

## Chapter 18 The Electromagnetic Spectrum and Light

**Section 18.1 Electromagnetic Waves****(pages 532–538)***This section describes the characteristics of electromagnetic waves.***Reading Strategy (page 532)**

**Comparing and Contrasting** As you read about electromagnetic waves, fill in the table below. If the characteristic listed in the table describes electromagnetic waves, write E in the column for Wave Type. Write M for mechanical waves and B for both. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.

Electromagnetic and Mechanical Waves	
Travels through a vacuum	E
Travels through medium	
Fits wave model	B
Fits particle model	
Transverse wave	
Longitudinal wave	

**What Are Electromagnetic Waves? (page 533)**

- What are electromagnetic waves? \_\_\_\_\_  
\_\_\_\_\_
- Electric fields are produced by electrically charged particles and by changing \_\_\_\_\_.
- Magnetic fields are produced by magnets, by changing \_\_\_\_\_, and by vibrating charges.
- Electromagnetic waves are produced when a(n) \_\_\_\_\_ vibrates or accelerates.
- Circle the letter of each sentence that is true about electric and magnetic fields.
  - An electromagnetic wave occurs when electric and magnetic fields vibrate at right angles to each other.
  - A magnetic field is surrounded by an electric current.
  - Changing electric and magnetic fields regenerate each other.
  - Electromagnetic waves are produced when an electric charge vibrates.
- Is the following sentence true or false? Electromagnetic waves need a medium to travel through. \_\_\_\_\_
- The transfer of energy by electromagnetic waves traveling through matter or across space is called \_\_\_\_\_.

**Chapter 18 The Electromagnetic Spectrum and Light****The Speed of Electromagnetic Waves (page 534)**

8. As a thunderstorm approaches, you see the lightning before you hear the thunder, because light travels \_\_\_\_\_ than sound.
9. Is the following sentence true or false? All electromagnetic waves travel at the same speed through a vacuum. \_\_\_\_\_
10. Circle the letter that gives the correct speed of light in a vacuum.
- a.  $3.00 \times 10^8$  kilometers per second
  - b.  $3.00 \times 10^8$  meters per hour
  - c.  $3.00 \times 10^8$  meters per second
  - d.  $3.00 \times 10^8$  kilometers per hour

**Wavelength and Frequency (page 535)**

11. Circle the letter of each sentence that is true about electromagnetic waves.
- a. Different electromagnetic waves can have different frequencies.
  - b. Wavelength is directly proportional to frequency.
  - c. Electromagnetic waves always travel at the speed of light.
  - d. All electromagnetic waves travel at the same speed in a vacuum.
12. As the wavelengths of electromagnetic waves increase, the frequencies \_\_\_\_\_, for waves moving in a(n) \_\_\_\_\_.

**Wave or Particle? (pages 536–537)**

13. Electromagnetic radiation behaves sometimes like a(n) \_\_\_\_\_ and sometimes like a stream of \_\_\_\_\_.
14. Interference only occurs when two or more waves overlap, so \_\_\_\_\_ experiment showed that light behaves like a \_\_\_\_\_.
15. The emission of electrons from a metal caused by light striking the metal is called the \_\_\_\_\_ effect.
16. Blue light has a higher frequency than red light, so photons of blue light have \_\_\_\_\_ energy than photons of red light.

**Intensity (page 538)**

17. The closer you get to a source of light, the \_\_\_\_\_ the light appears.
18. Intensity is the \_\_\_\_\_ at which a wave's energy flows through a given unit of area.
19. As photons travel farther from the source, the \_\_\_\_\_ of light decreases.

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# Section 18.2 The Electromagnetic Spectrum

(pages 539–545)

*This section identifies the waves in the electromagnetic spectrum and describes their uses.*

## Reading Strategy (page 539)

**Summarizing** Complete the table for the electromagnetic spectrum. List at least two uses for each kind of wave. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.

The Electromagnetic Spectrum		
Type of Waves	Uses	
Radio Waves	Communications	
Infrared Rays		Keeping food warm

## The Waves of the Spectrum (pages 539–540)

- Is the following sentence true or false? William Herschel determined that the temperature of colors of light was higher at the blue end and lower at the red end. \_\_\_\_\_
- Herschel’s curiosity led him to conclude there must be invisible \_\_\_\_\_ beyond the red end of the color band.
- Is the following sentence true or false? The full range of frequencies of electromagnetic radiation is called the electromagnetic spectrum. \_\_\_\_\_
- Name each kind of wave in the electromagnetic spectrum, from the longest to shortest wavelength.
  - \_\_\_\_\_
  - \_\_\_\_\_
  - \_\_\_\_\_
  - \_\_\_\_\_
  - \_\_\_\_\_
  - \_\_\_\_\_

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### Radio Waves (pages 540–542)

5. Circle the letter of each way that radio waves might be used.
- a. X-ray machines
  - b. microwave ovens
  - c. radio technology
  - d. television technology
6. What is the difference between amplitude modulation (AM) and frequency modulation (FM)? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
7. How far do microwaves generally penetrate food? \_\_\_\_\_  
\_\_\_\_\_
8. How is the Doppler effect used to detect the speed of a vehicle? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

### Infrared Rays (page 543)

9. Circle the letter of each way infrared rays are used.
- a. source of light
  - b. to discover areas of heat differences
  - c. source of heat
  - d. to discover areas of depth differences
10. Thermograms show variations in \_\_\_\_\_ and are used to find places where a building loses heat to the environment.

### Visible Light (page 543)

11. Is the following sentence true or false? One use for visible light is to help people communicate with one another. \_\_\_\_\_

### Ultraviolet Rays (page 544)

12. Ultraviolet radiation has applications in \_\_\_\_\_ and \_\_\_\_\_.
13. Is the following sentence true or false? Ultraviolet radiation helps your skin produce vitamin D. \_\_\_\_\_

### X-rays (page 544)

14. Is the following sentence true or false? X-rays have higher frequencies than ultraviolet rays. \_\_\_\_\_
15. Why are X-rays helpful? \_\_\_\_\_  
\_\_\_\_\_

### Gamma Rays (page 545)

16. Gamma rays have the highest \_\_\_\_\_ and therefore the most \_\_\_\_\_ and the greatest penetrating ability of all the electromagnetic waves.
17. How is gamma radiation used in medicine? \_\_\_\_\_  
\_\_\_\_\_

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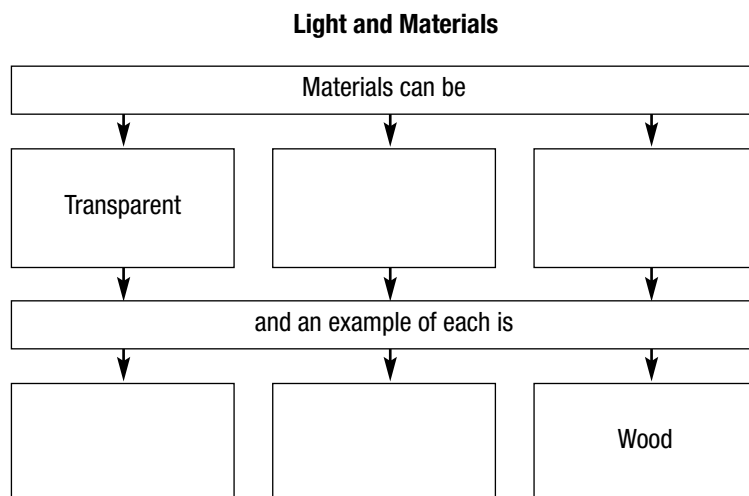
**Section 18.3 Behavior of Light**

**(pages 546-549)**

*This section discusses the behavior of light when it strikes different types of materials.*

**Reading Strategy (page 546)**

**Monitoring Your Understanding** As you read, complete the flowchart to show how different materials affect light. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.



**Light and Materials (pages 546–547)**

1. Is the following sentence true or false? Without light, nothing is visible. \_\_\_\_\_

*Match each term to its definition.*

<b>Term</b>	<b>Definition</b>
_____ 2. transparent	a. Material that absorbs or reflects all of the light that strikes it
_____ 3. opaque	b. Material that transmits light
_____ 4. translucent	c. Material that scatters light

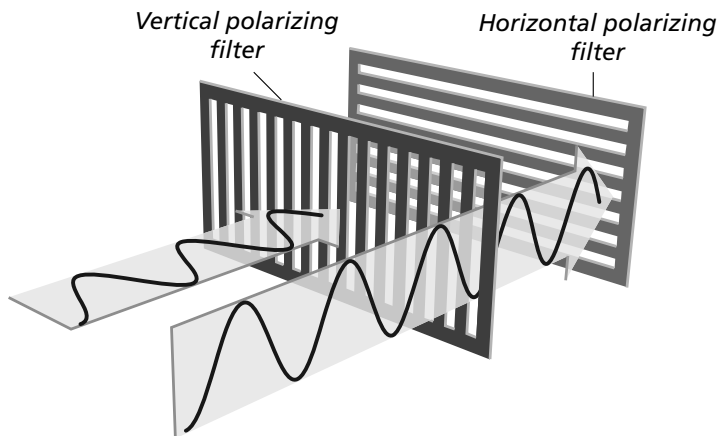
**Interactions of Light (pages 547–549)**

5. Is the following sentence true or false? Just as light can affect matter, matter can affect light. \_\_\_\_\_

6. When light strikes a new medium, it can be \_\_\_\_\_, \_\_\_\_\_, or \_\_\_\_\_.

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7. When light is transmitted, it can be refracted, polarized, or \_\_\_\_\_.
8. A copy of an object formed by reflected or refracted light waves is known as a(n) \_\_\_\_\_.
9. When parallel light waves strike an uneven surface and reflect off it in the same direction, \_\_\_\_\_ reflection occurs.
10. When parallel light waves strike a rough, uneven surface and reflect in many different directions, \_\_\_\_\_ reflection occurs.
11. Light bends, or \_\_\_\_\_, when it passes at an angle from one type of medium into another.
12. Explain why a mirage occurs. \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
13. Is the following sentence true or false? Light with waves that vibrate in only one plane is polarized light. \_\_\_\_\_



14. Refer to the drawing and complete the table on polarizing filters.

Polarizing Filters		
Direction of Light Vibration	Filter Type	Action
Horizontal wave	Vertically polarizing filter	
	Vertically polarizing filter	Light passes through.

15. How do sunglasses block glare? \_\_\_\_\_  
 \_\_\_\_\_
16. The effect when light is redirected as it passes through a medium is called \_\_\_\_\_.
17. Explain why the sun looks red at sunset and sunrise. \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

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**Section 18.4 Color**

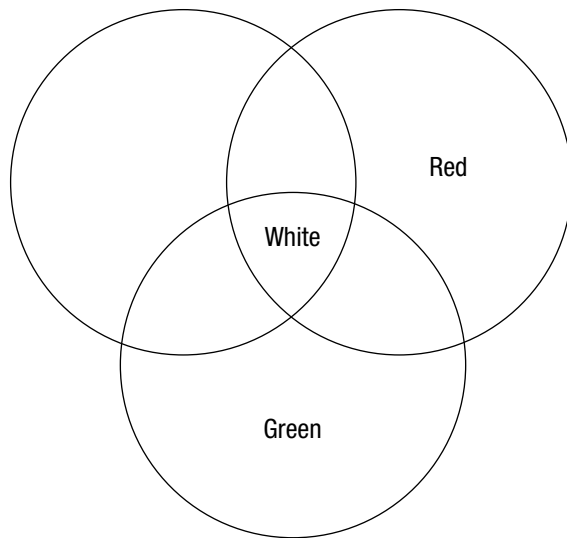
**(pages 550–553)**

*This section explains how a prism separates white light. It also discusses factors that influence the various properties of color.*

**Reading Strategy (page 550)**

**Venn Diagram** As you read, label the Venn diagram for mixing primary colors of light. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.

**Mixing Colors of Light**



**Separating White Light Into Colors (page 551)**

1. What did Isaac Newton’s experiments with a prism in 1666 show?  
 \_\_\_\_\_  
 \_\_\_\_\_
2. What happens when white light passes through a prism? \_\_\_\_\_  
 \_\_\_\_\_
3. Circle the letter of the process in which white light is separated into the colors of the rainbow.
 

a. reflection	b. dispersion
c. absorption	d. polarization
4. How does a rainbow form? \_\_\_\_\_  
 \_\_\_\_\_

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**The Colors of Objects (pages 551–552)**

5. List two factors that determine the color of an object seen by reflected light.
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
6. Is the following sentence true or false? I see a red car in sunlight because the color of light reaching my eyes is mostly red light.  
\_\_\_\_\_

**Mixing Colors of Light (page 552)**

*Match the colors of light with the correct type of color.*

<b>Type of Color</b>	<b>Colors of Light</b>
_____ 7. primary colors	a. Cyan, yellow, and magenta
_____ 8. secondary colors	b. Blue and yellow
_____ 9. complementary colors	c. Red, green and blue

*Match each color of light to its definition.*

<b>Type of Color</b>	<b>Definition</b>
_____ 10. primary colors	a. Formed when two primary colors combine
_____ 11. secondary colors	b. Combine in varying amounts to form all possible colors
_____ 12. complementary colors	c. Combine to form white light

**Mixing Pigments (page 553)**

13. What is a pigment? \_\_\_\_\_  
\_\_\_\_\_
14. List four natural sources of pigments.
  - a. \_\_\_\_\_ b. \_\_\_\_\_
  - c. \_\_\_\_\_ d. \_\_\_\_\_
15. The primary colors of pigments are \_\_\_\_\_, \_\_\_\_\_, and magenta.

*Match the primary colors of pigment to the color they produce when combined.*

<b>Primary Colors</b>	<b>Color Produced</b>
_____ 16. Cyan and magenta	a. green
_____ 17. Cyan and yellow	b. red
_____ 18. Yellow and magenta	c. blue

19. Any two colors of pigments that combine to make black pigment are \_\_\_\_\_ colors of pigments.

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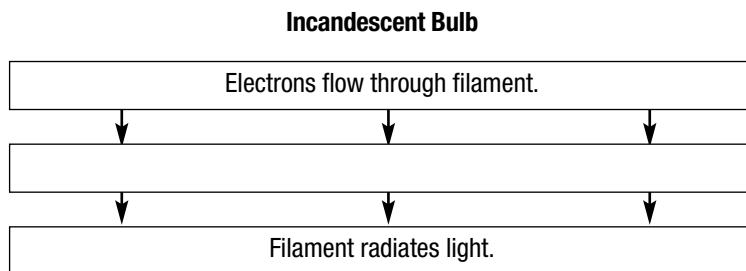
## Section 18.5 Sources of Light

(pages 558–562)

*This section discusses the major sources of light and their uses.*

### Reading Strategy (page 558)

**Flowchart** Complete the incandescent bulb flowchart. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.



1. Objects that give off their own light are \_\_\_\_\_.
2. List six common sources of light.
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
  - c. \_\_\_\_\_
  - d. \_\_\_\_\_
  - e. \_\_\_\_\_
  - f. \_\_\_\_\_

### Incandescent Light (page 558)

3. The light produced when an object gets hot enough to glow is \_\_\_\_\_.
4. As electrons flow through an incandescent light bulb, the \_\_\_\_\_ heats up.
5. Is the following sentence true or false? To increase the life of the filament, incandescent light bulbs contain oxygen at very low pressure. \_\_\_\_\_
6. Most of the energy given off by incandescent bulbs is in the form of \_\_\_\_\_.

### Fluorescent Light (page 559)

7. What happens in the process of fluorescence? \_\_\_\_\_  
\_\_\_\_\_
8. A solid material that can emit light by fluorescence is called a(n) \_\_\_\_\_.
9. Fluorescent bulbs emit most of their energy in the form of \_\_\_\_\_.
10. Is the following sentence true or false? Incandescent bulbs are more energy efficient than fluorescent bulbs. \_\_\_\_\_

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### Laser Light (page 560)

11. A laser is a device that generates \_\_\_\_\_.
12. The letters in the word *laser* stand for
  - l \_\_\_\_\_
  - a \_\_\_\_\_
  - s \_\_\_\_\_
  - e \_\_\_\_\_
  - r \_\_\_\_\_.
13. What is coherent light? \_\_\_\_\_  
\_\_\_\_\_
14. Why does coherent light have a relatively constant intensity? \_\_\_\_\_  
\_\_\_\_\_

### Neon Light (page 561)

15. How is neon light emitted? \_\_\_\_\_  
\_\_\_\_\_
16. List three gases used to produce neon light.
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
  - c. \_\_\_\_\_
17. Why do different types of neon light glow in different colors? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

### Sodium-Vapor Light (page 562)

18. Sodium-vapor lights contain a mixture of \_\_\_\_\_  
and a small amount of solid \_\_\_\_\_.
19. Explain what happens when an electric current passes through a sodium-vapor bulb. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

### Tungsten-Halogen Light (page 562)

20. Explain how a tungsten-halogen light bulb works. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_