

Chapter 25 LIGHT AND OPTICS

Chapter 25 Assessment

Vocabulary

Select the correct term to complete the sentences.

| | | |
|--------------|--------------------------|----------------------|
| fluorescence | translucent | CMYK color process |
| pixel | RGB color model | incandescence |
| prism | index of refraction | photon |
| light | white light | diffuse reflection |
| light ray | transparent | electromagnetic wave |
| mirror | converging lens | diverging lens |
| reflection | specular reflection | photoreceptors |
| refraction | electromagnetic spectrum | color |
| lens | | |

Section 25.1

- Visible ____ is what the human eye uses to see.
- You can use light produced by ____ to heat food.
- Atoms produce light by ____.
- A(n) ____ travels at the speed of light.
- A light wave at 500 THz is the ____ orange.
- You see all the colors of ____ when you see a rainbow.
- Ultraviolet light and microwaves are part of the ____.
- A(n) ____ is the smallest possible amount of light.

Section 25.2

- An HDTV screen has more ____ (s) than a regular TV screen.
- Magenta is a pigment used in the ____.
- The ____ is used by video cameras to achieve a range of colors.
- ____ are special cells on the surface of the retina that detect color and light intensity.

Section 25.3

- A surface with ____ produces a single reflected light ray for each incident ____.
- ____ occurs when light enters a material and bends.
- Three examples of optical devices are: ____, ____, and ____.
- Glass is a(n) ____ material because light passes through it without scattering.
- ____ materials allow light to pass through but scatter it in all directions.
- The ____ of water is 1.33.
- Surfaces that scatter light when it reflects have ____.
- A(n) ____ bends light rays inward toward the focal point.
- A(n) ____ bends light rays away from the focal point.
- ____ happens when light rays interact with a mirror.

Concepts

Section 25.1

- List four properties of light.
- Are the properties of visible light the same as the properties of electromagnetic waves? Why or why not?
- What role do atoms play in producing light?
- What is the relationship between the frequency and wavelength of light?
- Compare the speed, energy, wavelength, and frequency of red light and blue light.
- Describe an electromagnetic wave. How is one made? Is it possible for a human being to make an electromagnetic wave? Why or why not?

7. A flame from a Bunsen burner is reddish at the top and blue near the opening of the burner. Where is the flame hottest? Explain your answer.

Section 25.2

8. Describe the types, number, and sensitivity of the photoreceptors in the human eye.
9. Your brain perceives color by an additive process. How would you see the following combinations of light colors?
- red + blue
 - blue + green
 - red + green
 - red + blue + green
10. For stage lighting for a play in a theater:
- a magenta spot of light is created along with a green spot of light. What happens when these two spots of light combine?
 - light from a blue spotlight is combined with light from a green spotlight. What color light is produced?
11. In the CMYK color process, why is black pigment used instead of mixing cyan, magenta, and yellow pigments?
12. Most objects do not make their own light, so how do we see the colors of these objects?
13. What colors of light are reflected by the pigment cyan?
14. What primary additive colors of light will be allowed to pass through a magenta filter?
15. Describe the difference between the light you would see from a flashlight and the light you see from a printed page.
16. Compare the way color is produced by a TV screen with how color is printed in an illustration in this book.
17. Why do the leaves of most plants look green?

Section 25.3

18. How is a prism different from a mirror?
19. How do transparent and translucent materials differ?
20. Name the ways in which light can interact with matter. Give an example of a situation where more than one interaction happens at the same time.
21. Describe the difference between refraction and reflection.
22. List the different types of light interactions that are taking place in this image of stained glass.
23. Diamond has a higher index of refraction than water. What does this mean?
24. Explain how a converging lens changes the direction of light.
25. What is the difference between the focal length of a lens and its focal point?

**Problems****Section 25.1**

- Red light can have a wavelength of 0.0000007 meters. What is this wavelength in units of nanometers?
- Frequencies of 462 THz, 517 THz, and 638 THz represent the frequencies of three colors: blue, red, and yellow. Match each frequency to its color.
- Lightning strikes in the distance and six seconds later, thunder is heard. How far away was the lightning strike?
- How long does it take for light to travel from the Sun to Earth (about 150 million kilometers)?
- A 20-watt compact fluorescent lamp (CFL) costs about \$5.00, and a 75-watt incandescent bulb costs only \$1.00. Both devices produce similar amounts of light. Why might it be worth it to buy the more expensive CFL?

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6. Use this table to answer the following questions.

| Energy | Color | 1×10^{-9} m | Wavelength (nanometers) | Frequency (THz) |
|--------|--------|----------------------|-------------------------|-----------------|
| Low | Red | | 650 | 462 |
| | Orange | | 600 | 500 |
| | Yellow | | 580 | 517 |
| | Green | | 530 | 566 |
| | Blue | | 470 | 638 |
| High | Violet | | 400 | 750 |

- You can remember the order of the colors of light by remembering the name "Roy G. Biv." Each letter stands for a color. How would you describe the order of these colors in terms of wavelength, frequency, and energy?
- A friend says to you that his favorite color on this table is the third highest in terms of frequency but not as high energy as the color blue. What color is your friend talking about?
- Why is the energy of a wave directly related to its frequency? Come up with a hypothesis.

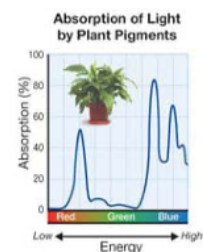
Section 25.2

- What color will a blue shirt appear in pure red light?
- Which of the CMYK colors would you mix if you wanted to produce the following colors of ink?
 - red
 - green
 - blue
- Compare the quality of the images produced by your eyes, a regular TV screen, and an HDTV screen in terms of pixels.

- Identify the color process (RGB or CMYK) used in each step.
 - Take a photograph with a digital camera.
 - The image appears on a computer monitor.
 - Print the image using a laser printer.
 - See the image on paper with your eyes.

- Answer the following questions using the absorption graph shown.

- Which colors of light are absorbed the most by plants?
- Which colors of light are reflected the most by plants?
- Based on the information from the absorption graph, explain why a plant will grow more quickly if it is grown in white light rather than green light.



Section 25.3

- Glare from headlights can make it hard to see when driving at night, and glare is worse when the roads are wet. Explain why, in terms of the two types of reflection.
- Why do ambulances often have the word *AMBULANCE* reversed on the front?
- The angle of reflection for a light ray reflecting off a mirror is 40 degrees. What is the angle of incidence for the incident ray? Justify your answer.
- A light ray bends away from the normal line when passing from glass to a liquid. Based on this information, how does the index of refraction for the liquid compare to the index of refraction for the glass?
- A clear plastic ball seems to disappear when placed in a liquid. What does this tell you about the indices of refraction for the clear plastic and the liquid?

Applying Your Knowledge

Section 25.1

- Electromagnetic waves are useful for sending data and information from one place to another. For example, cell phones use microwaves and televisions use radio waves. Explain why these waves are so effective. Pick one device that uses electromagnetic waves to send information and explain how it works.
- Thomas Edison is just one of many inventors who contributed to making electric light accessible to people. Research how one or more scientists contributed to the electric incandescent bulb. What is the general feeling about these types of light bulbs today?
- Describe the health connection between ultraviolet light and vitamin D.
- Make a chart that compares a photon and an atom.

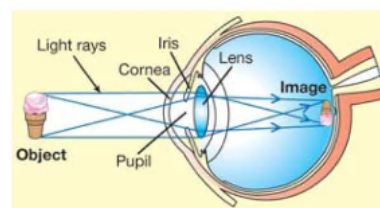
Section 25.2

- Pick a common animal and find out about this animal's eyesight. Does it see colors? Is the animal nocturnal?
- Color blindness is a condition in which a person has difficulty distinguishing certain colors.
 - Explain more about color blindness.
 - How common is color blindness?
 - How has society made modifications to assist people with color blindness?

Section 25.3

- Find out how white light is split into the colors of visible light by the following objects. Identify which light interaction is involved in splitting the light.
 - Glass prism
 - Water droplets in the atmosphere
 - Spectrometer

- When you learned about waves in Chapter 24, you learned about diffraction and interference. Light waves can also be diffracted and they experience interference. In the early 1800s, Thomas Young used these properties of light to provide evidence of the wave theory of light. Find out more about Young's work and write a paragraph about it.
- Research how the human eye works.
 - Based on your findings, describe the roles of the iris, pupil, retina, cornea, optic nerve, and lens.
 - The following diagram illustrate how light from an object forms an image on your retina. This diagram implies that we see all objects upside down. Is that true? Of course not! Find out why.



- Challenge: A ray diagram is a special diagram that helps you see how light passes through a lens and forms an image. Ray diagrams for converging and diverging lenses were shown in this chapter. From those diagrams, you can tell that each lens forms images and refracts light differently. Find out the answers to the following questions.
 - What is the difference between a real image and a virtual image?
 - Which of these types of lenses is used for magnifying objects? How does this lens magnify objects?
 - Which of these lenses forms a smaller, virtual image? Why?