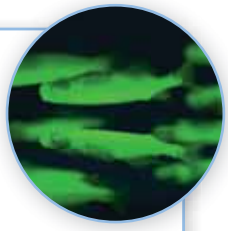
Chapter 10 Summary

10.1 Sources and Nature of Light

Key Concepts

- Incandescence is light that is emitted from an object because the object is very hot.
- Luminescence is light that is emitted in the absence of heat. Fluorescence, phosphorescence, chemiluminescence, and bioluminescence are all forms of luminescence.
- Light is transmitted in the form of electromagnetic waves. Visible light makes up only a small part of the electromagnetic spectrum.
- Light is used in many technologies. For example, blue light, with a special filter, can be used to detect oral cancer.



10.2 Properties of Light and Reflection

Key Concepts

- A ray is a straight line with an arrowhead that shows the direction in which light is travelling.
- The laws of reflection state that the angle of reflection is equal to the angle of incidence, and that the reflected ray always lies on the plane that is defined by the incident ray and the normal.
- The location of an image in a plane mirror can be found by drawing a ray diagram based on the laws of reflection and tested through inquiry.
- The four characteristics of an image in a plane mirror are the following: the image is the same size as the object, the same distance from the mirror as the object, and the same orientation as the object; the image is a virtual image.

10.3 Images in Concave Mirrors

Key Concepts

- The reflecting surface of a concave mirror curves inward.
- Rays that travel toward a concave mirror, parallel to and near the principal axis, will reflect and pass through the principal axis at the focal point.
- For an object between the focal point and the concave mirror, the virtual, upright image is larger than the object, and the image distance is larger than the object distance.
- For an object between the focal point and the centre of curvature, the real, inverted image is larger than the object, and the image distance is larger than the object distance.
- For an object beyond *C*, the real, inverted image is smaller than the object, and the image distance is smaller than the object distance.
- You can calculate the image distance and size using the mirror equation, $\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$, and the magnification equation, $m = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$.
- Spherical aberration is the distortion of an image in a curved mirror that results when reflected rays from the outer parts of the mirror do not go through the focal point.

10.4 Images in Convex Mirrors

Key Concepts

- The reflecting surface of a convex mirror curves outward.
- Rays that travel toward a convex mirror, parallel to and near the principal axis, will reflect back and spread out, away from each other.
- To find *F* for a convex mirror, extend the reflected rays backward until they appear to meet behind the mirror.
- For an object in a convex mirror, the virtual, upright image is smaller than the object.
- You can predict the location and size of an image in a convex mirror by drawing the bottom of the object on the principal axis and drawing at least two rays that travel from the top of the object toward the mirror.
- You can calculate the image distance and size of an image using the mirror equation, $\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$, and the magnification equation, $m = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$.
- The focal length of a convex mirror is negative because the focal point is virtual and behind the mirror.
- There are many practical uses for convex mirrors and surfaces, such as security mirrors and inspection mirrors.

Chapter 10 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

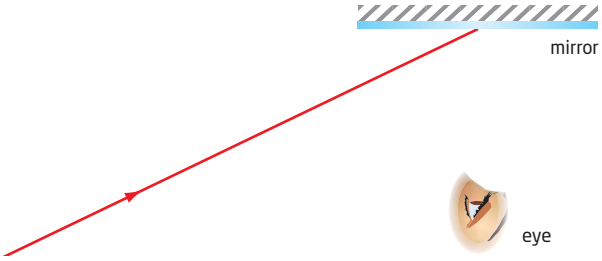
1. _____ light is produced by an older type of light bulb. New energy-saving light bulbs are _____. (10.1)
2. _____ is light produced by living organisms. (10.1)
3. _____ is the change in direction of a wave when it reaches a surface and bounces off the surface. (10.2)
4. The angle of _____ is equal to the angle of _____. (10.2)
5. When the image distance is negative, the image is _____. (10.2)
6. A mirror whose reflecting surface curves inward is a _____ mirror. (10.3)
7. The _____ point is the point on the _____ through which reflected rays pass. (10.3)
8. A mirror whose reflecting surface curves outward is a _____ mirror. (10.4)

Knowledge and Understanding K/U

9. Explain the process that produces the light for all sources of light.
10. List the energy transformation steps that occur in an electric discharge tube. That is, what form of energy is transformed into what other form of energy until the energy becomes light?
11. If light is a form of energy, explain how light can be different colours.
12. What is a light ray?
13. What is meant when the image is said to be behind the mirror? What do you call this type of image?
14. Explain how you would find the focal point of a convex mirror.
15. Why does spherical aberration occur?
16. Describe what a convex mirror looks like.

Thinking and Investigation T/I

17. Imagine that the room in the diagram below is dark and has black walls. The air in the room is free from dust and smoke. A very narrow beam of light enters the room in the direction indicated by the ray. If you stay at the position indicated by the eye, can you see the mirror on the opposite wall? Explain why or why not.



A light ray enters a dark room with black walls.

18. Sometimes, when you sit by a lake in a forest, you can see perfect images of the hills and trees in the lake. Other times, when you are sitting beside the same lake, you cannot see any images in the water. Explain the difference between these two situations.
19. Sometimes, on a sunny day, campers start a campfire using a small mirror to light paper or dry grass. What shape of mirror would they use? What is happening to the sunlight when they do this? Draw a ray diagram to illustrate your answer.
20. A photographer is standing 1.5 m in front of a plane mirror. She wants to take a picture of herself in the mirror. For what distance should she set the focus of her camera to get a clear image?

Communication C

21. BIG IDEAS Society has benefited from the development of a range of optical devices and technologies. Describe two technologies using light that society has benefited from. Explain how society has benefited from them.

22. BIG IDEAS Light has characteristics and properties that can be manipulated with mirrors for a range of uses. Describe a technology involving mirrors that increases the safety of people who use it.

23. Using a diagram or a concept map, describe the processes in the Sun that result in the emission of light from the Sun.

24. Draw a horizontal line, at least 20 cm long, to represent a principal axis. About 3 cm from the right end of the line, draw a curved line through the principal axis to represent a concave mirror. At 5 cm to the left of the concave mirror, draw a dot and label it *F*. At 3 cm to the left of *F*, draw an object that is 2 cm high.

- **a.** Complete this ray diagram to find the image.
- **b.** Explain the rationale for each ray that you drew.
- **c.** Describe the image by stating how far it is from the mirror, how high it is, whether it is real or virtual, and whether it is upright or inverted.

25. How can you tell from a ray diagram whether an image is real or virtual?

Application A

26. The famous Chinese magician Foo Ling Yu performs a classic magic trick using a concave mirror with a focal length of 1.6 m. Foo uses the mirror to produce an image of a light bulb that is the same size as the light bulb itself and is at the same location. Explain, in complete sentences, how Foo accomplishes this magic trick. Be specific about the location of the light bulb.

27. The photograph below shows one of several concrete structures in southeast England. These structures were built between 1915 and about 1930. During World War I, airships from mainland Europe bombed England. The English military wanted a way to detect these airships in time to take precautions. From what you have learned about mirrors and the reflection of waves, suggest how these structures were used as early warning systems.

This concrete structure, located in Folkestone, England, served a military purpose in World War I.

28. Choose a career related to optics from this chapter that interests you, and describe why it interests you.

29. The compact fluorescent bulbs are more efficient at producing light than incandescent bulbs, but the fluorescent bulbs are expensive. A newer alternative is to use LED (light-emitting diode) lighting. Until recently, LED lights have also been too expensive. However, researchers in the United Kingdom have produced new, promising technology using gallium nitride (GaN) LED lighting. Research GaN LED lighting using the Internet or other sources, and answer the following questions.

- **a.** Compare the predicted efficiency of GaN lighting with that of fluorescent bulbs.
- **b.** How many hours will the new bulbs last?
- **c.** What are two more advantages of GaN LED lighting compared with fluorescent lighting?
- **d.** Can LED lights be recycled?
- **e.** How can this technology benefit society?