

section **E** **Producing Light**

What You'll Learn

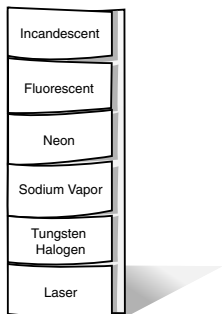
- how incandescent and fluorescent lightbulbs work
- about different lighting devices
- about coherent light
- how lasers are used

Study Coach

Outline As you read the section, create an outline to help you remember the different types of lights and how they work.

FOLDABLES™

Find Main Ideas Make the following Foldable to help you find the main ideas about producing light.



Before You Read

Lasers have many uses. You have probably seen light that was produced by a laser. Describe what this light looked like.

Read to Learn

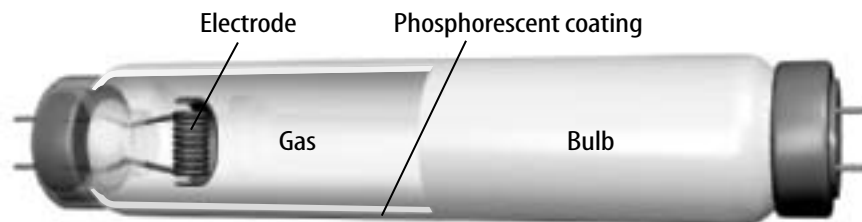
Incandescent Lights

Incandescent light is produced by heating a piece of metal until it glows. Inside a clear lightbulb you can see a small wire called a filament. Filaments in lightbulbs are usually made of tungsten metal. When an electric current flows through the filament, resistance makes the metal hot. The filament gets so hot that it glows brightly.

Fluorescent Lights

You may have fluorescent (floo-RE-sunt) lights in your home or school. A **fluorescent light** uses phosphors to change ultraviolet (UV) radiation to visible light. Phosphors are substances that give off light when they absorb ultraviolet radiation.

A fluorescent bulb, as in the figure, is filled with gas at low pressure. There are electrodes at each end of the tube. When an electric current passes through them, they give off electrons. The electrons then collide with the gas molecules in the tube. The collisions make the gas molecules give off UV radiation. The tube is coated on the inside with phosphors. The phosphors give off visible light when they absorb the UV radiation.

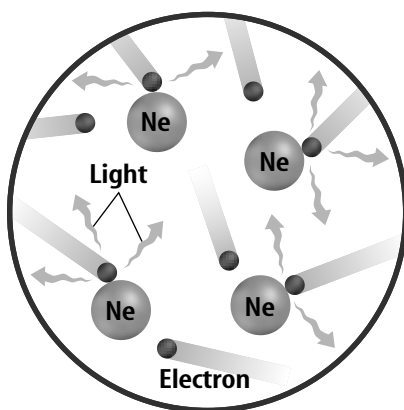


Which type of lighting is more efficient?

Fluorescent lights are more efficient than incandescent lights. A fluorescent bulb uses as little as one-fifth the energy that an incandescent bulb uses to make the same amount of light. Fluorescent bulbs also last much longer than incandescent bulbs. Because fluorescent bulbs are more efficient, they cost less to use over the life of the bulb. They also help reduce energy usage. By reducing energy usage, they could reduce the amount of fossil fuels needed to generate electricity. This would reduce the amount of carbon dioxide and pollutants that are released into Earth's atmosphere.

Neon Lights

Neon lights are glass tubes filled with gas. They work much the same way as fluorescent bulbs. An electric current flows through the tube. The electrons of the electric current collide with gas molecules, as shown in the figure. The collisions produce visible light. If the tube contains only neon gas, the light is bright red. Different colors are produced by adding other gases to the tube.



Applying Math

- 1. Calculate** Fluorescent lights use one-fifth the energy of incandescent lights. What percent is one-fifth?



Think it Over

- 2. Compare** How do the collisions in a fluorescent tube differ from the collisions in a neon tube?

Sodium-Vapor Lights

Sodium-vapor lights are often used for outdoor lighting. A sodium vapor lamp has a tube filled with neon gas, a small amount of argon gas, and a small amount of sodium metal. When the lamp is turned on, the gas mixture in the tube becomes hot. The sodium metal turns to vapor. The vapor gives off a yellow-orange glow.

Tungsten-Halogen Lights

Tungsten-halogen lights give off bright light. These lights have a tungsten filament, like incandescent bulbs. The filament is inside a quartz tube or bulb. The tube is filled with a halogen gas, such as fluorine or chlorine. The gas allows the filament to get hotter than the filament in an incandescent lightbulb. As a result, the light produced is much brighter. The bulb also lasts longer.

✓ Reading Check

3. **Describe** Why is one mirror in a laser only partly reflective?

Lasers

Lasers produce light waves that have the same wavelength. A laser's light begins when a number of light waves are given off at the same time. To produce these light waves, a number of atoms are given the same amount of energy. The atoms then release their energy and send off identical light waves. These light waves bounce off mirrors at opposite ends of the laser. One of the mirrors is only partly reflective. It allows some light to escape. This escaped light forms the beam that you see. Some of the light waves do not escape. These waves continue to bounce between the mirrors. This causes other atoms in the laser to produce more identical waves. As this process continues, a steady stream of laser light is produced. ✓

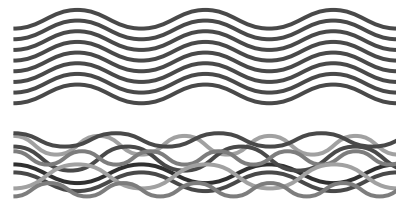
Lasers can be made with gases, liquids, or solids. One kind of laser uses a mixture of helium and neon gases to produce red light. The gases are sealed in a tube with a mirror at each end. The gas atoms get their energy from a flashtube. They lose their energy by giving off light waves.

What is coherent light?

Lasers produce narrow beams of light. Waves of laser light are coherent—they do not spread out. **Coherent light** is light of only one electromagnetic wavelength that travels with its crests and troughs aligned. This means the crests and troughs are always the same distance from each other. The first figure shows coherent light. Coherent light does not spread out because all the waves travel in the same direction. Because the beam does not spread out, the light energy stays concentrated in a small area.

What is incoherent light?

Incoherent light can contain more than one wavelength. The electromagnetic waves are not aligned. The second figure shows incoherent light. Notice that the waves have different wavelengths and they do not travel with their crests and troughs aligned. Light from a lightbulb is incoherent. Beams of incoherent light spread out. The energy of the light waves spreads out with the beam. This makes the intensity of incoherent light much less than the intensity of a laser beam. Incoherent light is better for lighting a room.



Picture This

4. **Identify** Circle the incoherent light and put a box around coherent light.

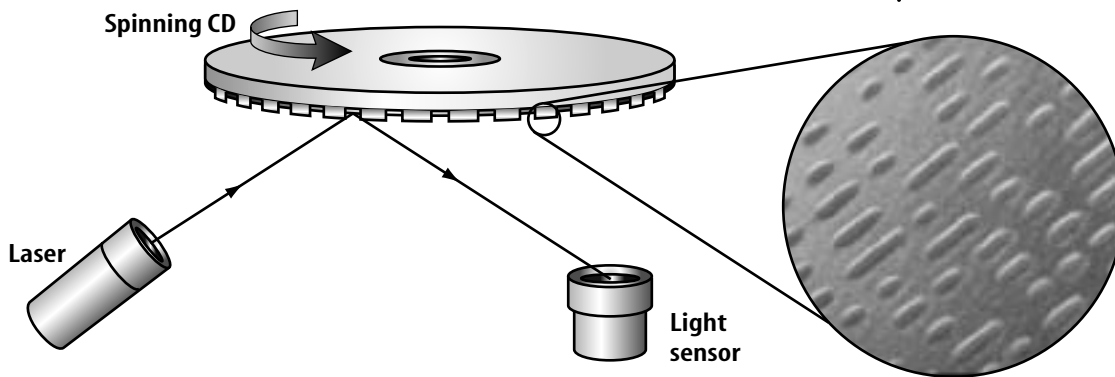
Using Lasers

Lasers have properties that make them important tools. They are used in CD players and even in surgery. A laser beam is narrow and does not spread out as it travels. So, lasers can carry energy to small areas. In industry, powerful lasers are used for cutting and welding. Surveyors and builders use lasers for measuring. Scientists use laser light reflected from mirrors on the Moon to measure the Moon's orbit with great accuracy. Information can be sent in pulses of light from lasers. This makes lasers useful in communication. In some telephone systems, pulses of laser light send conversations through long glass fibers called optical fibers.

How do compact discs work?

Compact discs (CDs) are plastic discs with reflective surfaces. They are used to store sound, images, and text in digital form. When a CD is made, information is burned into the surface of the disc with a laser. The laser creates millions of tiny pits, where information is stored.

A CD player also uses a laser to read the disc. Look at the figure below. The figure on the right shows the pits on the bottom surface of a CD. The laser shines on the spinning disc. As the beam hits the pits, different amounts of light are reflected to a light sensor. The reflected light is then converted to an electric signal. The signal creates sound in the speakers.



How are lasers used in medicine?

Lasers are often used in eye surgery. They can be used to remove cataracts, reshape the cornea, and repair the retina. Surgeons can use lasers in place of scalpels to cut body tissues. Laser energy seals off blood vessels as it cuts. This reduces bleeding during surgery. Most lasers do not cut deeply through the skin. This makes them useful in removing tumors or birthmarks on the surface of the skin.

Think it Over

5. **Explain** Why is a laser a good tool to make sure something is level?

Picture This

6. **Identify** Circle the part of the figure that shows where information is stored on a CD.

● After You Read

Mini Glossary

coherent light: light of only one wavelength that travels with its crests and troughs aligned

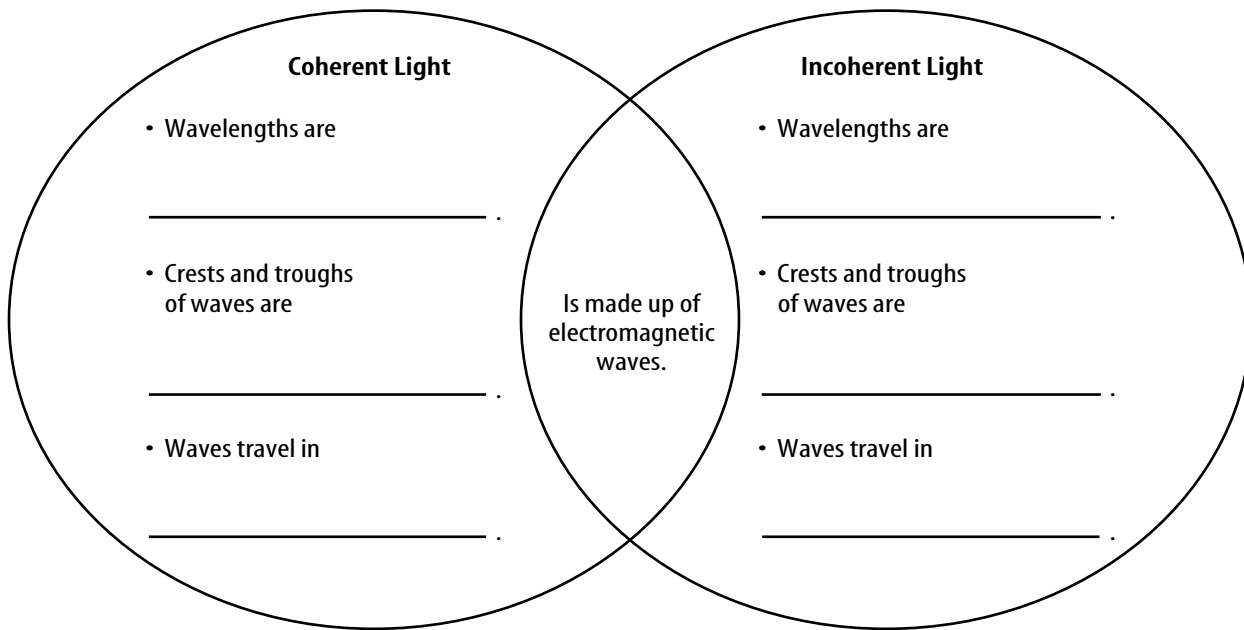
fluorescent light: light that uses phosphors to convert ultraviolet light to visible light

incandescent light: light that is produced by heating a piece of metal until it glows

incoherent light: light that can contain more than one wavelength and travels in many directions with its electromagnetic waves not aligned

1. Review the terms and their definitions in the Mini Glossary. Write a sentence using a term for a device that produces incoherent light.

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



3. **Study Coach** Think about what you have learned. How did outlining as you read help you learn about the different type of lights and lighting devices?

