5.1

Light Energy and Its Sources

What is light? Light is not something you can touch or taste. It doesn't have any mass. But you can see light, and it has other effects on matter. For example, a penny put in sunlight will get warmer than a penny placed in the shade. The penny in the sunlight gains energy from the light. Based on these observations, we can say that **light** is a form of energy that can be detected by the human eye. (After you have studied the properties of light, you will be able to state a more complex definition of light.)

You can learn more about light by looking carefully around you. For example, in a room lit by electric light, you can see the light that comes directly from the electric light to your eyes. But what about other objects in the room? How can you see them? The light energy from the electric light must spread throughout the room. Some of it bounces off objects, then travels to your eyes, enabling you to see objects and people in the room. **Figure 1** shows how light reaches your eyes.

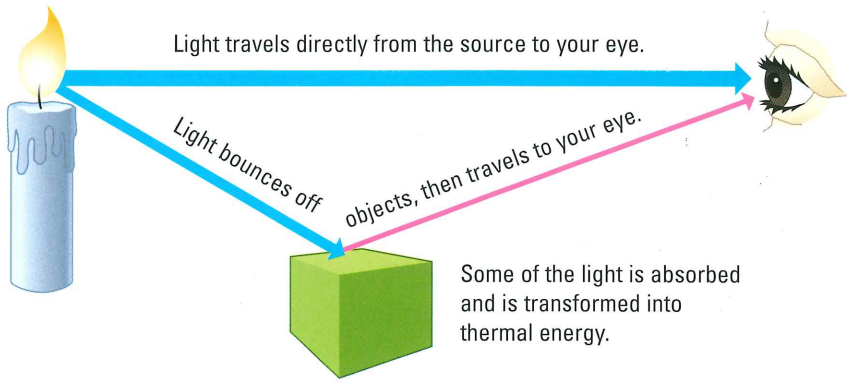


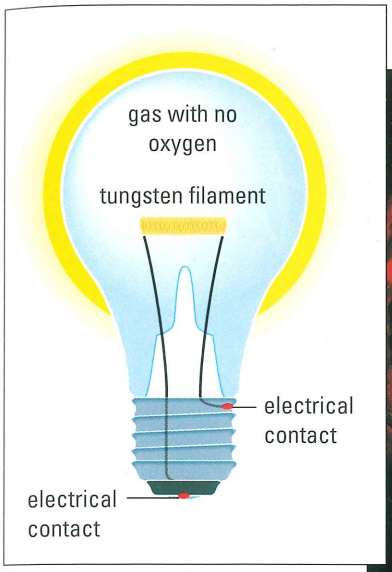
Figure 1
Light energy travels directly and indirectly to your eyes.

Sources of Light and Reflectors of Light

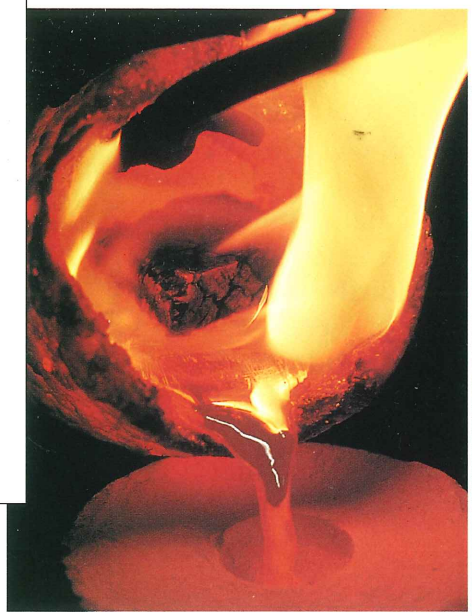
Light energy comes from many different sources, both natural and artificial. The Sun is the most important natural light source. Artificial sources of light are created by people. Objects that emit (give off) their own light are said to be **luminous**. The Sun is luminous; a burning candle is luminous. Objects that do not emit light, but only reflect light from other sources, are said to be **nonluminous**. Most things—this book, your desk, your classmates—are nonluminous. Even the Moon is nonluminous; it does not emit light. We see the Moon because it reflects light from the Sun.

In luminous objects, the input energy transforms into light energy. Common initial forms of energy are chemical energy, electrical energy, nuclear energy, and thermal energy.

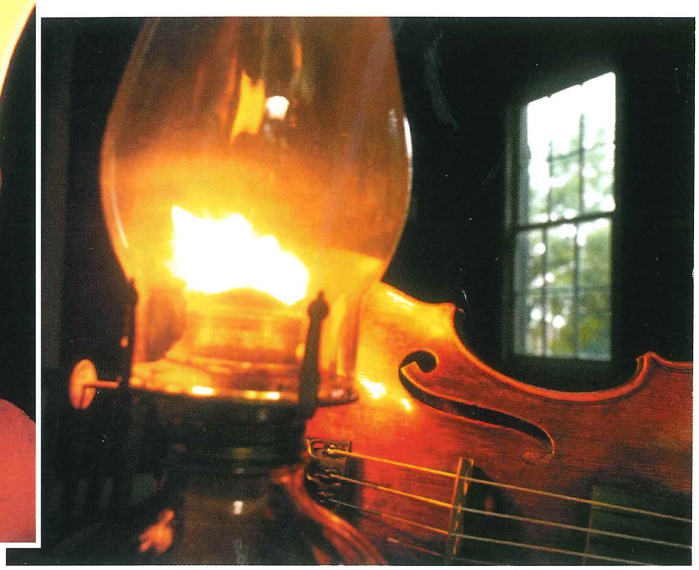
When designing light sources, people consider not only the brightness, location, attractiveness, and cost of a light source, they also consider how effectively the source transforms the initial energy into light energy. As you read about various light sources, consider which ones produce a lot of heat—they are not efficient sources of light.



a Electrical energy transforms into heat and light energy in an incandescent light bulb. Electricity passing through a fine metal wire (the tungsten filament) makes the wire very hot when the bulb is turned on.



b Thermal energy can heat a metal to such a high temperature that it emits light. Such light ranges from dull red through yellow to white and blue-white as the metal gets hotter. The colour of the emitted light indicates when the molten metal is ready to be poured.



c A kerosene lamp can provide enough light to read by. The chemical energy in the kerosene fuel transforms into heat and light energy.

Figure 2
Incandescent light sources.

Light from Incandescence

Things that are extremely hot become luminous. At high temperatures, they begin to emit light. The process of emitting light because of a high temperature is called **incandescence**. Some incandescent sources of light are shown in **Figure 2**. In incandescent sources, a large amount of the input energy becomes thermal energy, so these sources are not efficient sources of light.

Light from Phosphorescence

Certain materials, called phosphors, will give off light for a short time after you shine a light on them. They store the energy and then release it gradually as light energy. The process of emitting light for some time after receiving energy from another source is called **phosphorescence**. The colour of the light and how long it lasts depend on the material used. This is a good way to make light switches that glow in the dark. **Figure 3** shows a phosphorescent light source.

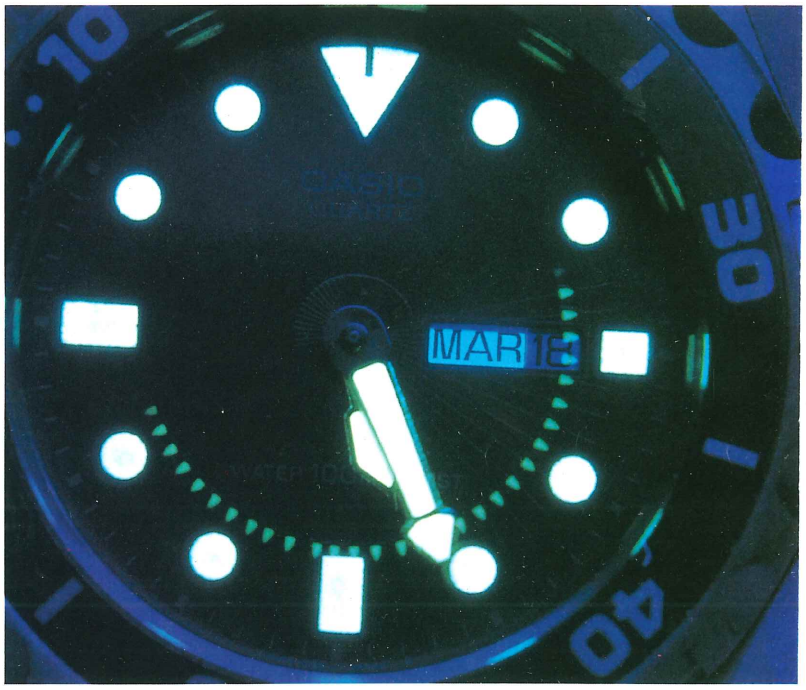


Figure 3
The painted luminous dials on some watches and clocks are phosphorescent.

Light from Electric Discharge

When electricity passes through a gas, the gas particles can emit light. This process of emitting light because of electricity passing through a gas is called **electric discharge**.

Lightning is an example of electric discharge in nature. The electricity discharges through the air, from one cloud to another, or from a cloud to Earth. Artificial light sources also make use of electric discharge. Electricity is passed through tubes filled with gases such as neon. The electricity causes the gases to emit light, as you can see in **Figure 4**. Neon gas gives off a red-orange colour. Sodium vapour gives off a yellowish light. Other gases emit light of other colours.

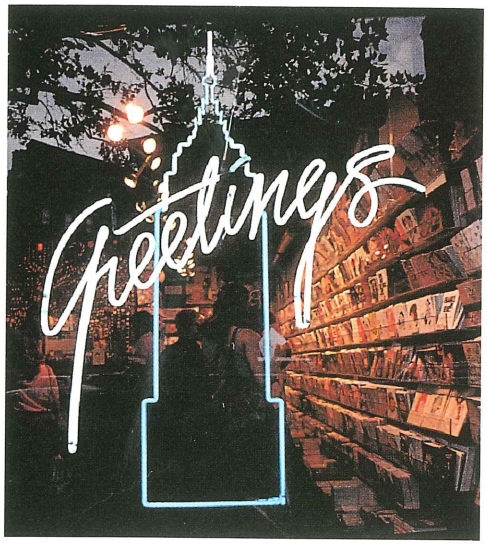
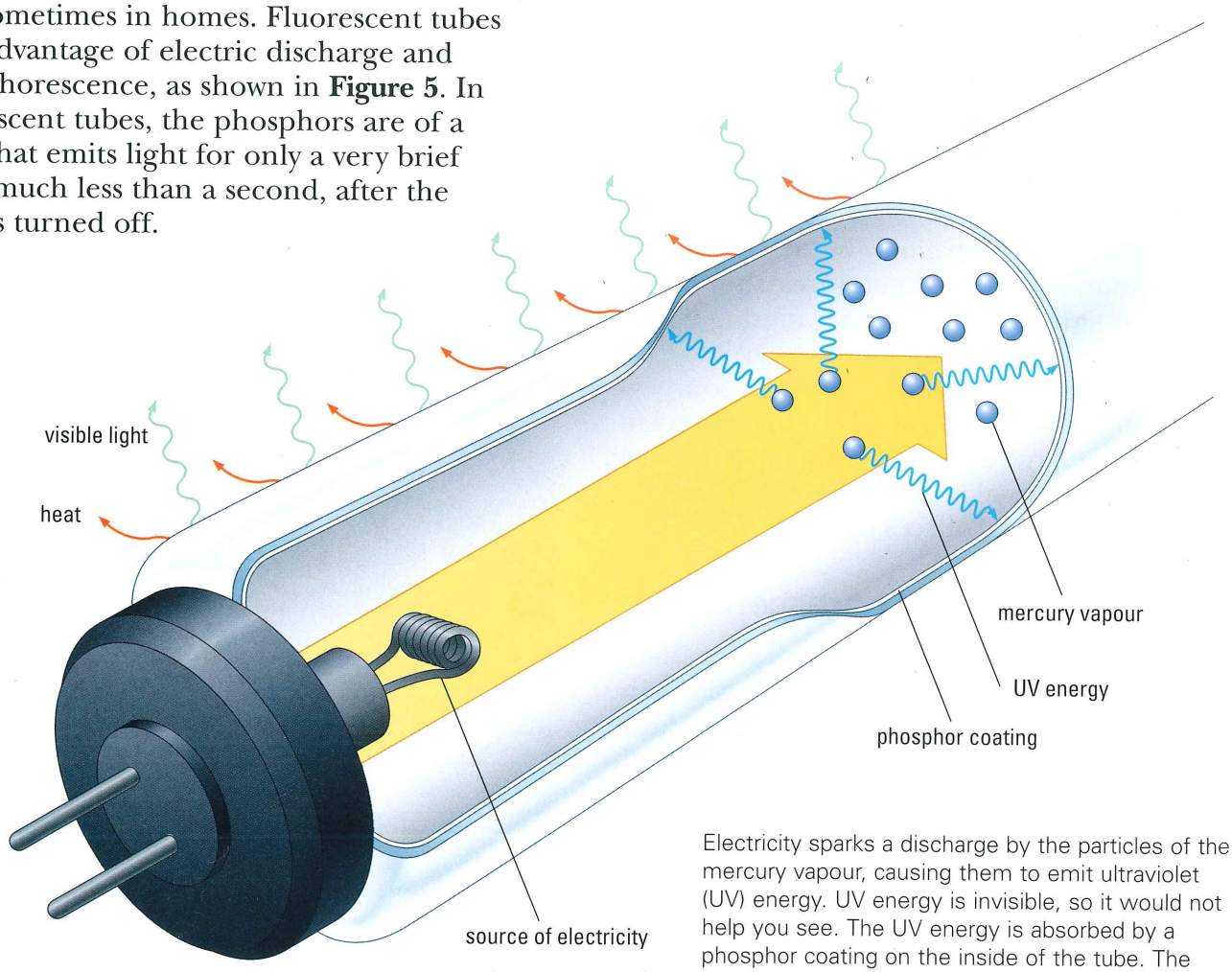


Figure 4
An artificial light source that makes use of electric discharge.

Light from Fluorescence

Fluorescence is the process of emitting light while receiving energy from another source. Fluorescent tubes are used in schools, offices, and sometimes in homes. Fluorescent tubes take advantage of electric discharge and phosphorescence, as shown in **Figure 5**. In fluorescent tubes, the phosphors are of a kind that emits light for only a very brief time, much less than a second, after the light is turned off.



Electricity sparks a discharge by the particles of the mercury vapour, causing them to emit ultraviolet (UV) energy. UV energy is invisible, so it would not help you see. The UV energy is absorbed by a phosphor coating on the inside of the tube. The coating emits light that you can see.

Figure 5
A fluorescent light source. Fluorescent tubes do not produce as much heat as incandescent light bulbs.

Light from Chemiluminescence

Chemiluminescence is the process of changing chemical energy into light energy with little or no change in temperature.

Safety lights, or "cool lights," produce light by chemiluminescence. In these devices, a thin wall separates two chemicals, as shown in **Figure 6**. When this wall is broken, the chemicals mix and react to produce a light until the chemicals are used up.

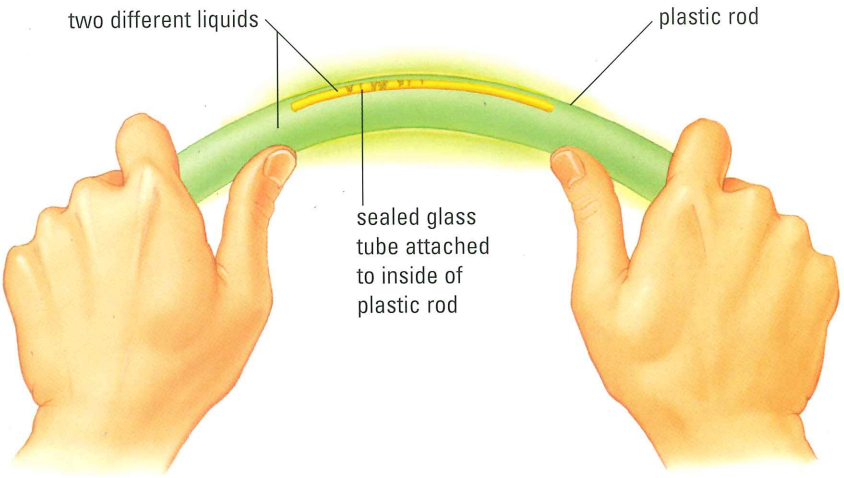


Figure 6
Cool lights are chemiluminescent light sources.

Light from Bioluminescence

Some living things, such as the fish in **Figure 7**, can make themselves luminous using a chemical reaction similar to chemiluminescence. This process is called **bioluminescence**. Fireflies, glow-worms, and types of fish, squid, bacteria, and fungi all display bioluminescence.

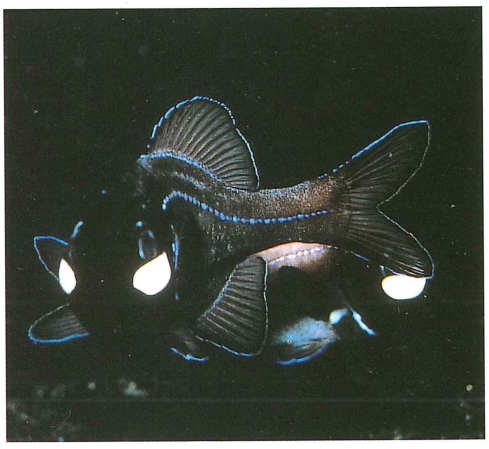


Figure 7
Many of the organisms that live deep in the ocean are bioluminescent. Scientists are not sure why so many species glow. Perhaps it allows members of the same species to find each other.

Design Challenge

Which of the sources of light discussed here could you use in your Challenge? What more would you have to learn about each source before deciding which is best for your uses?

Understanding Concepts

1. Which of the following are luminous?
   - **(a)** campfire
   - **(b)** the Moon
   - **(c)** a hot toaster filament
2. For the following luminous objects, make a flow chart to illustrate the process they use to emit light and the type of energy that is transformed into light energy:
   - **(a)** the lights in your home
   - **(b)** a lit match
   - **(c)** a car headlight
   - **(d)** Day-Glo paints and fabrics
3. Explain in your own words the difference between a phosphorescent source and a fluorescent source.
4. Describe how a flashlight can be luminous. Describe how it can also be nonluminous.

Making Connections

5. While cycling, your body's efficiency is about 20%. This means your body uses about 20% of the energy available for cycling. The remaining 80% becomes heat. Incandescent bulbs have an efficiency of about 5%, fluorescent tubes about 20%.
   - **(a)** Why does a bright incandescent bulb get much hotter than a bright fluorescent tube?
   - **(b)** Why don't people always use the most energy-efficient type of lighting? What other factors could affect their decision?

Exploring

6. Which kind of light source would be safest to use in buildings or mines that may be filled with explosive gas?

Reflecting

7. List ways in which light energy is important in your life. What sources of light do you use?