SCIENCE • GRADE 3

California Content Standards
Physical Sciences: 2.A
Physical Sciences: 2.B
Physical Sciences: 2.C
Physical Sciences: 2.D

Above Level

What Is Light?

FOCUScurriculum

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What Is Light?
California's Science Content Standards Met

GRADE 3 SCIENCE

PHYSICAL SCIENCES: 2—Light has a source and travels in a direction. As a basis for understanding this concept:

a. Students know sunlight can be blocked to create shadows.

b. Students know light is reflected from mirrors and other surfaces.

c. Students know the color of light striking an object affects the way the object is seen.

d. Students know an object is seen when light traveling from the object enters the eye.

GRADE 3 ENGLISH LANGUAGE ARTS

1.0 WORD ANALYSIS, FLUENCY, AND SYSTEMATIC VOCABULARY DEVELOPMENT

***Vocabulary and Concept Development 1.4*—**Use knowledge of antonyms, synonyms, homophones, and homographs to determine the meanings of words.

2.0 READING COMPREHENSION

***Comprehension and Analysis of Grade-Level-Appropriate Text 2.3*—**Demonstrate comprehension by identifying answers in expository text.

***Comprehension and Analysis of Grade-Level-Appropriate Text 2.5*—**Distinguish the main idea and supporting details in expository text.

***Comprehension and Analysis of Grade-Level-Appropriate Text 2.6*—**Extract appropriate and significant information from the text, including problem and solution.

Above Level

SCIENCE • GRADE 3

California Content Standards
Physical Sciences: 2.A
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Physical Sciences: 2.D

Student Book

What Is Light?

Print pages 5–18 of this PDF for the student book.

How to Make the Student Book

- **The student book is contained on pages 5–18 of this PDF. It begins on the next page.**
- **To make one student book, or a two-sided master copy that can be photocopied, you will print on both sides of seven sheets of 8.5″ x 11″ paper.**
- **Do a test printout of one book first to familiarize yourself with the procedure.**
- **Follow these instructions carefully.**

First–Select the Paper

Since you will be printing on both sides of the sheets of paper, select a good quality white paper. We recommend using at least a 22lb sheet.

Second–Check Printer Settings

Be sure you have the correct page setup settings for your computer and printer. You will print these pages in landscape format.

Third–Print EVEN Pages

Open the PDF of the book you want to print. Select print from your file menu. In your printer's dialogue box enter pages 5–18 to print. Then select EVEN pages only. It is important to print only the EVEN pages first. Click "Print" to print the even pages. (**Important note**: The first page that prints will be blank. DO NOT discard this page. It will be needed to print the cover in the next step.)

Forth–Print ODD Pages

When the even pages have printed, flip the stack of pages over to print the odd pages. Place the stack back in your printer. Select print from the file menu again. In your printer's dialogue box, select ODD pages. Click "Print" to print the odd the pages.

Fifth–Fold the Book

You now have a complete book. Check to be sure the pages are in the correct order with the book's cover as the top page. Then fold the stack of paper in half.

Sixth–Staple the Book

Use an extended-length stapler to staple the pages together. Place three staples in the spine of the book.

Please note that printers vary in how they output pages. Do a test printing with one book and adjust the procedure as necessary.

If you want to make a one-sided master copy, print ALL pages 5–18 at once. Then select "one-sided to two-sided" on the copy machine.

AL

What Is Light?

California's Science Content Standards Met

GRADE 3 SCIENCE

PHYSICAL SCIENCES: 2—Light has a source and travels in a direction. As a basis for understanding this concept:

a. Students know sunlight can be blocked to create shadows.

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GRADE 3 ENGLISH LANGUAGE ARTS

1.0 WORD ANALYSIS, FLUENCY, AND SYSTEMATIC VOCABULARY DEVELOPMENT

***Vocabulary and Concept Development 1.6*—**Use sentence and word context to find the meaning of unknown words.

2.0 READING COMPREHENSION

***Comprehension and Analysis of Grade-Level-Appropriate Text 2.3*—** Demonstrate comprehension by identifying answers in expository text.

***Comprehension and Analysis of Grade-Level-Appropriate Text 2.5*—** Distinguish the main idea and supporting details in expository text.

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FOCUS ON CALIFORNIA STANDARDS

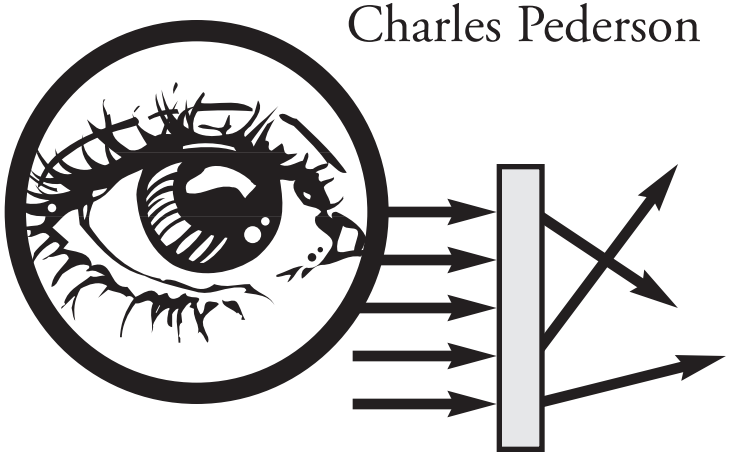
SCIENCE • GRADE 3

California Content Standards

Physical Sciences: 2.A, 2.B, 2.C, 2.D

What Is Light?

by Charles Pederson



SCIENCE • GRADE 3

California Content Standards

Physical Sciences: 2.A, 2.B, 2.C, 2.D

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Charles
Pederson

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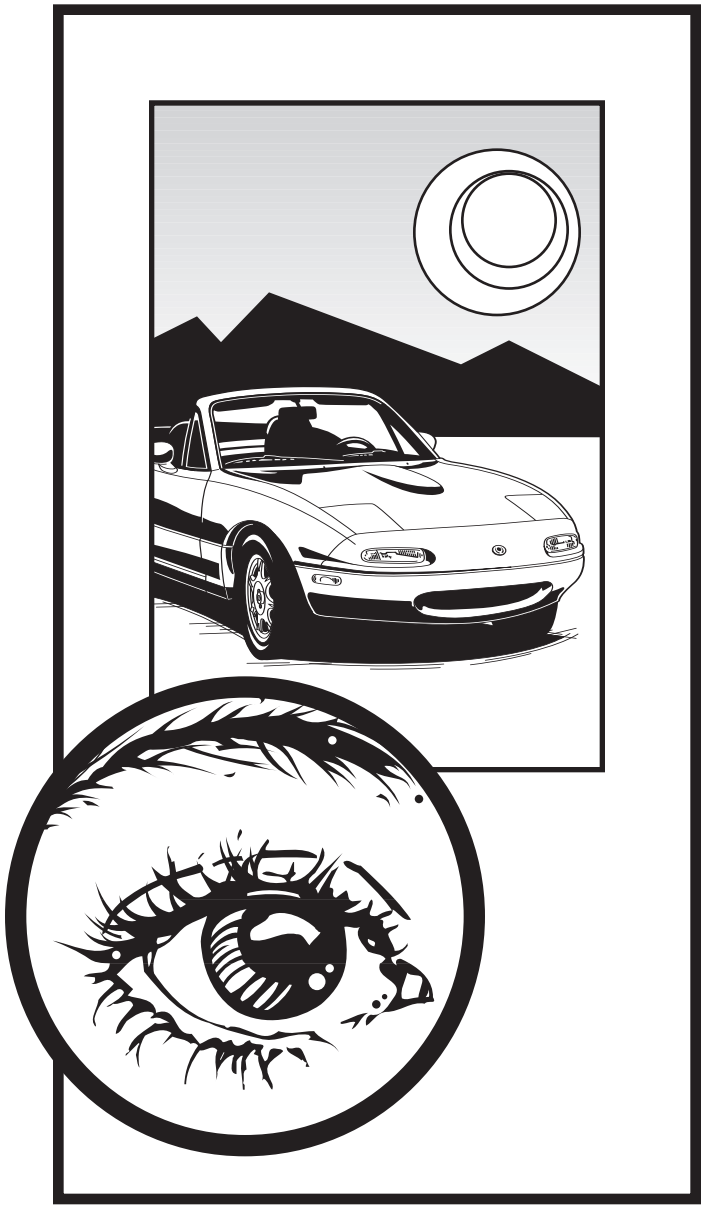
Table of Contents



Our eyes can see things because of light.

INTRODUCTION

Light Lets Us See

You open your eyes in the morning and look around. There is a fly sleeping upside down on the ceiling. Outside the window are colorful cars on the street. You get out of bed and look at your clothing for the day. 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 read about what light is. You will learn what it does. You will read about some scientists and their investigations about light. When you are done reading this book, you will know more about light. You'll be able to tell your friends something new!

CHAPTER 1

What Is Light?

Many scientists have wondered what light is. The ancient Greeks believed light was a stream of particles. They thought these particles flowed like water.

Christian Huygens lived in the 1600s. He was a scientist from the Netherlands in Europe. He developed a **theory** that light was like waves in water. He thought the waves moved in straight lines and had tops and bottoms. He believed these waves of light could be long or short.

Other scientists wondered, too. They designed experiments that showed both the ancient Greeks and Huygens were right. One of these scientists was Thomas Young.

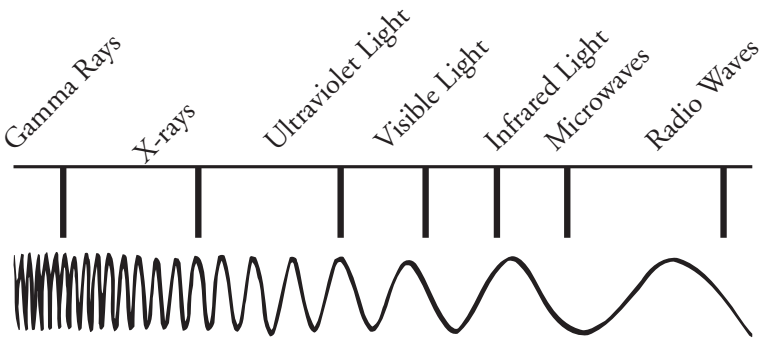
In the early 1800s, Young shined light through a narrow slit in a piece of paper. The light spread out on the other side. If he used two slits, the light spread out from both slits. The two beams of light interfered with each other. Light behaved just like two waves of water crashing into each other.

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

Today, we know light is a form of energy that does indeed travel in waves. The kind of energy our eyes can see is visible light energy. This light is part of the **visible spectrum**.

The visible spectrum is made up of light of many colors. Colors are different because of the wavelength of the light. When our eyes sense light that contains all the visible wavelengths, we see white light, or light without color.

The Electromagnetic Spectrum



What can you conclude about these waves by looking at this diagram?

visible spectrum: the light humans can see

CHAPTER 2

Properties of Light

What causes light? Light is caused by the release of energy from **atoms**. Just like bricks are the building blocks of a home, atoms are the building blocks of **matter**. All matter is made of atoms.

Atoms can gain and lose energy. When atoms gain energy they become "excited." One way to excite atoms is to heat them. For example, when atoms in metal are heated, the excited atoms give off energy. That makes the metal turn red. In a red-hot object, the atoms are getting enough energy to begin producing light that we can see.

When the metal gets even hotter, it turns white. Its atoms are very excited and are giving off lots of energy. All of the colors of light are being generated. The colors mix together and look white. This is how a light bulb works. A thin piece of metal in the bulb is heated. This excites the atoms in the metal. The atoms then give off energy in the form of white light.

atom: a basic unit of matter of which all things are made
matter: anything with mass that takes up space

Sources of Light

Light comes from two sources—natural and artificial. Natural sources are beyond human control. They include such things as lightning, the sun, and other stars. Artificial light sources are created by humans. They include such things as candles and electric light bulbs.

Both natural and artificial light can make objects hot and glowing. The sun and many light bulbs **emit** this **incandescent** light. You can actually feel the heat produced when some of the light energy is absorbed by your skin.

Natural and artificial light can also be cool, as with **fluorescent** lamps, or with fireflies and other objects that glow in the dark.

Brainstorm a list of other examples of incandescent or fluorescent light.

emit: to send out
incandescent: light produced from a hot object
fluorescent: light produced from a relatively cooler object

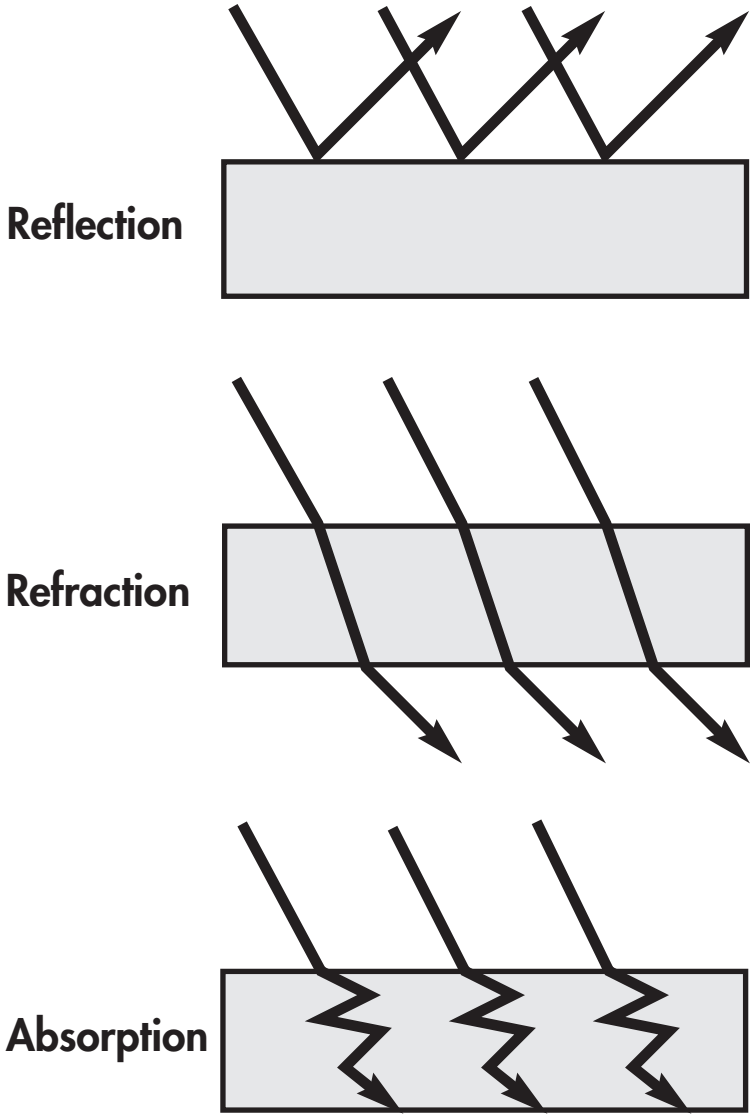
Behavior of Light

Light travels in a straight line until it hits an object. It may pass through it. It may also bounce off the object. Light that bounces is called reflected light. Smooth surfaces reflect light waves in one direction. Rough surfaces reflect light but **scatter** it in many directions. This is why we can see ourselves in a mirror but not in a wool sweater.

Absorbed light enters an object without bouncing off or passing through it. The atoms of some materials absorb certain colors of the visible spectrum. The remaining color or colors reflect from the material. Our eyes can then sense the color or colors reflected.

Refracted light is not absorbed by an object but rather passes through it. The light refracts, or bends. The amount of bending depends on the material. For example, when light passes through water, the water molecules slow the light down. This causes a pencil to appear to be bent when placed in a glassful of water. Try it. Some materials slow down and refract light more than others.

scatter: to reflect in many directions
absorbed: taken in and not reflected back
refract: to bend



Look for examples of reflected, refracted, and absorbed light. Summarize your observations in a short paragraph.

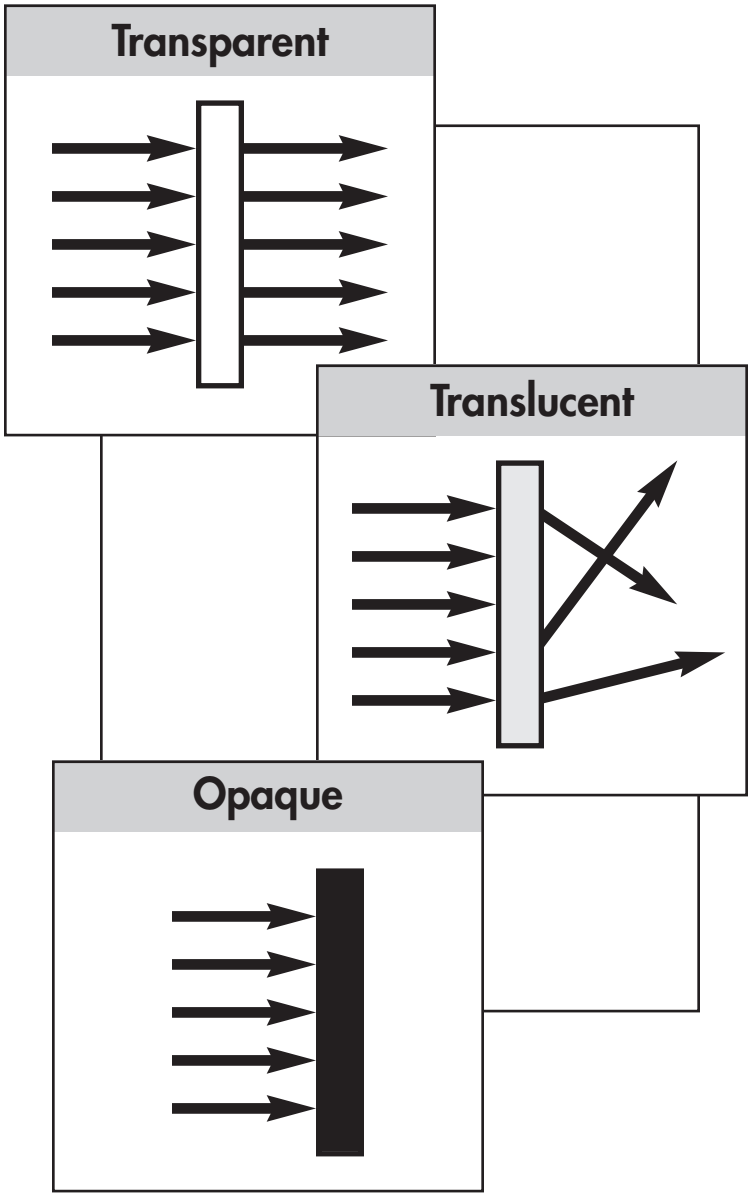
Materials that Affect Light

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

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.

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

transparent: allowing light to pass through without mixing
translucent: allowing light to pass through with mixing
opaque: blocking or reflecting all light



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

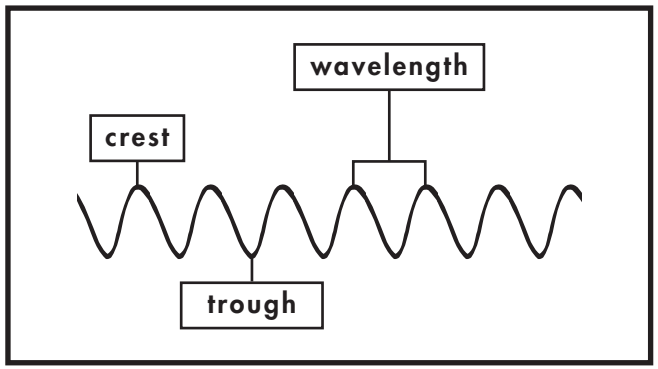
CHAPTER 3

Measuring Light

Scientists can measure light to prove it behaves both like a wave, as Christian Huygens believed, and a stream of particles, as the ancient Greeks believed.

Wavelength

We can measure light energy according to its wavelength and frequency. Light waves have tops and bottoms, like ocean waves. The tops are called crests. The bottoms are troughs. The wavelength of light is the distance from one crest to the next. Visible light is measured in billionths of meters, or nanometers. Nanometers are abbreviated *nm*. Visible light ranges from about 400 nm (red light) to 700 nm (violet light). That's very short!



Frequency

Frequency is measured by how many waves pass a point in one second. Frequency is measured in Hertz. It is abbreviated *Hz*. Visible light ranges from about 430 to 750 trillion Hz. That's fast!

Scientists have long wondered how fast light travels. Does it have a speed limit? In the late 1600s, Danish **astronomer** Olaus Roemer showed it does have a speed limit. He observed that Jupiter's moons seemed to disappear behind the planet at different times depending on how far Jupiter was from Earth. From this, he figured out the speed of light. His measurements were close but not completely accurate.

In 1926, Albert Michelson measured the speed of light accurately. The American used rotating mirrors. He was able to measure how quickly the light returned from a reflector back to a mirror. He said that in space, light cannot travel faster than 186,282 miles per second.

Explain why it was important for Michelson to conduct experiments about the speed of light.

astronomer: a person who studies stars, planets and other objects in space

CHAPTER 4

Optics
The Study of Light

The ancient Greeks believed that light and color were not directly related. They thought color came from white light being changed by an object's color. Besides, if you take red, orange, yellow, and all the other rainbow colors of paint and mix them up, you just get a murky brown-black, not white.

Isaac Newton asked himself if white light really was white. Or, was there more to it than that? Newton was a leader in the study and uses of light in the 1600s and 1700s. He wrote a book called *Opticks*. It dealt with measuring and using light. Today, we still use Newton's word *optics* for this area of science.

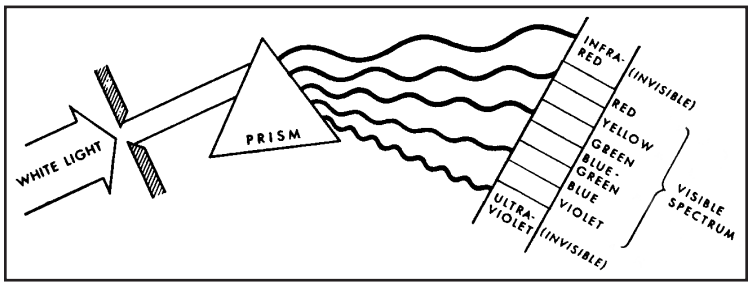
To find the answer to his question, Newton shaded a window. The shade had a hole in it. One beam of sunlight entered the room through the hole. Newton placed a prism in the sunlight. A prism is a wedge-shaped piece of polished glass.

Newton discovered that white light passing through a prism bends or refracts. The prism split the invisible white light into visible colored light.

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.

The colors of light that make up the visible spectrum are the colors in a rainbow. You can easily remember them by using the acronym—ROY G. BIV which stands for Red, Orange, Yellow, Green, Blue, Indigo, and Violet. These are the colors of the visible spectrum in the correct order of their wavelength.

Try it yourself. You can make white light from colored light. Shine beams of light through a red, yellow, and blue filter. When the three colors of light combine, the light becomes white.



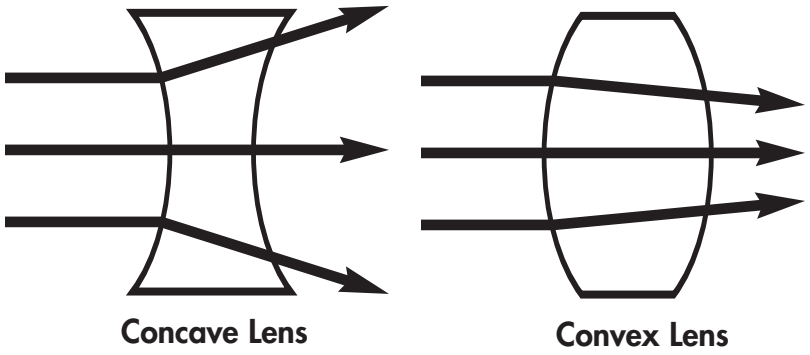
A prism splits white light into visible light.

Instruments to Study Light

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

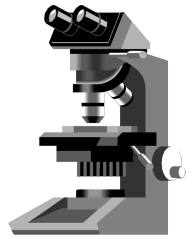
Concave lenses curve inward. They have a narrow center and thicker outer edge. Light rays passing through a concave lens refract away from the others. This causes things seen through the lens to look smaller.

The middle of a convex lens, such as a magnifying glass, 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 in the 1500s and 1600s. 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. A 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. Others are strong enough to cut through steel.

Mirrors are important instruments, too. They reflect light smoothly.

CHAPTER 5

Light Events

We can see rainbows, optical illusions, and shadows because of light. You may not have thought of these as being related to light, but they are.

Rainbows

You probably 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 horizontal lines below. Is one line longer than the other?

Optical illusions trick the brain and eyes. If you take a ruler or 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 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 back

astronomer—a person who studies stars, planets and other objects in space

atom—a basic unit of matter of which all things are made

emit—to send out

matter: anything with mass that takes up space

opaque—blocking or reflecting all light

refract—to bend

scatter—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 spectrum—the light humans can see

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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ENGLISH-LANGUAGE ARTS • GRADE 3

Above Level

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Comprehension and Analysis of Grade-Level-Appropriate Text: 2.5
Comprehension and Analysis of Grade-Level-Appropriate Text: 2.6

English-language Arts Activities

What Is Light?

Print pages 20–24 of this PDF for the reading activities.

Identify Main Ideas

TRY THE SKILL

Identifying the main idea and supporting details helps you understand and remember what you read.

Read this paragraph from *What Is Light?* and try to identify the main idea.

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

Is the following the main idea?

Transparent materials are made of glass.

No! This statement is too specific and does not summarize the main idea. How about the one below? Is it the main idea?

Transparent materials allow light to pass through them.

Yes! This is the main idea of the paragraph.

Read the paragraphs from *What Is Light?* Shade the circle next to the main idea.

1. Scientists have created many different instruments to study light and its behavior. Specially shaped pieces of glass or plastic called lenses are one of the primary instruments. A prism is a 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 the others. This causes things seen through the lens to look smaller.

Ⓐ Concave lenses make objects look smaller.

Ⓑ Convex lenses curve outward.

Ⓒ Lenses are useful for studying light.

2. Light comes from two sources—natural and artificial. Natural sources are beyond human control. They include such things as the sun and stars. Artificial light sources are created by humans. They include such things as candles and electric light bulbs.

Ⓐ Light sources can be natural or created by people.

Ⓑ Humans cannot control natural light sources.

Ⓒ Candles and lamps are two artificial light sources.

Compare and Contrast

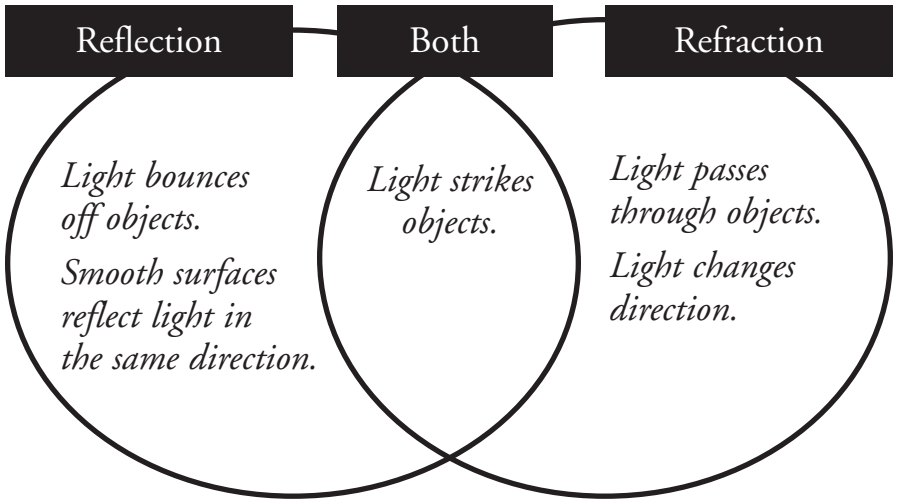
TRY THE SKILL

Comparing and contrasting can help you understand what you read. Comparing tells how things are alike. Contrasting tells how things are different.

Read the following paragraphs. Then read the Venn diagram that compares and contrasts.

Reflection: Light does several things when it hits an object. It may pass through it. It may also bounce off the object. This light is reflected.

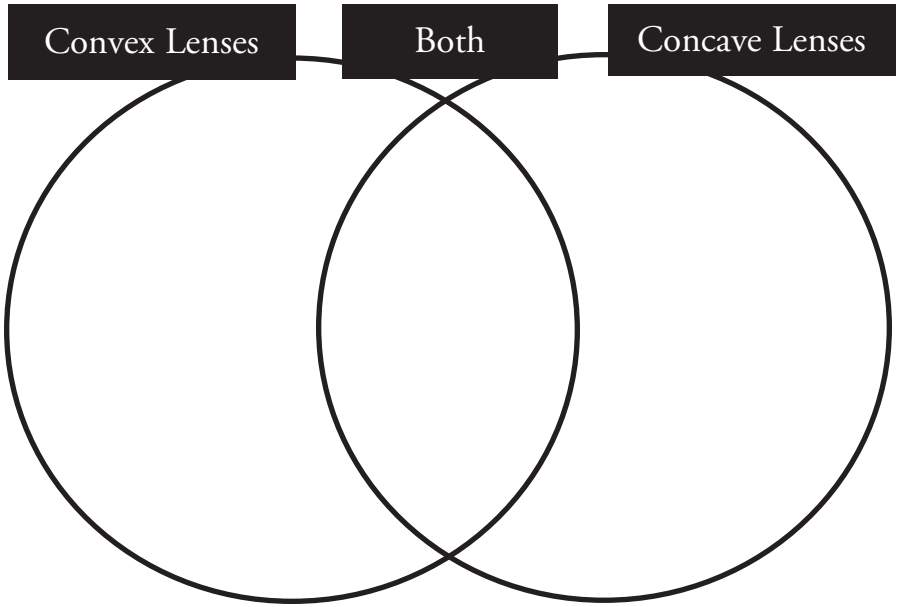
Refraction: Some objects bend light. It is refracted. The amount of bending depends on the material. Water, for example, slows down light. This causes a pencil to look bent when placed in a glassful of water.



Read the paragraphs below. Think about comparing and contrasting. Then complete the Venn diagram.

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

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



Interpret Graphic Information

TRY THE SKILL

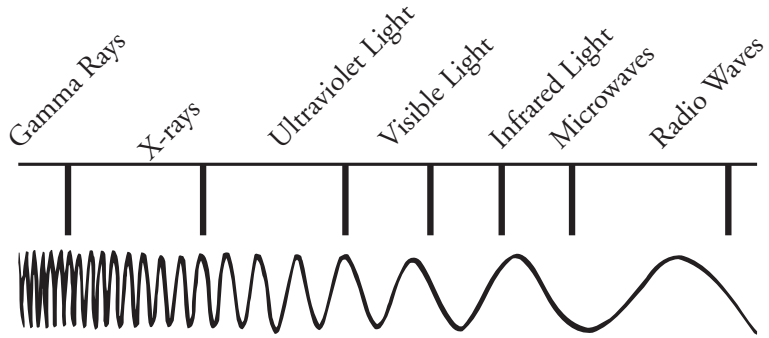
Graphic information is presented in picture or chart form. For example, look at the following chart. Then study the questions and answers.

Rain Amounts in Minnesota and Iowa

	June	July	August
Minnesota	20 inches	8 inches	9 inches
Iowa	19 inches	6 inches	12 inches

1. **In which month does Minnesota receive the least rain?**
   July
2. **Does Minnesota or Iowa receive more rain in August? How much more?**
   Iowa receives 3 more inches of rain than Minnesota.
3. **Which month is best for farmers in these states if farmers like lots of rain?**
   June

Look at the illustration. Then answer the questions.



1. Are wavelengths of visible light longer or shorter than radio waves?

   _____

2. Which wave length is longest—gamma rays, infrared, or visible light?

   _____

3. Shorter wavelengths have higher frequency. Which waves have the lowest frequency?

   _____

4. If longer waves travel better through walls, which will travel worst?

   _____

Antonyms

Antonyms are words that have opposite meanings from each other. Some examples of antonyms are:

night and *day*
up and *down*
inside and *outside*
left and *right*

Read the following paragraph from *What Is Light?* Look for the antonyms.

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

The middle of a convex lens, such as a magnifying glass, curves outward. This causes light rays to refract toward each other, making them look larger.

***Inward* and *outward* are antonyms. So are *smaller* and *larger*.**

TRY THE SKILL

Read the following paragraph from *What Is Light?* Circle the antonyms.

What causes light? Light is caused by the release of energy from atoms. When atoms gain energy, they become "excited." When they lose energy they become "deexcited." Atoms can either run into another atom to get rid of the energy or they can emit the energy as light.

One way to excite atoms is to heat them. For example, when metal is heated, its excited atoms give off energy that makes the metal turn red.

When the metal gets even hotter, it turns white. Its atoms are very excited and are giving off lots of energy.

When the metal is cooled, its atoms are deexcited. The metal slowly returns to its original color.

Think of as many antonyms as you can that have to do with light. Write them on the lines below.

_____

_____

_____

Answer Key

Identify Main Ideas

1. C

2. A

Compare and Contrast

Convex Lenses: lens curves outward; light refracts; objects look larger

Both: specially shaped glass; called lenses

Concave Lenses: lens curves inward; narrow center and thicker edge; light refracts away; objects look smaller

Interpret Graphic Information

1. shorter

2. infrared

3. radio waves

4. gamma rays

Antonyms

gain–lose

excited–deexcited

heated—cooled