



Physical Science

Matter and Energy

On Level

Light Is Energy

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Light Is Energy

What are some ways that energy can be changed from one form to another?

CORE CURRICULUM STATEMENTS

Energy exists in many forms, and when these forms change energy is conserved.

Energy exists in various forms: heat, electric, sound, chemical, mechanical, light.

Energy can be transferred from one place to another.

Some materials transfer energy better than others (heat and electricity).

Energy and matter interact: water is evaporated by the Sun's heat; a bulb is lighted by means of electrical current; a musical instrument is played to produce sound; dark colors may absorb light, light colors may reflect light.

Interactions with forms of energy can be either helpful or harmful.



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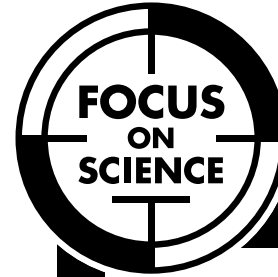
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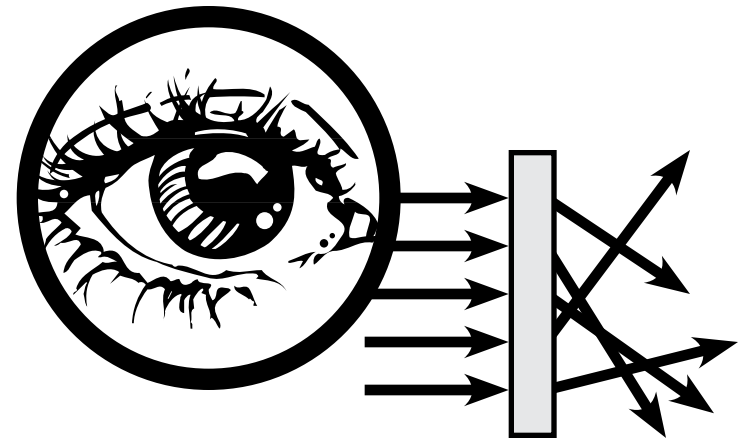


Physical Science

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Light Is Energy

by
Charles Pederson





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– Predict –

*What do you think you will
learn from this book?*

INTRODUCTION

Light Lets Us See

You open your eyes in the morning and look around. A fly is sleeping upside down on the ceiling. Outside the window are colorful cars on the street. You wonder what to wear. What colors go together?

Did you ever wonder how you can see these things? Light is the reason. When we see objects, our eyes sense the light bouncing off the objects.

This book is all about light. You will learn what light is. You will find out what light does. You also will read about some people who helped us understand light. When you are done, you will know more about light. You'll be able to tell your friends something new!



Our eyes can see things because of light.

What Is Light?

Long ago, the ancient Greeks believed light was a stream of particles. They thought these particles flowed like water.

In the 1600s, Christian Huygens wondered about light. He developed a **theory** that light was like waves. Huygens thought the waves moved in straight lines, and had tops and bottoms. He believed these light waves could be long or short.

In the 1800s, Thomas Young designed experiments that showed the ancient Greeks and Huygens were right. Young shined light through a narrow slit in a piece of paper. The light spread out on the other side. If two slits were used, the light spread out from both slits. The light beams interfered with each other. This was just like when two waves of water hit and change each other.

theory: an explanation that is based on evidence and reason and can be confirmed

Today, we know light is a form of energy. Light comes from two types of sources—natural and **artificial**. People cannot control natural sources. These include the sun, other stars, and lightning. However, people can create artificial light sources. These include such things as candles and electric light bulbs.

The type of light our eyes can see is **visible** light energy. Visible light is made up of many colors. We see a red ball when red light bounces off the ball. We see a yellow flower when yellow light bounces off the flower.

When our eyes sense light with all the colors, we see white light or light without color. Later in the book, you will learn how a scientist proved this.

artificial: made by people, not made by nature
visible: able to be seen

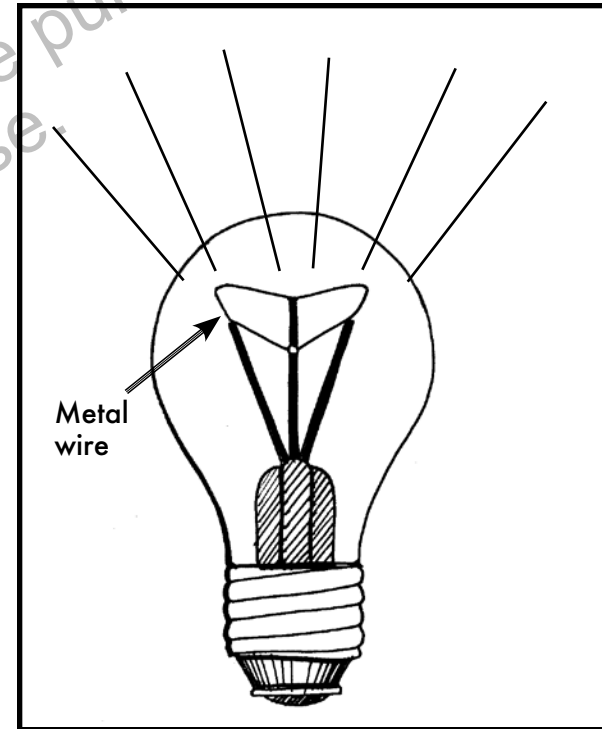
Properties of Light

What causes light? Light is caused by the release of energy from tiny particles in **matter**.

Particles in matter can gain and lose energy. When particles gain energy, they become “excited.” One way to excite them is to heat them. For example, when particles in metal are heated, the excited particles give off energy. That makes the metal turn red. In a red-hot object, the particles are getting enough energy to begin producing light that we can see. When the metal gets even hotter, it turns white.

matter: what all things are made of; anything that takes up space

This is how a light bulb works. Electricity flows through a thin piece of metal in the bulb. The tiny particles in the metal move around and bounce into each other. They heat up. When the metal gets hot enough, energy is released, creating white light.

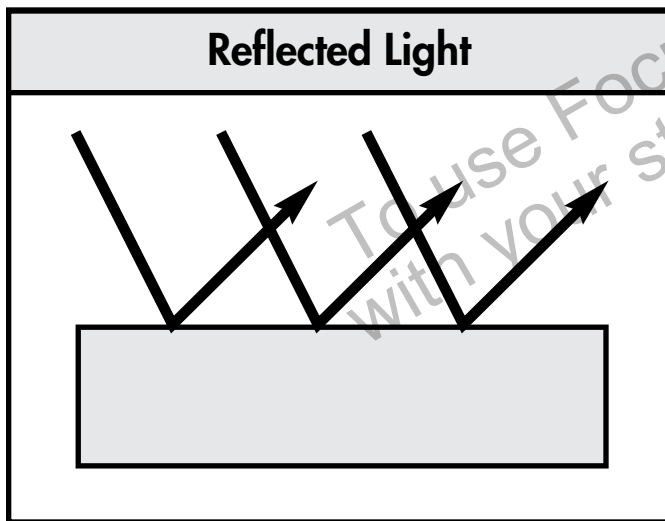


When the wire in a light bulb becomes hot enough, it releases white light.

Behavior of Light

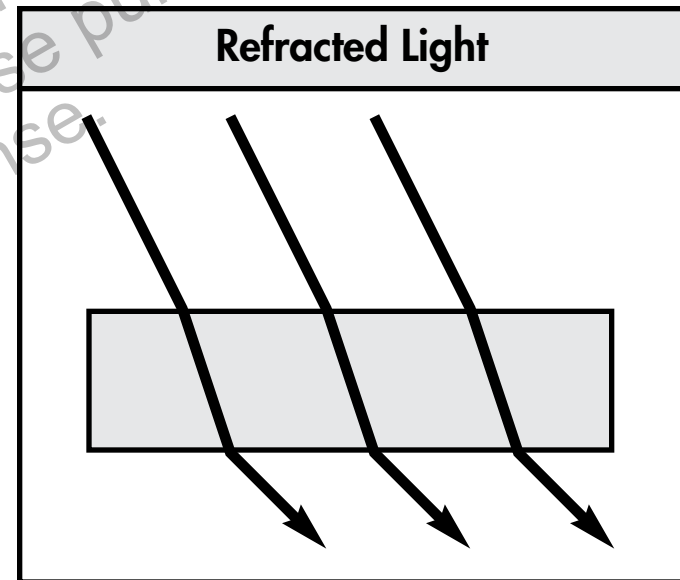
Light travels in a straight line until it hits an object. It may pass through the object or bounce off the object.

Light that bounces is **reflected**. Smooth surfaces reflect light waves in one direction. This is why we can see ourselves in a mirror. Rough surfaces reflect the rays in many directions. These are **scattered**.



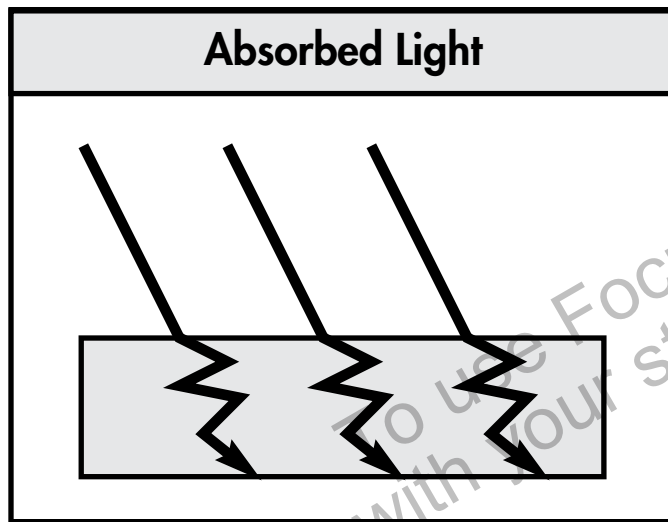
reflected: bounced or thrown back
scattered: reflected in many directions

Some objects allow light to pass through but bend it. The light is **refracted**. The amount of bending depends on the material. Water, for example, slows down light and bends it. This causes a pencil to look bent when placed in a glassful of water. Try it and see for yourself.



refracted: bent

Light that is **absorbed** enters an object without reflecting or refracting. Tiny particles in objects absorb certain colors. The remaining color or colors bounce off. The colors that bounce off are the ones that we see.

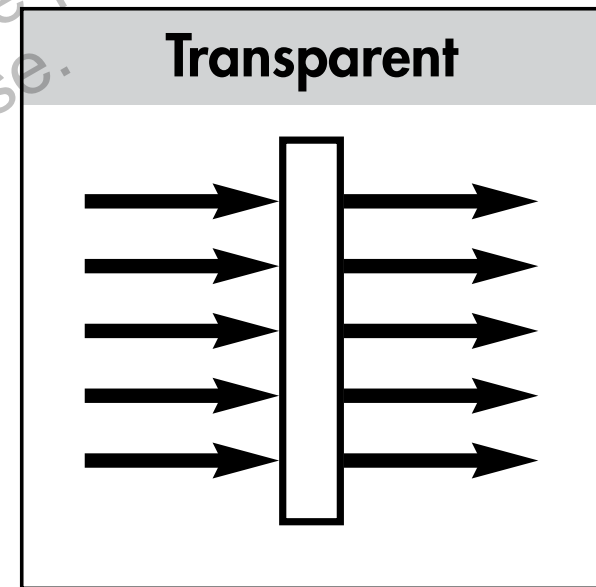


*– Describe –
Describe examples of reflected,
refracted, and absorbed light.*

absorbed: taken in and not reflected or thrown back

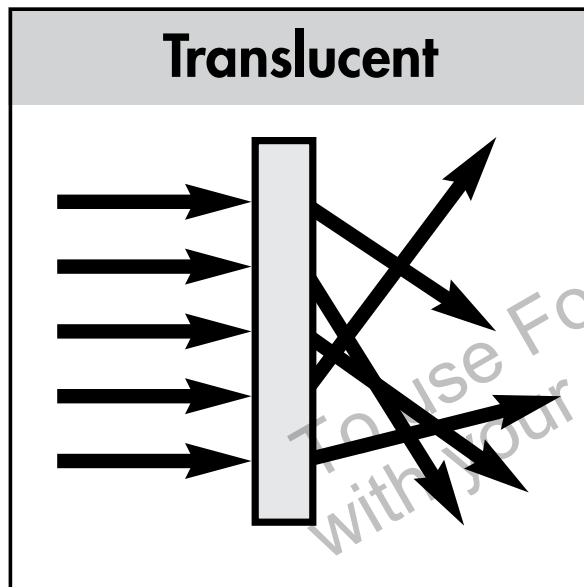
Materials that Affect Light

Three types of materials affect how we see light. **Transparent** materials allow light to pass through them without mixing or bouncing. We can clearly see an object on the other side of transparent materials. Clear glass or plastic are transparent materials.



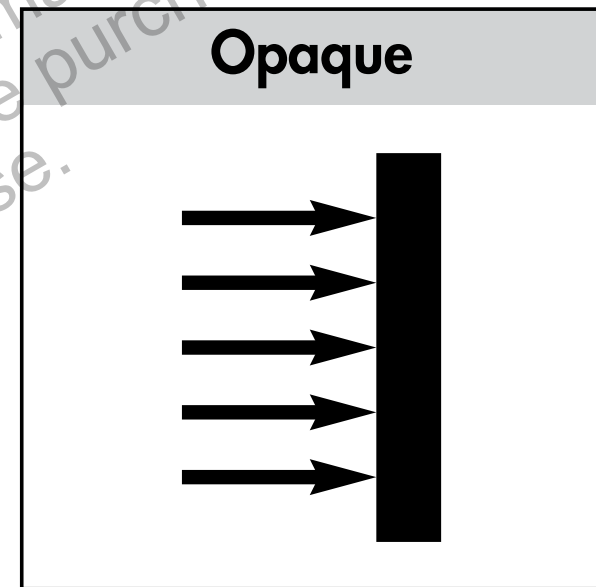
transparent: allowing light to pass through without mixing

Translucent materials let some light pass through. However, translucent materials mix up the light rays slightly. This causes the images to look blurry. Frosted glass is an example of a translucent material.



translucent: allowing light to pass through with mixing

Opaque materials block or reflect all light. Opaque materials stop it from passing through the material. We cannot see anything on the other side of opaque materials. Opaque materials include such things as wood and steel.



– Transfer –
Name several materials that are transparent, translucent, and opaque.

opaque: blocking or reflecting all light

Optics

The Study of Light

Isaac Newton was a leader in the study and uses of light. Hundreds of years ago, he wrote a book about measuring and using light. The book was named Opticks. Today, we still use Newton's word optics for this area of science.

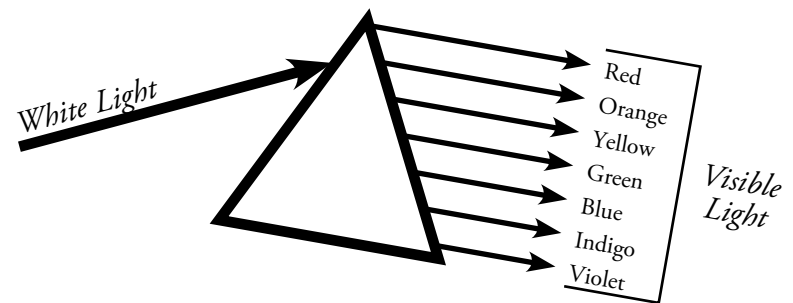
Newton asked himself if white light really was white. Or was there more to it than that?

To find the answer, Newton shaded a window. The shade had a hole in it. One beam of sunlight fell into the room through the hole. Newton placed a prism in the sunlight. A prism is a wedge-shaped piece of polished glass. It refracts white light passing through the prism.

The refracted light fell on a wall. It looked like a beautiful rainbow. Newton repeated the experiment many times to be sure it was accurate.

The experiment helped Newton decide that white light is not the absence of colors. It is instead the presence of all visible colors.

You can prove this yourself. Shine beams of light through a red, yellow, and blue filter. When the three colors of light combine, the light becomes white.



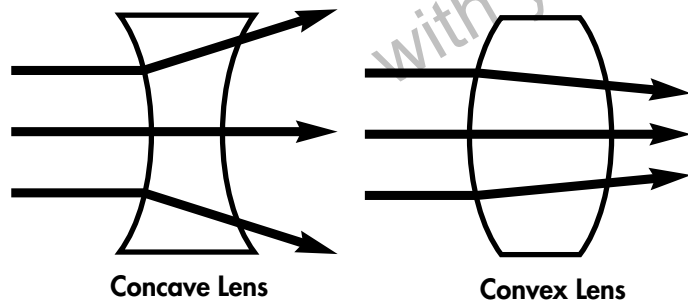
A prism splits white light into visible light.

Instruments to Study Light

Scientists have created many different instruments to study light. Specially shaped pieces of glass or plastic called lenses are one of the main instruments. A prism is one type of lens.

Concave lenses curve inward. They have a narrow center and thicker outer edge. Light rays passing through a concave lens refract away from each other. This causes things seen through the lens to look smaller.

The middle of a convex lens curves outward. This causes light rays to refract toward each other, making objects look larger.



*Light refracts when it passes through lenses.
Concave lenses make things look smaller.
Convex lenses make them look larger.*

Another early optical scientist was Galileo Galilei.

He used a telescope to study planets and stars.

A telescope has a convex shaped piece of glass. It bends light so users can see faraway objects. Galileo's telescope changed the way people thought about space.



Microscopes are another optical instrument. An optical microscope uses one or more convex lenses to make extremely small objects visible.



Lasers give off thin beams of very powerful light. Lasers have different strengths. Some are delicate enough to perform eye surgery. Some are strong enough to cut through steel. They make people's lives better.

Light Phenomena

We can see rainbows, optical illusions, and shadows because of light.

Rainbows

You have seen rainbows on rainy days. Rainbows occur when light passes through the raindrops. Each raindrop acts as a tiny prism. It refracts the sun's white light into its rainbow colors.

Optical Illusions

Optical illusions are another light event. They trick the eye. They show the difference between what your brain expects and what your eye sees. Look at the two lines below. Is one longer than the other?



Optical illusions trick the brain and eyes. If you take a ruler and mark the ends of the lines, you'll see the two lines above are the same length.

Shadows

Shadows are interesting, too. They are caused by the absence of light. Shadows occur because light travels in a straight line. When the light strikes an opaque object, the object blocks the light on the other side. This is where the shadow is.

Shadows have two parts. The umbra is the darkest part of a shadow. In the umbra, no light falls. But light still acts like waves. The waves leak around the sides of the opaque object. They cause the shadow's edges to be less dark. This slightly lighter edge is called the penumbra.

Did you know nighttime is a giant shadow? The opaque Earth blocks the sunlight and casts a giant shadow. The parts of Earth turned away from the sun lie in this shadow.

Glossary

absorbed—taken in and not reflected or thrown back

artificial—made by people, not made by nature

matter—what all things are made of; anything that takes up space

opaque—blocking or reflecting all light

reflected—bounced or thrown back

refracted—bent

scatter—to reflect in many directions

theory—an explanation that is based on evidence and reason and can be confirmed

translucent—allowing light to pass through with mixing

transparent—allowing light to pass through without mixing

visible—able to be seen

To Find Out More . . .

Want to learn more about light?

Try these books

Light by Darlene R. Stille. Child's World, 2005.

Light: From Sun to Bulbs by Christopher Cooper. Heinemann, 2003.

Access these Web sites

See the Light

<http://library.thinkquest.org/13405/index.html>

Optical Research Associates

Optics for Kids: The Science and Engineering Behind It

http://www.opticalres.com/kidoptx_f.html

Write for more information

The Exploratorium

3601 Lyon Street

San Francisco, CA 94123

415-397-5673

Museum of Science and Industry

57th Street and Lake Shore Drive

Chicago, IL 60637-2093

773-684-1414

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Assessments

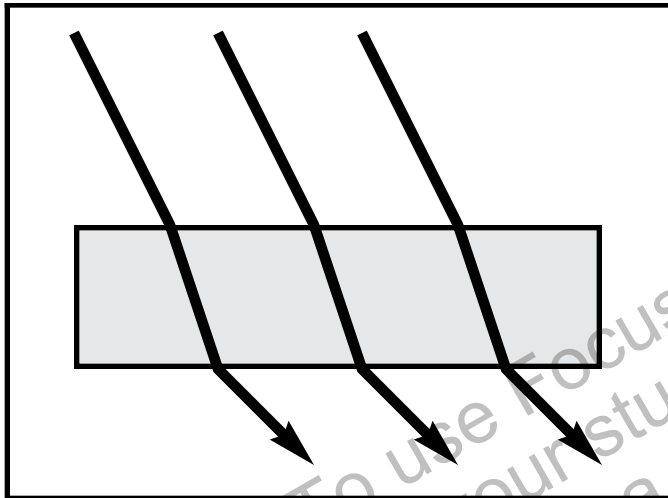
Light Is Energy

Print pages 20–22 of this PDF for the assessments.

Check Understanding

Shade the circle next to the correct answer.

1. The illustration below shows light hitting an object.



What is happening to the light as it hits the object?

- Ⓐ The light is being refracted.
- Ⓑ The light is being absorbed.
- Ⓒ The light is being reflected.
- Ⓓ The light is being transparent.

Write your answer on the lines provided.

2. Identify one example of a translucent material.

Explain what effect the material has on light that hits it.

Assessment Scoring Guidelines

1. Answer A is correct.
2. A correct response will identify a translucent material such as frosted glass and explain that frosted glass allows light rays to pass through it but it mixes up the rays causing images to look blurry.
3. Transparent materials might include a clear material such as glass or plastic.

Transparent materials allow light to pass directly through them.

4. Opaque materials might include such things as wood, metal, or concrete.

Opaque materials do not allow light to pass through them.

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English Language Arts Activities

Light Is Energy

Print pages 24–28 of this PDF for the reading activities.

Summarize Main Ideas

TRY THE SKILL

The main idea is the most important point the author is trying to make. For example, read the following example from *Light Is Energy*.

What causes light? Light is caused by the release of energy from tiny particles in matter. Particles in matter can gain and lose energy. When particles gain energy, they become “excited.” One way to excite them is to heat them.

The main idea of the paragraph is “The movement of particles in matter produces light.” Try another one. What is the main idea of the following paragraph?

Shadows have two parts. The umbra is the darkest part of a shadow. In the umbra, no light falls. But light still acts like waves. The waves leak around the sides of the opaque object. They cause the shadow’s edges to be less dark. This slightly lighter edge is called the penumbra.

The main idea of the paragraph is “There are two parts to shadows: the darker umbra and the lighter penumbra.”

Read the following paragraph from *Light Is Energy*. Summarize the main idea of the paragraph. Write it on the lines.

Light comes from two types of sources—natural and artificial. People cannot control natural sources. These include the sun and stars. However, people create artificial light sources. These include such things as candles and electric light bulbs.

Context Clues

TRY THE SKILL

To figure out the meaning of an unknown word, look for words in the same sentence or nearby sentences that give you clues.

Look for word clues in each sentence at the right to figure out which word from the box should complete it. Then write the correct word on the line.

absorbed: taken in and not reflected or thrown back

opaque: blocking or reflecting all light

reflected: bounced or thrown back

refracted: bent

translucent: allowing light to pass through with mixing

transparent: allowing light to pass through without mixing

1. I could not see through the wood door because it was _____.

2. I could see the color of the shirt because the light was _____.

3. The pencil in the water looked broken because the light _____.

4. I saw myself in the mirror when light _____ from it.

5. He could barely see the tree through the _____ glass.

6. Jamal could see clearly through the _____ glass of the clean window.

Cause and Effect

TRY THE SKILL

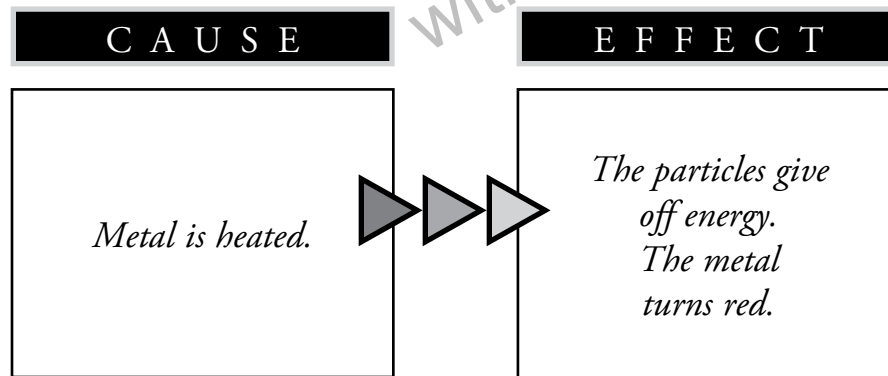
To find out an effect, you ask, “What happened?” To find out a cause, you ask, “Why did that happen?” Identifying causes and effects is a way to better understand what you read.

Read this passage from the book:

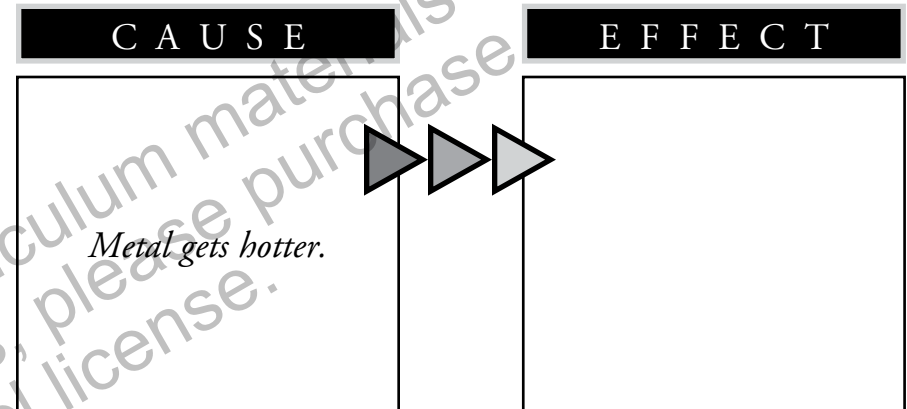
For example, when metal is heated the particles in the metal give off energy. It makes the metal turn red.

When the metal is very hot, it turns white. The particles are very excited and are giving off lots of energy. When the metal is cooled, the particles are de-excited. The metal slowly returns to its original color.

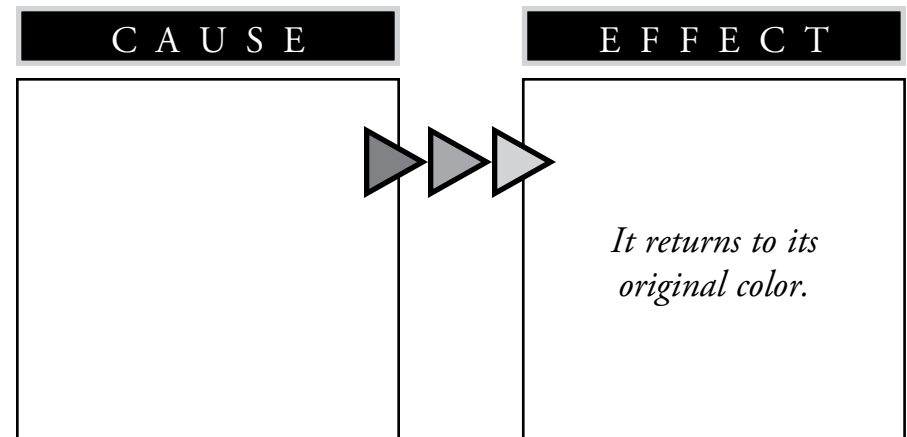
This graphic explains what happened.



Read the passage again. Then complete this graphic. Tell what happens as the metal gets hotter.



Now complete this graphic. Tell why the metal returns to its original color.



Use Graphic Organizers

TRY THE SKILL

Graphic organizers help you understand information by taking it out of the text and putting it in the form of a picture. Often, when you see a set of facts, the facts make more sense than when you read them in the text.

Use this organizer to explain how the three different types of materials affect light. Draw a diagram and write a summary about each one.

Transparent	Translucent	Opaque

Answer Key

Summarize Main Ideas

Natural light sources include the sun and stars. Artificial light sources are created by man such as candles and light bulbs.

Context Clues

1. opaque
2. absorbed
3. refracted
4. reflected
5. translucent
6. transparent

Cause and Effect

Effect—It turns white.

Cause—Metal cools.

Use Graphic Organizers

Transparent materials allow light to pass through them without mixing or bouncing. We can clearly see an object on the other side of transparent materials. Clear glass or plastic are transparent materials.

Translucent materials also let light pass through. However, translucent materials mix up the light rays slightly. This causes the images to look blurry. Frosted glass is an example of a translucent material.

Opaque materials block or reflect all light. Opaque materials stop it from passing through the material. We cannot see anything on the other side of opaque materials. Opaque materials include wood and stone.