Chapter 26  Sound

Exercises

26.1 The Origin of Sound (page 515)

Match each sound source with the part that vibrates.

<table>
<thead>
<tr>
<th>Sound Source</th>
<th>Vibrating Part</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. violin</td>
<td>a. strings</td>
</tr>
<tr>
<td>2. your voice</td>
<td>b. reed</td>
</tr>
<tr>
<td>3. saxophone</td>
<td>c. column of air at the mouthpiece</td>
</tr>
<tr>
<td>4. flute</td>
<td>d. vocal chords</td>
</tr>
</tbody>
</table>

5. Sound waves are a type of ____________ wave.
6. What normally determines the frequency of sound waves?

7. Define pitch.

8. As people grow older, they often have more trouble hearing sounds at the ____________ end of the range of frequencies.
9. Sound waves with frequencies below the normal range are ____________ waves.
10. Sound waves with frequencies above the normal range are ____________ waves.

26.2 Sound in Air (pages 515–517)

11. Is the following sentence true or false? Sound vibrates the air much like particles move back and forth along a stretched spring. ____________
12. A pulse of compressed air is called a ____________, and a pulse of low-pressure air is called a ____________
13. For all wave motion, it is not the ____________ that travels, but a ____________ that travels.
14. Explain what happens when a tuning fork is struck against one end of an open tube.

26.3 Media That Transmit Sound (page 517)

15. What did Native Americans learn long ago when they put their ears to the ground?
Chapter 26  Sound

   a. The sound is softer and travels slower through the metal than through air.
   b. The sound is louder and travels slower through the metal than through air.
   c. The sound is softer and travels faster through the metal than through air.
   d. The sound is louder and travels faster through the metal than through air.

17. Circle the letter of the best conductor of sound.
   a. a gas  b. a liquid  c. a solid  d. a vacuum

18. Suppose a ringing bell is placed inside a sealed jar filled with air. The air is then removed from the jar, creating a vacuum. Describe the difference in what a person nearby hears before and after the air is removed from the jar.

26.4 Speed of Sound (page 518)

19. Is the following sentence true or false? During a thunderstorm, you hear the thunder before you see the lightning. ______________

20. The speed of sound in a gas depends primarily on ______________ and ______________.

21. Circle the letter of the speed of sound in dry air at 0°C.
   a. 20 m/s  b. 330 m/s  c. 60 m/s  d. 1200 m/s

22. ______________ in the air increases the speed of sound in air.

23. For each degree increase in air temperature above 0°C, the speed of sound in air increases about ______________ m/s.

24. The speed of sound at normal room temperature is about ______________.

25. Do lighter gas particles transmit sound faster or slower than heavier gases found in air? ______________

26. Is the following sentence true or false? The speed of sound in a solid material depends not on the material’s density, but on its elasticity. ______________

26.5 Loudness (page 519)

27. What is the intensity of sound proportional to?

     ______________
Chapter 26  Sound

28. Is the following sentence true or false? Sound intensity is a physiological sensation, but loudness can be measured by instruments. ________________

<table>
<thead>
<tr>
<th>Sound Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of Sound</td>
</tr>
<tr>
<td>Jet engine, at 30 m</td>
</tr>
<tr>
<td>Old subway train</td>
</tr>
<tr>
<td>Average factory</td>
</tr>
<tr>
<td>Normal speech</td>
</tr>
<tr>
<td>Library</td>
</tr>
</tbody>
</table>

29. Study the table above. Circle the letter beside the source of sound that is 100 times as intense as the normal sound of a library.
   a. Jet engine, at 30 m  
   b. Old subway train  
   c. Average factory  
   d. Normal speech

30. Physiological hearing damage begins at exposure to ________________ decibels.

31. Is the following sentence true or false? The cells of the receptor organ in the inner ear do not regenerate. ________________

26.6 Natural Frequency (page 520)

32. Define natural frequency.

33. Circle the letter of the properties upon which an object’s natural frequency depends.
   a. elasticity and shape  
   b. mass and shape  
   c. volume and elasticity  
   d. volume and mass

34. Is the following sentence true or false? A natural frequency is one at which maximum energy is required to produce forced vibrations. ________________

26.7 Forced Vibration (page 520)

35. Why is the sound made by an unmounted tuning fork faint when compared to the sound of the fork when its base is on a tabletop?

36. Define forced vibration.

37. The part of any stringed musical instrument that undergoes forced vibration and makes the sound you hear is a ________________.
26.8 Resonance (pages 521–522)

38. Define resonance.

39. Describe how a child’s swing illustrates resonance.

40. Describe what is happening to the tuning fork shown in the figure above.
   a. 
   b. 
   c. 
   d. 
   e. 

41. Describe how resonance affects the way you listen to a radio.

26.9 Interference (pages 522–523)

42. A ________ of a sound wave corresponds to a crest of a transverse wave.

43. A ________ of a sound wave corresponds to a trough of a transverse wave.

44. When the crests of one wave overlap the crests of another wave, there is ________ interference and an increase in ________.

45. When the crests of one wave overlap the troughs of another wave, there is ________ interference and a decrease in ________.

46. Is the following sentence true or false? Constructive sound interference is a useful property in antinoise technology. ________

47. Describe how antinoise technology is used to protect the hearing of jackhammer users.

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26.10 Beats (pages 524–525)

Use the figure below to answer Questions 48 and 49.

48. Use the figure to explain how beats are formed.

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

49. Suppose one tuning fork in the figure vibrates 264 times per second, and the other vibrates 262 times per second.
   a. How often are the forks in step? ________________
   b. What is the frequency of beats? ________________

50. Is the following sentence true or false? If a piano tuner hears beats, the piano is out of tune. ________________
Chapter 27  Light

Exercises

27.1 Early Concepts of Light (page 533)

Match the scientist with his idea about the nature of light. An idea may be used more than once.

<table>
<thead>
<tr>
<th>Scientist</th>
<th>Idea About Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Einstein</td>
<td>a. Light is a wave.</td>
</tr>
<tr>
<td>2. Empedocles</td>
<td>b. Light consists of tiny particles.</td>
</tr>
<tr>
<td>3. Euclid</td>
<td>c. Vision results from streamers or filaments emitted by the eye making contact with an object.</td>
</tr>
<tr>
<td>4. Huygens</td>
<td></td>
</tr>
<tr>
<td>5. Plato</td>
<td></td>
</tr>
<tr>
<td>6. Socrates</td>
<td></td>
</tr>
</tbody>
</table>

7. Is the following sentence true or false? The idea that light consists of tiny particles was first proposed in the early 1900s. _________________

8. What characteristic of light did Huygens provide evidence of?

9. What phenomena did Einstein explain in the theory he published in 1905? _________________

10. _______ are massless bundles of concentrated electromagnetic energy.

11. What is the modern theory of light?

27.2 The Speed of Light (pages 534–535)

12. Is the following sentence true or false? Roemer’s measurement of discrepancies in the position of Jupiter’s moon Io was the first demonstration showing that light travels at a finite speed. _________________

13. How did Huygens interpret the discrepancy in Roemer’s measurement?

14. Circle the letter beside the correct speed of light.
   a. 300,000 m/s   b. 300,000,000 m/s
   c. 300,000 km/s   d. 300,000,000 km/s

15. Albert Michelson received the Nobel Prize for using a system of mirrors to measure _________________.

16. How much time does it take light to travel from the sun to Earth?

17. What is a light-year?

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27.3 Electromagnetic Waves (page 536)
18. What is the source of the energy in light?

19. The energy in an electromagnetic wave is part ________________ and part ________________.

20. Name the different waves that make up the electromagnetic spectrum.
   a. ________________  e. ________________
   b. ________________  f. ________________
   c. ________________  g. ________________
   d. ________________

21. Electromagnetic waves of frequencies slightly lower than the red waves of visible light are called ________________.

22. Electromagnetic waves of frequencies slightly higher than the violet waves of visible light are called ________________.

27.4 Light and Transparent Materials (pages 537–538)
23. Is the following sentence true or false? How a receiving material responds when light is incident upon it depends only on the frequency of the light. ________________

24. Is the following sentence true or false? Electrons are able to respond to the ultrafast vibrations of visible light because the electrons have a small enough mass to vibrate that fast. ________________

25. How do the atoms in a transparent material interact with light?

26. The natural vibration frequencies of an electron depend on how strongly it is attached to ________________.

27. What two things can happen to the energy received by an atom in glass when ultraviolet light shines on the glass?
   a. ________________
   b. ________________

28. Why does resonance occur when ultraviolet light shines on glass?

29. What happens when electromagnetic waves with frequencies lower than ultraviolet light shine on glass?

30. Is the following sentence true or false? Infrared waves vibrate only the electrons in glass. ________________
27.5 Opaque Materials (page 539)

31. What are opaque materials?

32. Is the following sentence true or false? In opaque materials, any coordinated vibrations given by light to the atoms and molecules are turned into random kinetic energy, or internal energy.

33. Explain why metals reflect light and appear shiny.

34. Our atmosphere is transparent to _______ light and _______ light, but almost opaque to _______ light.

35. Why is it possible to get a sunburn on a cloudy day?

27.6 Shadows (pages 540–541)

36. What is a light ray?

37. Generally, shadows form where _______.

38. Would you position a light source close or far from an object in order to produce a sharp shadow?

39. Is the following sentence true or false? Most shadows have clearly defined edges.

40. A total shadow is called a(n) _______.

41. Where are two places a penumbra can form?

42. During a solar eclipse, the shadow of _______ falls on _______.

43. What will you observe if you stand in an umbra during a solar eclipse?

44. What will you observe if you stand in a penumbra during a solar eclipse?

45. What is a lunar eclipse?

46. Is the following sentence true or false? Shadows cannot occur when light is bent while passing through a transparent material.
27.7 Polarization (pages 542–543)

47. Is the following sentence true or false? Polarization is a characteristic of transverse waves and not longitudinal waves. 

48. Define polarization. 

49. If you shake a rope up and down, it becomes _______________ polarized.

50. If you shake a rope from side to side, it becomes _______________ polarized.

51. Write P if the source emits polarized light or NP if the source emits unpolarized light.

   _____ a. vibrating electron       _____ c. the sun
   _____ b. incandescent bulb       _____ d. a candle flame

52. Describe what happens to light from an unpolarized source that falls on a polarizing filter. 

53. Each of the figures below is an analogy for the effect of crossed sheets of polarizing material. Explain what happens if the ropes are light and the picket fences are polarizing filters.

54. How are the axes of polarized sunglasses aligned in order to eliminate glare from horizontal surfaces? 

Chapter 27  Light

27.8 Polarized Light and 3-D Viewing (pages 544–546)

55. How do your eyes perceive vision in three dimensions?

56. Is the following sentence true or false? The combination of views you see from both eyes gives depth to what you see.

57. Explain the effect that allows you to see a hidden message in a stereogram.

58. The figure above shows a person watching a 3-D slide show.
   a. How are the photographs taken in order to be used in the 3-D slide show?

   b. How are the photographs used in the slide show projected?

   c. How is the viewer able to see the 3-D effect in the show?
Chapter 29  Reflection and Refraction

Exercises

29.1 Reflection (page 579)
1. What usually happens when a wave reaches a boundary between two media?

2. The return of a wave back to its original medium is called ____________.
3. Explain what happens when a spring is attached to a wall and you send a pulse along the spring’s length.

4. Is the following sentence true or false? Shiny metals, such as aluminum and silver, reflect almost all the frequencies of visible light.

5. When light strikes glass perpendicularly, much of its energy is ____________.

29.2 The Law of Reflection (page 580)
6. On the diagram below, label the following: normal, incident ray, angle of incidence, reflected ray, and angle of reflection.

Match each phrase with the correct term or terms.

Phrase Term(s)
7. a line perpendicular to a surface a. angle of reflection
8. the angle between the incident ray and the normal b. angle of incidence
9. the angle between the reflected ray and the normal c. law of reflection
d. normal
10. the relationship between the angle of incidence and angle of reflection
29.3 Mirrors (pages 580–581)

11. A _____________ is an image that appears to be in a location where light does not really reach.

12. Can your eye tell the difference between an object and its virtual image? Explain.

13. The virtual image formed by a _____________ mirror (a mirror that curves outward) is _____________ and _____________ to the mirror than the object is.

14. When an object is close to a _____________ mirror (a mirror that curves inward), the virtual image is _____________ and _____________ than the object is.

15. Identify which mirror is concave and which mirror is convex.

29.4 Diffuse Reflection (pages 582–583)

16. What is diffuse reflection?

17. Explain why light is reflected in many directions when striking a rough surface.

18. Is the following sentence true or false? If the differences in elevations in a surface are small (less than about one-eighth the wavelength of the light that falls on it), the surface is considered polished. ________________

19. An open-mesh parabolic dish acts like a _____________ reflector for visible light waves but like a _____________ reflector for long-wavelength radio waves.

20. What determines whether a surface is a diffuse reflector or a polished reflector?
Chapter 29  Reflection and Refraction

29.5 Reflection of Sound (pages 583–584)
21. Is the following sentence true or false? The fraction of sound energy reflected from a surface is less when the surface is rigid and smooth, and more when the surface is soft and irregular. 

22. Sound energy not reflected is ________________ or ________________.

23. ________________ is the study of reflective properties of surfaces and sound.

24. Define reverberations.

25. What properties of sound must be considered when designing an auditorium or concert hall?

26. Explain why being able to see a reflection of a musical instrument means, you will also be able to hear it.

29.6 Refraction (pages 584–585)
27. What is refraction?

28. Circle the letter of each statement that is true about refraction.
   a. When a wave that is traveling at an angle changes its speed upon crossing a boundary between two media, it continues in a straight line.
   b. Water waves bend, or refract, when one part of each wave is made to travel slower (or faster) than another part.
   c. Refraction is the same as reflection.
   d. Water waves are refracted as they move from deep water into shallow water.

29. On a wave diagram, it is convenient to draw lines, called ________________, which represent the positions of different crests.

30. Is the following sentence true or false? At each point along a wave front, the wave is moving parallel to the wave front. 

29.7 Refraction of Sound (page 586)
31. Sound waves are refracted when parts of a wave front travel at ________________.
Chapter 29  Reflection and Refraction

32. How does a sound wave become refracted?

_________________________________________________________________

33. How does a layer of warm air on top of a layer of colder air near the ground affect sounds waves?

_________________________________________________________________

29.8 Refraction of Light (pages 587–588)

34. Changes in the speed of light as it passes from one medium to another, or variations in the temperatures and densities of the same medium, cause _________________.

35. Is the following sentence true or false? The wave fronts of light from the sun look like straight lines because the source of light is so far away. ________________

36. When light rays enter a medium in which their speed decreases, the rays bend toward the _________________.

37. Circle the letter of each statement that is true.
   a. If a laser beam enters a container of water at the left and exits at the right, the path would be the same as if the light entered from the right and exited at the left.
   b. Light paths are reversible for reflection but not refraction.
   c. The apparent depth of a glass block is less than the real depth because of refraction.
   d. A full glass mug appears to hold more colored liquid than it actually does because of reflection.

29.9 Atmospheric Refraction (pages 588–590)

38. What is a mirage?

_________________________________________________________________

39. Since molecules in hot air are farther apart, light travels ________________ through it than through the cooler air above, resulting in a ________________ of the light rays.

40. Is the following sentence true or false? Because of refraction, we see the sun for several minutes after the sunset. ________________

29.10 Dispersion in a Prism (page 590)

41. Light of frequencies closer to the natural frequency of the electron oscillators in a medium travels more ________________ in the medium.

42. Why is the statement in Question 41 true?

_________________________________________________________________
Chapter 29  Reflection and Refraction

43. Is the following sentence true or false? Since the natural frequency of most transparent materials is in the ultraviolet part of the spectrum, visible light of higher frequencies travels more slowly than light of lower frequencies. __________________

44. What is dispersion?

29.11 The Rainbow (pages 591–593)

45. What needs to happen in order for a person to see a rainbow?

46. Why aren’t rainbows completely round?

47. Explain why, if each drop of water disperses a full spectrum of colors, an observer can only see a single color from any one drop.

48. How does a secondary rainbow form?

29.12 Total Internal Reflection (pages 593–595)

Match each phrase with the correct term or number.

<table>
<thead>
<tr>
<th>Phrase</th>
<th>Terms and Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>_____ 49. the angle of incidence that results in light being refracted at an angle of 90° with respect to the normal</td>
<td>a. 24.6°</td>
</tr>
<tr>
<td>_____ 50. the complete reflection of light back into its original medium</td>
<td>b. critical angle</td>
</tr>
<tr>
<td>_____ 51. critical angle for glass</td>
<td>c. 43°</td>
</tr>
<tr>
<td>_____ 52. critical angle for diamond</td>
<td>d. total internal reflection</td>
</tr>
</tbody>
</table>

53. What are optical fibers?

54. What are two applications for optical fibers?