Study Guide

Interactive Textbook

- Complete student edition
- Section and chapter self-assessment
- Assessment reports for teachers

Help Students Read

Building Vocabulary

Word/Part Analysis Help students understand key terms containing the word part *fract-*. Tell them that *fract-* comes from a Latin verb meaning "to break." Explain that when refraction occurs, a straight ray of light "breaks," or bends. Ask: **In addition to refraction, which key terms contain *fract-*?** *(Diffraction, refracting telescope, index of refraction)* Challenge students to relate each of these key terms to the meaning of *fract-*.

Paraphrasing Have students rewrite, in their own words, the paragraph in Section 5, under the heading *Producing Laser Light*, that describes how laser light is produced. Tell them to try to make the paragraph shorter and more concise by expressing the main ideas in simpler terms and by deleting some of the details.

Connecting Concepts

Concept Maps Help students develop one way to show how the information in this chapter is related. Light gives objects their color; can be reflected by mirrors and refracted by lenses to create images; is perceived by the eye; and is used in instruments such as telescopes, microscopes, and lasers. Have students brainstorm to identify the key concepts, key terms, details, and examples. Then, write each one on a self-sticking note and attach it at random on chart paper or on the board.

Tell students that this concept map will be organized in hierarchical order and to begin at the top with the key concepts. Ask students these questions to guide them to categorize the information on the self-sticking notes: **How is light related to the color of objects? How do mirrors and lenses produce images? What is the role of the eye in vision? What are optical instruments, and how do they use light?** Prompt students to use connecting words or phrases, such as "cause," "can be," "are characterized by," and "include," to indicate the basis for the connections in the map. The phrases should form a sentence between or among a set of concepts.

Answer Accept logical presentations by students.

All in One Teaching Resources

- Key Terms Review: *Light*
- Connecting Concepts: *Light*

Chapter

Study Guide

1 Light and Color

Key Concepts

- When light strikes an object, the light can be reflected, transmitted, or absorbed.
- An opaque object is the color of the light it reflects. A transparent or translucent object is the color of the light it transmits.
- When combined in equal amounts, the three primary colors of light produce white light. As pigments are added together, fewer colors of light are reflected and more are absorbed.

Key Terms

transparent material
translucent material
opaque material
primary colors
secondary color
complementary colors
pigment

2 Reflection and Mirrors

Key Concepts

- There are two types of reflection—regular reflection and diffuse reflection.
- A plane mirror produces a virtual image that is upright and the same size as the object.
- Concave mirrors form virtual or real images. Convex mirrors form only virtual images.

Key Terms

ray
regular reflection
diffuse reflection
plane mirror
image
virtual image
concave mirror
optical axis
focal point
real image
convex mirror

3 Refraction and Lenses

Key Concepts

- A convex lens can form virtual images or real images. A concave lens can produce only virtual images.

Key Terms

index of refraction
mirage
lens
convex lens
concave lens

4 Seeing Light

Key Concepts

- You see objects when a process occurs that involves both your eyes and your brain.
- Convex lenses are used to correct near-sightedness. Concave lenses are used to correct farsightedness.

Key Terms

cornea
pupil
iris
retina
rods
cones
optic nerve
nearsighted
farsighted

5 Using Light

Key Concepts

- Telescopes use lenses or mirrors to collect and focus light from distant objects. A microscope uses a combination of lenses to produce and magnify an image. The lens of a camera focuses light to form a real, upside-down image on film in the back of the camera.
- Laser light consists of light waves that all have the same wavelength, or color. The waves are coherent, or in step.
- In addition to their use by stores, industry, and engineers, lasers are used to read information on compact discs, create holograms, and perform surgery.
- Optical fibers can carry a laser beam for long distances because the beam stays totally inside the fiber as it travels.

Key Terms

telescope
refracting telescope
objective
eyepiece
reflecting telescope
microscope
camera
laser
hologram
optical fiber
total internal reflection

Review and Assessment

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Organizing Information

Comparing and Contrasting
Copy the graphic organizer about mirrors and lenses onto a separate sheet of paper. Then complete it and add a title. (For more on Comparing and Contrasting, see the Skills Handbook.)

Mirrors and Lenses

Type of Mirror	Effect on Light Rays	Type of Image
Plane	Regular reflection	a. ?
b. ?	c. ?	Real or virtual
Convex	Spread out	d. ?

Type of Lens	Effect on Light Rays	Type of Image
Convex	e. ?	f. ?
g. ?	h. ?	Virtual

Reviewing Key Terms

Choose the letter of the best answer.

1. A material that reflects or absorbs all of the light that strikes it is a(n)
   a. translucent material.
   b. opaque material.
   c. transparent material.
   d. polarizing filter.
2. When light bounces off an uneven surface, the result is called
   a. regular reflection.
   b. refraction.
   c. diffuse reflection.
   d. internal reflection.
3. A curved piece of glass or other transparent material that is used to refract light is a
   a. prism. **b.** lens.
   c. mirage. **d.** mirror.
4. A ring of muscle that changes the size of the eye's pupil is the
   a. retina.
   b. cornea.
   c. iris.
   d. ciliary muscle.
5. A device that produces coherent light is a(n)
   a. telescope.
   b. microscope.
   c. laser.
   d. optical fiber.

If the statement is true, write *true*. If it is false, change the underlined word or words to make the statement true.

6. Primary colors combine to make any color.
7. Lines that represent light waves are called rays.
8. An upright image that forms where light seems to come from is a virtual image.
9. For a nearsighted person, nearby objects appear blurry.
10. Holograms are long, thin strands of glass or plastic that can carry light for long distances.

Writing in Science

Persuasive Letter Write a short letter to your representative in Congress asking him or her to continue supporting telescopes in space. Include at least two advantages of space telescopes in your letter.

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All in One Teaching Resources

- Transparency O55
- Chapter Test
- Performance Assessment Teacher Notes
- Performance Assessment Student Worksheet
- Performance Assessment Scoring Rubric

ExamView® Computer Test Bank CD-ROM

Review and Assessment

Organizing Information

a. Virtual
b. Concave
c. Converge or meet
d. Virtual
e. Converge, or meet
f. Real or virtual
g. Concave
h. Spread out

Reviewing Key Terms

1. b **2.** c **3.** b **4.** c **5.** c
6. True
7. True
8. True
9. farsighted
10. Optical fibers

Writing in Science

Writing Mode Persuasion

Scoring Rubric
4 Exceeds criteria
3 Meets criteria
2 Includes a weak argument and/or gives only one advantage of space telescopes
1 Fails to make an argument and/or give advantages of space telescopes

Light

Show the Video Assessment to review chapter content. Discussion question: **What phenomena on Earth affect the images produced by conventional telescopes?** *(Water vapor, dust, heat, and other things in Earth's atmosphere can all distort light that reaches telescopes on Earth. Light pollution on Earth can also reduce clarity of a telescope image.)* **Why can the Hubble Space Telescope produce sharper images than earthbound telescopes?** *(Because it orbits 600 km above Earth's surface, it can provide images that are free from atmospheric distortion.)*

Checking Concepts

11. Transparent materials, such as clear glass, transmit light. Translucent materials, such as frosted glass, transmit and scatter light. Opaque materials, such as wood, reflect and/or absorb light but do not transmit light.

12. Rose petals reflect red light and absorb light of all other colors. The leaves reflect green light and absorb light of all other colors.

13. Complementary colors of light can be combined to form white light.

14. Students' diagrams should correctly identify the type of mirror and the location of the focal point and optical axis. The optical axis should divide the mirror into a top and bottom half. The focal point should be on the optical axis. It is in front of a concave mirror and behind a convex mirror.

15. Real images are upside-down images that form where rays of light meet. They are produced by concave mirrors when the object is beyond the focal point. Virtual images are upright images that form where rays of light appear to meet. They are produced by plane mirrors, convex mirrors, and concave mirrors (in the latter, only when the object is closer than the focal point).

16. The index of refraction is higher in materials in which light travels more slowly.

17. As light rays move through hot air, they are bent upward and appear as though they are coming from the surface of the road.

18. The cornea and lens help focus light. The rods and cones in the retina send signals to the brain along the optic nerve.

19. The ciliary muscles relax or contract to change the shape of the lens. The lens is made thicker to focus on near objects, and it is made thinner to focus on distant objects.

20. Light rays are totally reflected off the internal surface of a medium if the angle of incidence is great enough.

Review and Assessment

Checking Concepts

11. Describe transparent, translucent, and opaque materials. Give an example of each.

12. Why do you see the petals of a rose as red and the leaves as green?

13. What colors can be formed by combining complementary colors?

14. Sketch the optical axis and focal point(s) of a concave mirror and a convex mirror.

15. Describe real and virtual images. How can each type of image be formed by mirrors?

16. How is the index of refraction of a substance related to the speed of light in the substance?

17. Explain why you see a mirage on a hot road.

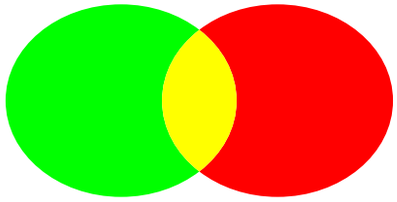
18. Which parts of the eye help to focus light? Which part carries a signal to the brain?

19. Explain how your eyes are able to clearly see both near and distant objects.

20. How does total internal reflection depend on the angle of incidence of light rays?

Thinking Critically

21. **Classifying** Do the colors shown below represent pigments or colors of light? Explain.



22. **Applying Concepts** Can a plane mirror produce a real image? Explain.

23. **Comparing and Contrasting** How are convex and concave mirrors alike? How are they different?

24. **Inferring** You shine a light through a convex lens so it forms a spot on an index card. Where should the lens and card be located to make the spot as small as possible?

25. **Relating Cause and Effect** Explain why your eyes can only see shades of gray in dim light.

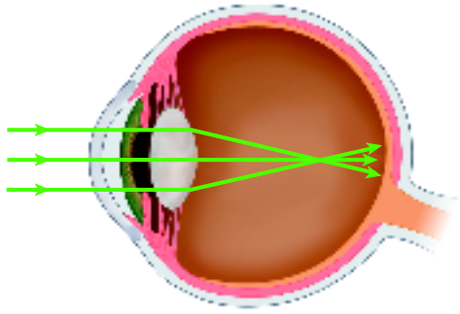
26. **Problem Solving** A telescope produces an upside-down image. How could you modify the telescope so the image is upright?

27. **Comparing and Contrasting** How is a microscope similar to a convex lens used as a magnifying lens? How is it different?

28. **Making Generalizations** Why is laser light never white?

Applying Skills

Use the diagram to answer Questions 29–31.



29. **Classifying** Which type of vision problem does this eye have?

30. **Problem Solving** What type of lens can correct this vision problem?

31. **Communicating** Copy the diagram above on a separate sheet of paper. Add a correcting lens to your diagram and show how the lens makes the three rays focus on the retina.

Lab zone Chapter Project

Performance Assessment Demonstrate your optical instrument to your class. Explain how your instrument works and how it can be used. Use diagrams that show how the mirrors or lenses in your instrument reflect or refract light.

Lab zone Chapter Project

L3

Performance Assessment

Give students an opportunity to demonstrate their optical instruments to the class. Have them explain how their instruments work. Tell them to use diagrams to show how light is reflected and refracted by mirrors and lenses in their instruments.

Ask students to identify ways their instruments could be used. They might compare their instruments to those they have read about in the text. Urge them to explain their design process and to identify ways they improved their instruments or ways it might be improved.

Standardized Test Prep

Test-Taking Tip

Reading All the Answer Choices

It is important that you read all of the answer choices in a multiple-choice question before selecting the one you think is correct. More than one answer choice may be correct, but one choice may be clearly better than the others. "All of the above" may also be a choice and is usually listed last. If you don't read all of the choices, you may miss the best answer.

Sample Question

The compound microscope has at least two convex lenses: an objective and an eyepiece. The objective forms an enlarged real image of the specimen. The eyepiece enlarges the first image, producing the virtual image you see when you look through the microscope.

Compound microscopes

- **A** have two or more convex lenses.
- **B** produce a virtual image.
- **C** have both an eyepiece and an objective.
- **D** all of the above

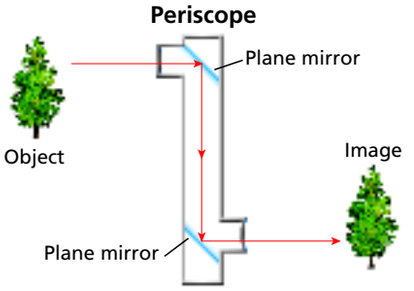
Answer

The best answer is **D** because choices **A**, **B**, and **C** are all correct statements.

Choose the letter of the best answer.

1. The index of refraction for water is 1.33 and for glass is 1.5. When light moves from glass into water, the speed of light
- **A** increases.
- **B** decreases.
- **C** remains the same.
- **D** depends on the angle of incidence.

2. A convex lens can produce a real or a virtual image. Which type of mirror is most similar to a convex lens?
- **F** plane mirror
- **G** convex mirror
- **H** concave mirror
- **J** none of the above



Use the diagram above and your knowledge of science to answer Question 3.

3. If you want to build a periscope, what measurement is most important?
- **A** the angle between the two mirrors
- **B** the distance between the mirrors
- **C** the width of the mirrors
- **D** the width of the tube

4. A friend hypothesizes that a periscope produces an upright image that reverses left and right. How could you test this hypothesis?
- **F** Test A: Draw a ray diagram to determine the type of image that is produced.
- **G** Test B: Look at your friend through the periscope to see if her image is upright.
- **H** Test C: Look at your friend through the periscope and ask her to move her right hand. Observe which hand (left or right) is moving in the image.
- **J** Conduct both Test B and Test C.

5. You view an American flag through sunglasses that are tinted green. What colors do you see?
- **A** green
- **B** black
- **C** green and black
- **D** red and blue

Constructed Response

6. How is a camera like a human eye? Give the function of each part of a camera and identify the part of the eye that has the same function. Use the following terms in your answer: *lens, diaphragm, film, cornea, pupil,* and *retina.*

Thinking Critically

21. The colors represent colors of light, because red and green light combine to form yellow light.

22. No; the image is always virtual, because a plane mirror cannot focus light rays.

23. Both types of mirrors have shiny surfaces, an optical axis, and a focal point; both can produce virtual images. Concave mirrors can produce real images as well, but convex mirrors cannot. Concave mirrors are curved inward, whereas convex mirrors are curved outward.

24. The lens and card should be located as far from the light as possible.

25. Rods, which allow you to see in dim light, are not sensitive to color. Cones, which are sensitive to color, are not effective in dim light.

26. You could add another convex lens to invert the image again.

27. Both can form enlarged images and are focused by moving a lens. However, magnification can be changed in a microscope by changing objectives. Microscopes also can have much higher magnification.

28. Laser light is never white because it consists of light of just one wavelength, whereas white light consists of light of many different wavelengths.

Applying Skills

29. Nearsightedness

30. Concave lens

31. Students' diagrams should show how a concave lens spreads out the rays of light before they pass into the eye. The light passing through the lens of the eye should focus on the retina.

Standardized Test Prep

1. A **2.** H **3.** A **4.** J **5.** C

6. Light enters the camera through the lens, which focuses light like the cornea and lens of the eye. The camera's diaphragm, like the eye's pupil, can change in size to control the amount of light that enters. An image forms on the film at the back of a camera, similar to the way an image forms on the retina at the back of the eye.