Name _____ Class _____ Date _____

CHAPTER 3 Light and Living Things

SECTION 2

Interactions of Light with Matter

California Science Standards

7.6.b, 7.6.c, 7.6.e, 7.6.f, 7.6.g

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- How does light interact with matter?
- What determines the color of objects we see?
- How does light travel?

What Is Reflection?

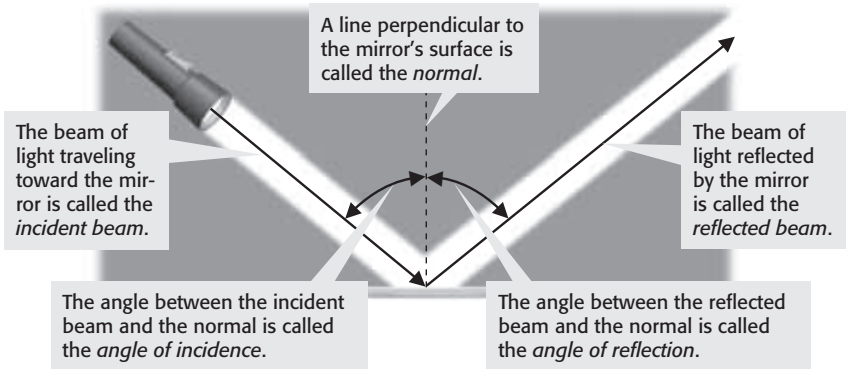
Reflection happens when light waves bounce off an object. Light travels in a straight line unless it hits an object or goes into a new material.

Reflection changes the direction of light. Light reflects off surfaces like a ball bounces off the ground. If you throw the ball straight down, it will bounce straight up. If you throw the ball at an angle, it will bounce away at an angle.

Light acts according to the *law of reflection*. The law of reflection states that the angle made by light hitting a surface equals the angle of light reflected. ☑

The figure below shows a beam of light hitting a mirror. This beam of light is called incident light and the angle it makes is called the *angle of incidence*. A dashed line, called a *normal*, is drawn perpendicular to the mirror. The angles of incidence and reflection are on either side of the line.

The Law of Reflection



STUDY TIP

Clarify Concepts In your science notebook, draw figures that show regular reflection and diffuse reflection. Write one or two sentences to summarize each figure.

READING CHECK

1. Identify According to the law of reflection, what two angles are equal?

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TAKE A LOOK

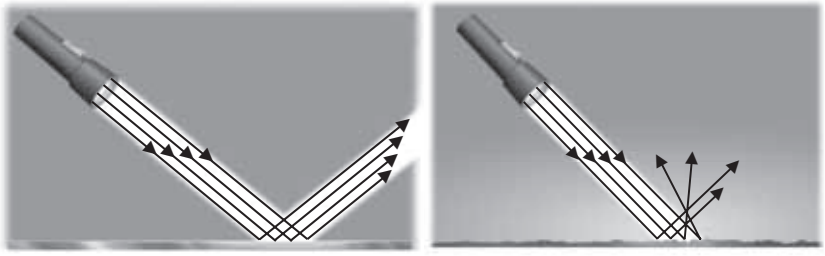
2. Identify Color the angle of incidence one color and the angle of reflection another color.

What Are the Types of Reflection?

Why can you see your image in a mirror but not in a wall? The two surfaces are different. A mirror's surface is very smooth and shiny. Thus, light beams reflect off all points of the mirror at the same angle. This kind of reflection is called *regular reflection*.

A wall's surface is slightly rough. Light beams will hit the wall's surface and reflect at many different angles. So, the light scatters as it is reflected. This kind of reflection is called *diffuse reflection*. The figure below shows the difference between the two kinds of reflection.

Regular Reflection vs. Diffuse Reflection



Regular reflection occurs when light beams are reflected at the same angle. When your eye detects the reflected beams, you see a reflection on the surface.

Diffuse reflection occurs when light beams reflect at many different angles. You can't see a reflection because not all of the reflected light comes straight toward your eyes.

What Are Light Sources?

A light source is an object that produces light. Flames, light bulbs, the sun, and firefly tails are all light sources. Objects that produce visible light are called *luminous*.

Most things around you are not light sources. But you can still see them because light from light sources reflects off the objects into your eyes. We say the light *illuminates* the object.

If you look at a TV set in a bright room, you see the cabinet surrounding the TV and the image on the screen. But if you look at the same TV in the dark, you see only the image on the screen. That's because the screen is a light source, but the cabinet is not. The cabinet needs to reflect light in order for you to see it. ☑

Critical Thinking

3. Compare Explain the difference between regular and diffuse reflection.

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Say It

Clarify Concepts Working with a partner, take turns reading aloud the captions in the figure. Explain to each other why you can't see your reflection in a sweater.

READING CHECK

4. Explain Why can't you see the cabinet surrounding a TV in a dark room? Use the words "light source" and "illuminates" in your answer.

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What Is Absorption of Light?

When a beam of light shines through the air, particles in the air gain some of the energy from the light. This transfer of energy is called **absorption**. This causes the light to lose some of its energy. Because of this, the beam of light becomes dim. The farther the light travels from its source, the more energy is absorbed by air particles. So, the light that reaches your eye is dimmer than the light was at the source. ☑

READING CHECK

5. Explain How does absorption explain why light becomes dimmer as it travels through the air?

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What Is Scattering of Light?

Scattering occurs when light moves in all directions after colliding with particles of matter. Light scatters when it strikes a rough surface, like a wall.

Light from the ship shown below is scattered out of the beam by particles in the fog. This scattered light allows you to see things that are outside the beam. But, because light is scattered out of the beam, the beam becomes dimmer.

Regular Reflection vs. Diffuse Reflection

A beam of light is dimmer when it is far from its source. This is partly because it is scattered by particles in the air.

TAKE A LOOK

6. Describe As the two light beams move farther from the ship, they get dimmer. What else happens to the light beams?

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READING CHECK

7. Explain Why is the sky blue? Your answer should include the word "scattered."

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Scattering makes the sky look blue. Sunlight is made up of many different colors of light. Light with shorter wavelengths is scattered more by air particles than light with longer wavelengths. Blue light, which has a very short wavelength, is scattered more than any other color. So, when you look at the sky, you see a background of blue light. ☑

How Does Light Interact with Matter?

When light hits any form of matter, it can interact with the matter in different ways. The light can be reflected, absorbed, or transmitted.

Reflection happens when light bounces off an object. Reflected light allows you to see things. Absorption is the transfer of light energy to matter. Absorbed light can make things feel warmer. **Transmission** is the passing of light through matter. In order for you to see, light must be transmitted to your eyes. When it gets to your eyes, it is transmitted to the back of each eye.

Light interacting with glass is shown in the figure below.

Light is transmitted, reflected, and absorbed when it strikes the glass in a window.

TRANSPARENT, TRANSLUCENT, OR OPAQUE

Transparent matter easily transmits visible light. Air, glass, and water are transparent matter. You can see objects clearly when you view them through transparent matter.

Translucent matter transmits light but also scatters the light as it passes through the matter. Wax paper is an example of translucent matter.

Opaque matter does not transmit any light. You cannot see through opaque objects. Metal, wood, and this book are opaque.

CALIFORNIA STANDARDS CHECK

7.6.f Students know light can be reflected, refracted, transmitted, and absorbed by matter.

8. List What are three ways light can interact with matter?

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Say It

Discuss Work with a partner and brainstorm different opaque, translucent and transparent objects you see every day.

How Is an Object's Color Determined?

We see different wavelengths of light as different colors. For example, we see long wavelengths as red and short wavelengths as violet. Colors like pink and brown are seen when certain colors of light mix with each other. ☑

The color that something appears to be is determined by the wavelengths of light that reach your eyes. Light can reach your eyes after being reflected off an object, transmitted through an object, or emitted by an object. When your eyes receive the light, they send signals to your brain. Your brain interprets the signals as colors.

READING CHECK

9. Identify How do we see different wavelengths of light?

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REFLECTING AND ABSORBING LIGHT

When white light strikes a colored opaque object, some colors of light are absorbed, and some are reflected. Only the light that is reflected reaches your eyes. The colors of light reflected by an opaque object determine the color you see. ☑

READING CHECK

10. Explain What determines the color you see when you look at an opaque object?

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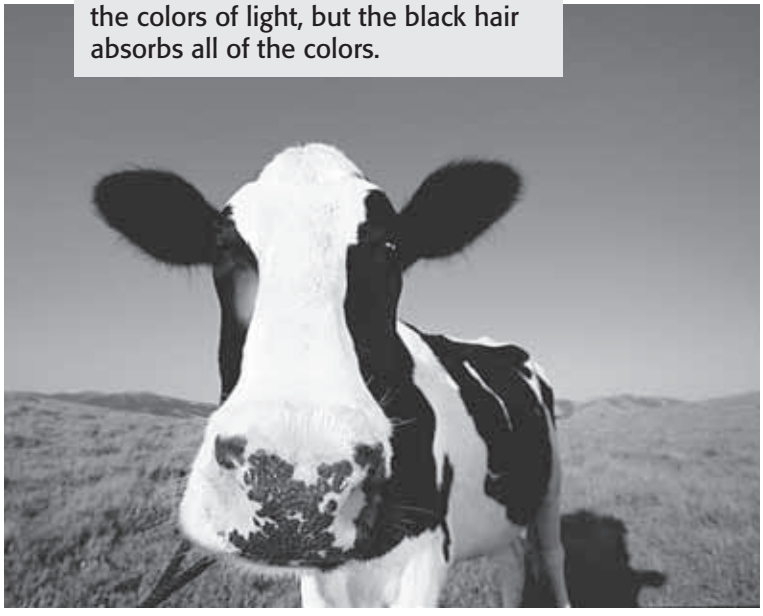
A strawberry reflects red light and absorbs all other colors. This is why a strawberry looks red. What colors of light does the cow shown below reflect? White light includes all colors of light. So, white objects—such as the cow's white hair—appear white because all the colors of light are reflected. On the other hand, black is the absence of color. When light strikes a black object, all the colors are absorbed.

This cow's white hair reflects all of the colors of light, but the black hair absorbs all of the colors.



Critical Thinking

11. Infer Which parts of the cow shown in the figure will feel warmer on a sunny day—the black spots or the white areas? Explain.

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What Determines Color in Non-Opaque Objects?

The colors of transparent and translucent objects are determined differently than the colors of opaque objects. Ordinary window glass is colorless in white light because it transmits all the colors that strike it. In other words, all the colors of light that make up white light pass through window glass. ☑

Some transparent or translucent objects are colored, such as stained-glass windows. When you look at a stained-glass window, you see the color of light that was transmitted or reflected. The other colors are absorbed, so you don't see them.

READING CHECK

12. Explain Why does ordinary window glass look colorless in white light?

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How Do Pigments Produce Color?

A pigment is a material that gives a substance its color by absorbing some colors of light and reflecting others. Almost everything contains pigments. ☑

Melanin is a pigment that gives your skin its color. Chlorophyll is the pigment that gives plants a green color. Chlorophyll absorbs light energy, which is converted into chemical energy during photosynthesis. Some tree leaves have other pigments that make leaves look orange, red, or yellow in the fall.

READING CHECK

13. Describe What is a pigment?

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Some leaves contain orange and yellow pigments. However, you can't see them if chlorophyll is present. In the fall, chlorophyll breaks down and other pigments in the leaves can be seen.

TAKE A LOOK

14. Identify Use colored pencils to show that the leaves on the left-hand side of the figure contain chlorophyll. Use colored pencils to show that the leaves on the right-hand side of the figure have lost their chlorophyll.

What Happens If You Mix Pigments?

Each pigment absorbs at least one color of light. When you mix pigments together, more colors of light are absorbed, or taken away. The primary pigments are yellow, cyan (a blue shade), and magenta. These are the colors of ink used in a color printer. These pigments can be combined to make any other color. ☑

READING CHECK

15. Explain What happens when you mix pigments?

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Name _____ Class _____ Date _____

Section 2 Review

7.6.b, 7.6.c, 7.6.e, 7.6.f, 7.6.g

SECTION VOCABULARY

absorption in optics, the transfer of light energy to particles of matter

reflection the bouncing back of a ray of light, sound, or heat when the ray hits a surface that it does not go through

Wordwise The prefix *re-* means "again" or "back." The root *flect* means "to bend."

scattering an interaction of light with matter that causes light to change its energy, direction of motion, or both

transmission the passing of light or other form of energy through matter.

1. **Identify** For an object to be seen, it must do one of two things. What must the object do?

2. **Describe** What is the path that light travels if it does not hit an object or travel through a new medium?

3. **Describe** What is sunlight composed of? Why is the sky blue?

4. **Identify** What are three things that light can do when it interacts with matter?

5. **Draw** Using two arrows and a dashed line, show the law of reflection in the figure below.

Mirror

6. **Apply Concepts** Complete the table below applying the concepts discussed in this section.

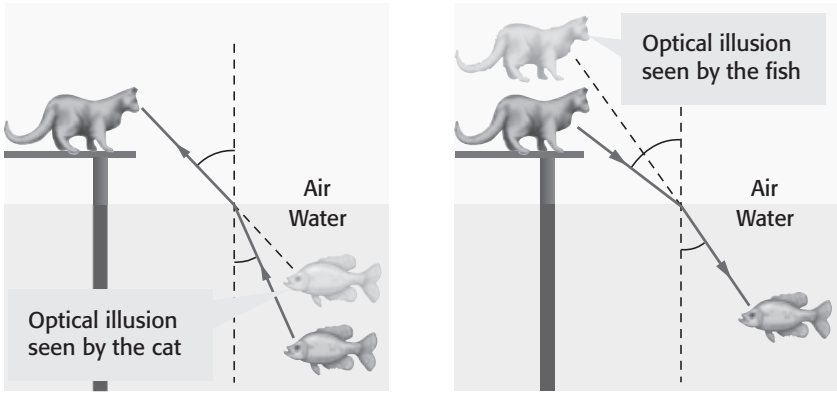
Description	What light will do
A beam of light reflected from a rough surface	Light will show diffuse reflection.
A beam of light passing through a fog	
A beam of light shining on a glass window	

What Can Refraction Cause?

Refraction causes white light to separate into different colors. Color separation causes rainbows to form. Rainbows form when water drops refract sunlight. ☑

White light is made up of all the wavelengths, or colors, of visible light. When white light is refracted, waves with short wavelengths bend more than waves with long wavelengths do.

The figure below shows an *optical illusion*. Optical illusions are caused by refraction.



Because of refraction, the cat and the fish see optical illusions. To the cat, the fish seems closer than it really is. To the fish, the cat seems farther away than it really is.

READING CHECK

3. Explain How do rainbows form?

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Critical Thinking

4. Explain Which colors of light bend the most when refracted? Explain.

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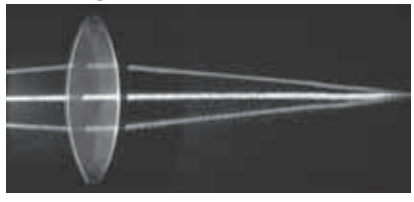
How Do Lenses Refract Light?

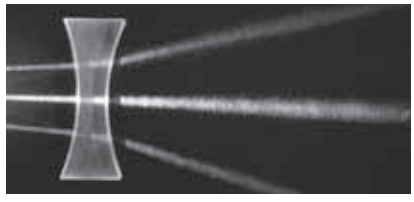
A **lens** is a transparent object that can form an image by refracting light. Two kinds of lenses are shown below. Light rays that pass through the center of any lens are not refracted. The point where the refracted beams intersect is the *focal point*. The distance from the middle of the lens to the focal point is the *focal length*.

How Lenses Refract Light

When light rays pass through a **convex lens**, the rays are refracted toward each other.



When light rays pass through a **concave lens**, the rays are refracted away from each other.



TAKE A LOOK

5. Identify Circle the beams in each figure that are not refracted. Label the focal point, F, and the focal length, f, in the image of the convex lens.