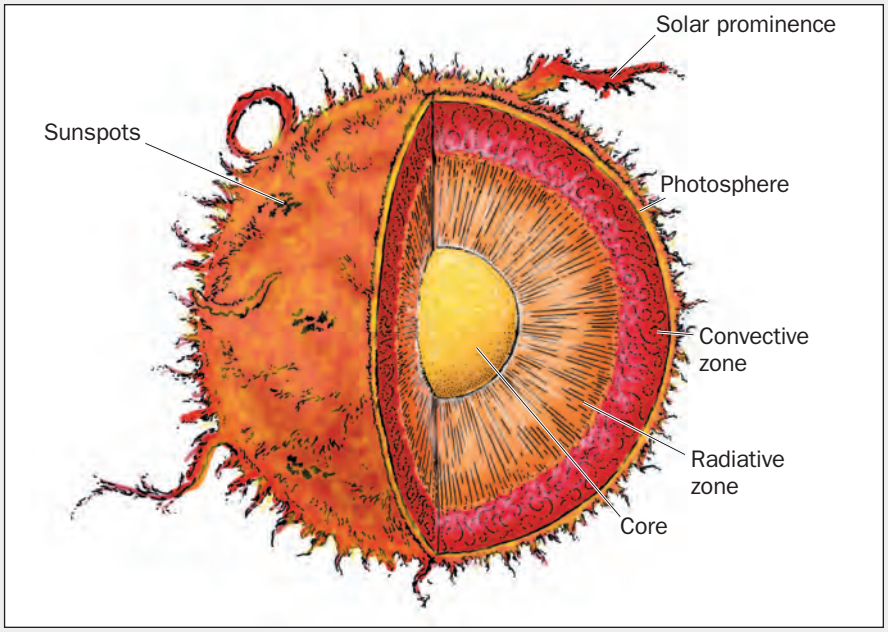
Was there any evidence that heat was released during the energy transformations you observed in the flashlight, match, or candle?

E.R. DEGGINGER/COLOR-PIC, INC.

In a fluorescent tube, electrical energy passes into mercury vapor inside the tube and excites the mercury vapor. The excited vapor makes the white coating on the inside of the tube glow.

SOURCES OF LIGHT

Light sources—objects that make their own light, such as lightbulbs, the Sun, or candles—are said to be luminous. Some examples of luminous objects are shown here. Can you think of others?



The Sun is a giant ball of gas, mainly hydrogen and helium, about 1,400,000 kilometers in diameter. Light and heat are released from the surface layer of the Sun. Inside the Sun, nuclear reactions—similar to those that occur in hydrogen bombs—release energy. The temperature in the Sun's interior is about 15,000,000 degrees Celsius (°C) (27,000,000 degrees Fahrenheit (°F)). The glowing surface of the Sun (called the photosphere) is much cooler, about 5600 °C (10,000 °F)!

JEFF MCADAMS, PHOTOGRAPHER, COURTESY OF CAROLINA BIOLOGICAL SUPPLY COMPANY

Light-emitting diodes (LEDs)—like the ones that make up the numbers in this clock—produce light from electrical energy. Because they make almost no heat, they are much more efficient at producing light than ordinary lightbulbs.

ADAM BLOCK/NATIONAL OPTICAL ASTRONOMY OBSERVATORY/ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY/NATIONAL SCIENCE FOUNDATION

Lightning is produced when static electricity in clouds discharges and produces a spark. This spark is so hot that it superheats the air, causing the air to expand explosively and make thunder.

E.R. DEGGINGER/COLOR-PIC, INC.

In an ordinary lightbulb, the filament—usually a piece of thin tungsten—glows when electrical energy passes through it. The filament does not burn up because it is enclosed in a glass bulb containing a non-reactive gas such as argon. In addition to light, these lightbulbs produce quite a lot of waste heat—heat that is not used. This wasted heat means these lightbulbs are not energy efficient. Fluorescent lightbulbs, which produce far less waste heat, are more energy efficient.

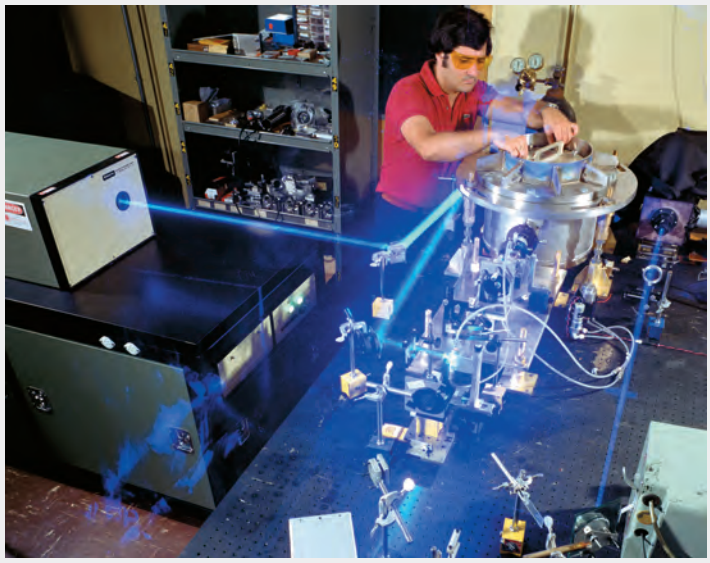
CHRIS CORRIE PHOTOGRAPHY

Fires, candles, and oil lamps release light when the fuel in them reacts with oxygen. Heat and light are produced in this chemical reaction.

COURTESY OF OMNIGLOW CORPORATION

In glow sticks, a chemical reaction produces light, but not much heat. When the stick is bent, a glass vial inside breaks. This allows the reactants to mix. The process of producing light by this type of chemical reaction is called chemoluminescence. Unlike fire, it produces very little heat.

LAWRENCE BERKELEY NATIONAL LABORATORY



In this laser, light is produced when a flash of light is used to excite atoms inside a special tube in the laser. The excited atoms produce an intense beam of single-colored light. Laser light has special properties that make it a very useful light source. You'll learn more about lasers later in the module.

LIFE LIGHT

The waters of Mosquito Bay, Puerto Rico, contain about 200,000 glowing microbes per liter. When disturbed, as by this swimmer, they release a blue light. Sadly, this glowing performance is endangered by pollution.

Many kilometers down—in the deepest parts of the oceans—there is no sunlight. Down here in the darkness, thousands of species of organisms thrive, from single-celled microbes to giant worms and squid. Water covers much of the Earth. A huge volume of water makes up the oceans and seas. So it is not surprising that this is where you will find most of Earth's living things.

Most of this water lies in darkness. But some organisms living down here have eyes. Why have eyes if there is no light to see by? While no sunlight reaches these depths, there is light. Many marine organisms make their own light by a process called bioluminescence—"life light." They use this light to communicate with their own species or, in some cases, as a lure to capture their prey.

For example, the flashlight fish has glowing body parts! Under its eyes are pockets that contain bioluminescent microbes (bacteria). These bacteria make light all the time, but the fish hides these glowing pockets under a movable flap of skin. When the fish wants to reveal its lights, it simply moves the flap.

But how do organisms make light? They don't

JOHN RANDALL

The flashlight fish has lights below its eyes. It makes light with the help of bioluminescent bacteria.

JAMES E. LLOYD, DEPARTMENT OF ENTOMOLOGY AND NEMATOLOGY, UNIVERSITY OF FLORIDA, GAINESVILLE

Fireflies use chemical reactions within their cells to transform chemical energy from food to light energy.

use lightbulbs, but they do have something in common with flashlights. In a flashlight, part of the chemical energy in the batteries is transformed (via electrical energy) in the lightbulb to light and heat energy. Bioluminescent organisms also transform chemical energy into light. They use special enzymes—chemicals that speed up the chemical reaction—in this process. These enzymes cause a chemical called luciferin to react with oxygen. Light energy is released during this reaction.

Bioluminescence is very common in marine organisms. Many fish and squid glow. So do some microscopic organisms that float in the water. These are sometimes present in such large numbers that they can make a whole sea glow. For example, Mosquito Bay, Puerto Rico, is famous for its nightly performance of bioluminescence.

Organisms living in the depths of the oceans are not the only species that make their own light. Some nonmarine organisms also make light. Have you ever seen fireflies or lightning bugs? They use bioluminescence to communicate with each other. Try communicating with them on a warm summer's evening by using a flashlight. You may be surprised how many will reply to a short flash of light!

Go for a nighttime walk in the woods and you may observe rotting trees that glow in the dark. Glowing fungi inhabit the trees. Why do they glow? Perhaps to attract insects that can spread their spores.

Keep your eyes open. You may see other organisms glow. □