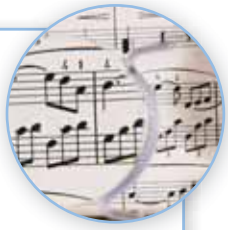
Chapter 12 Summary

12.1 Characteristics of Lenses

Key Concepts

- Lenses are classified as either converging or diverging, depending on how they affect parallel light rays that refract through them.
- Converging lenses have one or two convex surfaces and are thicker in the centre than on the edges. Diverging lenses have one or two concave surfaces and are thinner in the centre than on the edges.
- The focal point of a converging lens is the point at which parallel rays meet after passing through the lens. The focal point of a diverging lens is the point from which the diverging rays appear to have come after parallel rays have passed through the lens.
- With thick lenses, rays that are farther from the principal axis do not pass through the focal point. This causes spherical aberration.
- Different colours of light have different indices of refraction. Therefore, they focus at different points. This causes chromatic aberration.



12.2 Images Formed by Lenses

Key Concepts

- Ray diagrams consisting of three rays can be drawn to determine the characteristics of images formed by lenses.
- When an object is between a converging lens and the focal point, the image is always virtual, upright, and larger than the object.
- When an object is farther from a converging lens than the focal point, the image is always real and inverted. If the object is between the focal point and twice the focal point, the image will be larger that the object. If the object is more than twice the distance of the focal point from the mirror, the image will be smaller than the object.
- When an object is at the focal point of a converging lens, its image will be real, inverted, and the same size as the object.
- When an image is formed by a diverging lens, it is always upright, virtual, smaller than the object, and on the same side as the object.
- Given the focal length of the lens and the size and location of the object, you can use algebraic equations to calculate the characteristics of the image.

12.3 Lens Technologies and the Human Eye

Key Concepts

- Lenses are used in several technologies. For example, microscopes are used to magnify specimens. Microscopes are used in many fields.
- The cornea refracts light first. Then the eye lens focusses the light once the light enters the eye.
- Myopia (near-sightedness) is caused by an eyeball that is too long. Hyperopia (far-sightedness) is caused by an eyeball that is too short.
- Presbyopia prevents a person from being able to focus up close and is caused by the hardening of the eye lens. Astigmatism causes blurry vision because the cornea is not perfectly round.
- Myopia, hyperopia, presbyopia, and astigmatism can be corrected with eyeglasses, contact lenses, and surgery.
- People in the military and law enforcement and people studying wildlife use night-vision devices to intensify available light.

Chapter 12 Review

Make Your Own Summary

Summarize the key concepts of this chapter using a graphic organizer. The Chapter Summary on the previous page will help you identify the key concepts. Refer to Study Toolkit 4 on pages 565–566 to help you decide which graphic organizer to use.

Reviewing Key Terms

Match each of these key terms to its definition below.

a. chromatic aberration
b. diverging
c. eyepiece
d. hyperopia
e. presbyopia
f. reflecting
g. retina

1. _____ lenses are thinner in the centre than they are around the edges. (12.1)

2. When viewing a specimen in a microscope, you look through the _____. (12.3)

3. _____ telescopes use both mirrors and lenses. (12.3)

4. _____ caused problems for Galileo's and Kepler's telescopes. (12.3)

5. The light-sensitive part of the eye is the _____. (12.3)

6. When people reach 40 to 50 years of age, they nearly always develop _____. (12.3)

7. When someone's eyes cannot focus on nearby objects, that person has _____. (12.3)

Knowledge and Understanding K/U

8. What type of lens causes parallel rays to come together after passing through the lens?

9. What happens to parallel rays when they hit a flat piece of glass at an oblique angle with the surface of the glass?

10. Why do lenses have two focal points when mirrors have only one?

11. What two factors determine the focal length of a lens?

12. Define *chromatic aberration*.

13. One type of lens can produce an image that is upright, virtual, and larger than the object. What type of lens is this, and where must the object be located?

14. The rules for drawing ray diagrams and the algebraic equations for lenses specify that they apply only to thin lenses. Explain why the lenses must be thin for these applications.

15. The following two questions are on telescopes.

a. In what way was Kepler's telescope an improvement over Galileo's telescope?

b. What was a disadvantage of Kepler's telescope?

16. Copy the table below into your notebook. The conditions are for an object in front of a diverging lens. Describe and then explain how the rays travel.

Ray Diagrams for Diverging Lenses

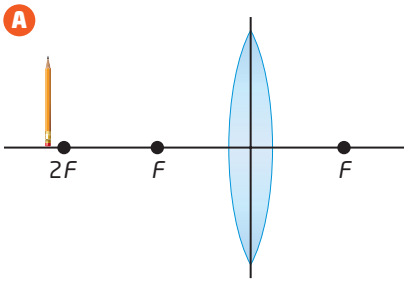
Condition	Where the Ray Goes	Explanation
a. The ray travels parallel to the principal axis until it reaches the diverging lens.		
b. The ray travels toward the centre of the lens.		
c. The ray travels toward the lens as though it were going to the focal point on the far side of the lens.		

17. Would a night-vision device allow someone to see inside an empty building in complete darkness? Explain.

Thinking and Investigation T/I

18. Copy the diagrams below and complete a ray diagram of the object in each. Describe the four characteristics of each image.

A



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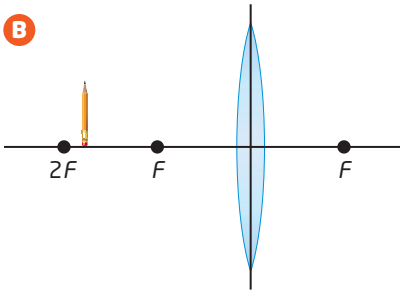

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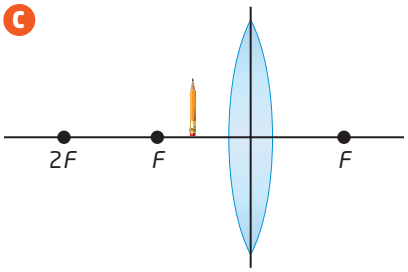

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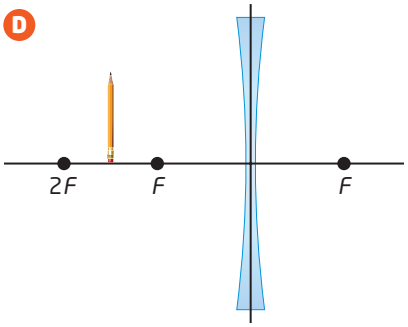
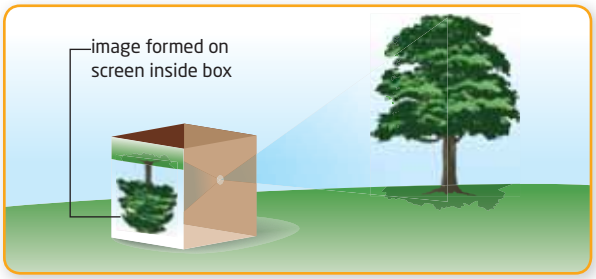


19. A pinhole camera is a box that has a tiny hole in one end and a screen or another type of detector on the inside of the other end, as shown in the diagram below. There is no lens in the hole, but a clear image is created on the screen. Use rays to explain how a pinhole with no lens can form an image that is not blurry.



20. Reducing the aperture of an inexpensive camera reduces the amount of spherical aberration. Explain why this is true.

Communication C

21. Make a sketch of a ray diagram for a hyperopic eye. Explain what causes hyperopia.

22. BIG IDEAS Light has characteristics and properties that can be manipulated with mirrors and lenses for a range of uses. Using an example from this chapter, explain how characteristics and properties of lenses can be used to society's benefit.

23. BIG IDEAS Society has benefited from the development of a range of optical devices and technologies. Choose an optical device from this chapter, and explain how society has benefited from it.

Application A

24. What do you think would be some advantages of wearing contact lenses over eyeglasses?

25. Describe three situations in which night-vision devices would be advantageous.

26. Suppose that you are an optometrist. Explain the advantages and disadvantages of wearing bifocals to a patient who is over 50 years old.