Chapter 11 Vibrations and Waves

Conceptual Questions

1) The time for one cycle of a periodic process is called the
A) amplitude.
B) wavelength.
C) frequency.
D) period.

Answer: D
Diff: 1 *Page Ref: Sec. 11.1–11.3*

2) For a periodic process, the number of cycles per unit time is called the
A) amplitude.
B) wavelength.
C) frequency.
D) period.

Answer: C
Diff: 1 *Page Ref: Sec. 11.1–11.3*

3) For vibrational motion, the maximum displacement from the equilibrium point is called the
A) amplitude.
B) wavelength.
C) frequency.
D) period.

Answer: A
Diff: 1 *Page Ref: Sec. 11.1–11.3*

4) A mass on a spring undergoes SHM. When the mass is at its maximum displacement from equilibrium, its instantaneous velocity
A) is maximum.
B) is less than maximum, but not zero.
C) is zero.
D) cannot be determined from the information given.

Answer: C
Diff: 1 *Page Ref: Sec. 11.1–11.3*

5) A mass on a spring undergoes SHM. When the mass passes through the equilibrium position, its instantaneous velocity

   A) is maximum.

   B) is less than maximum, but not zero.

   C) is zero.

   D) cannot be determined from the information given.

   Answer: A
   Diff: 1 *Page Ref: Sec. 11.1–11.3*

6) A mass on a spring undergoes SHM. When the mass is at maximum displacement from equilibrium, its instantaneous acceleration

   A) is a maximum.

   B) is less than maximum, but not zero.

   C) is zero.

   D) cannot be determined from the information given

   Answer: A
   Diff: 1 *Page Ref: Sec. 11.1–11.3*

7) A mass is attached to a vertical spring and bobs up and down between points A and B. Where is the mass located when its kinetic energy is a minimum?

   A) at either A or B

   B) midway between A and B

   C) one–fourth of the way between A and B

   D) none of the above

   Answer: A
   Diff: 2 *Page Ref: Sec. 11.1–11.3*

8) A mass is attached to a vertical spring and bobs up and down between points A and B. Where is the mass located when its kinetic energy is a maximum?

   A) at either A or B

   B) midway between A and B

   C) one–fourth of the way between A and B

   D) none of the above

   Answer: B
   Diff: 2 *Page Ref: Sec. 11.1–11.3*

9) A mass is attached to a vertical spring and bobs up and down between points A and B. Where is the mass located when its potential energy is a minimum?

A) at either A or B

B) midway between A and B

C) one-fourth of the way between A and B

D) none of the above

Answer: B
Diff: 2 *Page Ref: Sec. 11.1-11.3*

10) A mass is attached to a vertical spring and bobs up and down between points A and B. Where is the mass located when its potential energy is a maximum?

A) at either A or B

B) midway between A and B

C) one-fourth of the way between A and B

D) none of the above

Answer: A
Diff: 2 *Page Ref: Sec. 11.1-11.3*

11) Doubling only the amplitude of a vibrating mass-and-spring system produces what effect on the system's mechanical energy?

A) increases the energy by a factor of two

B) increases the energy by a factor of three

C) increases the energy by a factor of four

D) produces no change

Answer: C
Diff: 1 *Page Ref: Sec. 11.1-11.3*

12) Doubling only the mass of a vibrating mass-and-spring system produces what effect on the system's mechanical energy?

A) increases the energy by a factor of two

B) increases the energy by a factor of three

C) increases the energy by a factor of four

D) produces no change

Answer: D
Diff: 1 *Page Ref: Sec. 11.1-11.3*

13) Doubling only the spring constant of a vibrating mass–and–spring system produces what effect on the system's mechanical energy?

A) increases the energy by a factor of two

B) increases the energy by a factor of three

C) increases he energy by a factor of four

D) produces no change

Answer: A
Diff: 1 *Page Ref: Sec. 11.1–11.3*

14) A mass oscillates on the end of a spring, both on Earth and on the Moon. Where is the period the greatest?

A) Earth

B) the Moon

C) same on both Earth and the Moon

D) cannot be determined from the information given

Answer: C
Diff: 2 *Page Ref: Sec. 11.1–11.3*

15) Increasing the spring constant k of a mass–and–spring system causes what kind of change in the resonant frequency of the system? (Assume no change in the system's mass m.)

A) The frequency increases.

B) The frequency decreases.

C) There is no change in the frequency.

D) The frequency increases if the ratio k/m is greater than or equal to 1 and decreases if the ratio k/m is less than 1.

Answer: A
Diff: 1 *Page Ref: Sec. 11.1–11.3*

16) Increasing the mass M of a mass–and–spring system causes what kind of change in the resonant frequency of the system? (Assume no change in the system's spring constant k.)

A) The frequency increases.

B) The frequency decreases.

C) There is no change in the frequency.

D) The frequency increases if the ratio k/m is greater than or equal to 1 and decreases if the ratio k/m is less than 1.

Answer: B
Diff: 1 *Page Ref: Sec. 11.1–11.3*

17) Increasing the amplitude of a mass–and–spring system causes what kind of change in the resonant frequency of the system? (Assume no other changes in the system.)

A) The frequency increases.

B) The frequency decreases.

C) There is no change in the frequency.

D) The frequency depends on the displacement, not the amplitude.

Answer: C
Diff: 1 Page Ref: Sec. 11.1–11.3

18) A mass m hanging on a spring has a natural frequency f. If the mass is increased to 4m, what is the new natural frequency?

A) 4f

B) 2f

C) 0.5f

D) 0.25f

Answer: C
Diff: 1 Page Ref: Sec. 11.1–11.3

19) A simple pendulum consists of a mass M attached to a weightless string of length L. For this system, when undergoing small oscillations

A) the frequency is proportional to the amplitude.

B) the period is proportional to the amplitude.

C) the frequency is independent of the mass M.

D) the frequency is independent of the length L.

Answer: C
Diff: 2 Page Ref: Sec. 11.4

20) When the mass of a simple pendulum is tripled, the time required for one complete vibration

A) increases by a factor of 3.

B) does not change.

C) decreases to one–third of its original value.

D) decreases to $1/\sqrt{3}$ of its original value.

Answer: B
Diff: 1 Page Ref: Sec. 11.4

21) Both pendulum A and B are 3.0 m long. The period of A is T. Pendulum A is twice as heavy as pendulum B. What is the period of B?

A) 0.71T

B) T

C) 1.4T

D) 2T

Answer: B
Diff: 1 *Page Ref: Sec. 11.4*

22) When the length of a simple pendulum is tripled, the time for one complete vibration increases by a factor of

A) 3.

B) 2.

C) 1.7.

D) 1.4.

Answer: C
Diff: 1 *Page Ref: Sec. 11.4*

23) What happens to a simple pendulum's frequency if both its length and mass are increased?

A) It increases.

B) It decreases.

C) It remains constant.

D) It could remain constant, increase, or decrease; it depends on the length to mass ratio.

Answer: B
Diff: 1 *Page Ref: Sec. 11.4*

24) Simple pendulum A swings back and forth at twice the frequency of simple pendulum B. Which statement is correct?

A) Pendulum B is twice as long as A.

B) Pendulum B is twice as massive as A.

C) The length of B is four times the length of A.

D) The mass of B is four times the mass of A.

Answer: C
Diff: 2 *Page Ref: Sec. 11.4*

25) If you take a given pendulum to the Moon, where the acceleration of gravity is less than on Earth, the resonant frequency of the pendulum will

A) increase.

B) decrease.

C) not change.

D) either increase or decrease; it depends on its length to mass ratio.

Answer: B
Diff: 1 Page Ref: Sec. 11.4

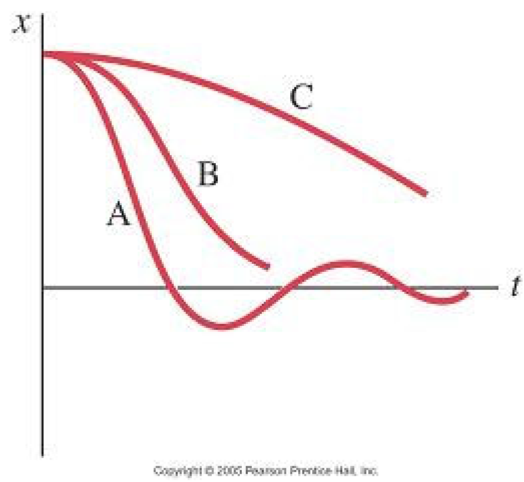

FIGURE 11–1

26) Curve A in Fig. 11–1 represents

A) an underdamped situation.

B) an overdamped situation.

C) a moderately damped situation.

D) critical damping.

Answer: A
Diff: 1 Page Ref: Sec. 11.5

27) Curve B in Fig. 11–1 represents

A) an underdamped situation.

B) an overdamped situation.

C) a moderately damped situation.

D) critical damping.

Answer: D
Diff: 1 Page Ref: Sec. 11.5

28) Curve C in Fig. 11–1 represents

A) an underdamped situation.

B) an overdamped situation.

C) a moderately damped situation.

D) critical damping.

Answer: B

Diff: 1 *Page Ref: Sec. 11.5*

29) For a forced vibration, the amplitude of vibration is found to depend on the

A) sum of the external frequency and the natural frequency.

B) difference of the external frequency and the natural frequency.

C) product of the external frequency and the natural frequency.

D) ratio of the external frequency and the natural frequency.

Answer: B

Diff: 1 *Page Ref: Sec. 11.6*

30) In a wave, the maximum displacement of points of the wave from equilibrium is called the wave's

A) speed.

B) frequency.

C) wavelength.

D) amplitude.

Answer: D

Diff: 1 *Page Ref: Sec. 11.7–11.8*

31) The distance between successive crests on a wave is called the wave's

A) speed.

B) frequency.

C) wavelength.

D) amplitude.

Answer: C

Diff: 1 *Page Ref: Sec. 11.7–11.8*

32) The number of crests of a wave passing a point per unit time is called the wave's

A) speed.

B) frequency.

C) wavelength.

D) amplitude.

Answer: B

Diff: 1 *Page Ref: Sec. 11.7–11.8*

33) For a wave, the frequency times the wavelength is the wave's

A) speed.

B) amplitude.

C) intensity.

D) power.

Answer: A
Diff: 1 Page Ref: Sec. 11.7–11.8

34) The frequency of a wave increases. What happens to the distance between successive crests if the speed remains constant?

A) It increases.

B) It remains the same.

C) It decreases.

D) It cannot be determined from the information given.

Answer: C
Diff: 1 Page Ref: Sec. 11.7–11.8

35) A wave moves on a string with wavelength λ and frequency f. A second wave on the same string has wavelength 2λ and travels with the same velocity. What is the frequency of the second wave?

A) 0.5f

B) f

C) 2f

D) It cannot be determined from the information given.

Answer: A
Diff: 1 Page Ref: Sec. 11.7–11.8

36) Consider a traveling wave on a string of length L, mass M, and tension T. A standing wave is set up. Which of the following is true?

A) The wave velocity depends on M, L, T.

B) The wavelength of the wave is proportional to the frequency.

C) The particle velocity is equal to the wave velocity.

D) The wavelength is proportional to T.

Answer: A
Diff: 2 Page Ref: Sec. 11.7–11.8

37) A string of mass m and length L is under tension T. The speed of a wave in the string is v. What will be the speed of a wave in the string if the mass of the string is increased to 2m, with no change in length?

A) 0.5v

B) 0.71v

C) 1.4v

D) 2v

Answer: B

Diff: 1 *Page Ref: Sec. 11.7–11.8*

38) A string of mass m and length L is under tension T. The speed of a wave in the string is v. What will be the speed of a wave in the string if the length is increased to 2L, with no change in mass?

A) 0.5v

B) 0.71v

C) 1.4v

D) 2v

Answer: C

Diff: 1 *Page Ref: Sec. 11–7–11.8*

39) A string of mass m and length L is under tension T. The speed of a wave in the string is v. What will be the speed of a wave in the string if the tension is increased to 2T?

A) 0.5T

B) 0.71T

C) 1.4T

D) 2T

Answer: C

Diff: 2 *Page Ref: Sec. 11.7–11.8*

40) In seismology, the S wave is a transverse wave. As an S wave travels through the Earth, the relative motion between the S wave and the particles is

A) parallel.

B) perpendicular.

C) first parallel, then perpendicular.

D) first perpendicular, then parallel.

Answer: B

Diff: 1 *Page Ref: Sec. 11.7–11.8*

41) In seismology, the P wave is a longitudinal wave. As a P wave travels through the Earth, the relative motion between the P wave and the particles is

A) parallel.

B) perpendicular.

C) first parallel, then perpendicular.

D) first perpendicular, then parallel.

Answer: A
Diff: 1 *Page Ref: Sec. 11.7–11.8*

42) The intensity of a wave is

A) proportional to both the amplitude squared and the frequency squared

B) proportional to the amplitude squared and inversely proportional to the frequency squared.

C) inversely proportional to the amplitude squared and proportional to the frequency squared.

D) inversely proportional to both the amplitude squared and the frequency squared.

Answer: A
Diff: 1 *Page Ref: Sec. 11.9–11.10*

43) A wave pulse traveling to the right along a thin cord reaches a discontinuity where the rope becomes thicker and heavier. What is the orientation of the reflected and transmitted pulses?

A) Both are right side up.

B) The reflected pulse returns right side up while the transmitted pulse is inverted.

C) The reflected pulse returns inverted while the transmitted pulse is right side up.

D) Both are inverted.

Answer: C
Diff: 1 *Page Ref: Sec. 11.11*

44) Two wave pulses with equal positive amplitudes pass each other on a string, one is traveling toward the right and the other toward the left. At the point that they occupy the same region of space at the same time

A) constructive interference occurs.

B) destructive interference occurs.

C) a standing wave is produced.

D) a traveling wave is produced.

Answer: A
Diff: 1 *Page Ref: Sec. 11–12*

45) Two wave pulses pass each other on a string. The one traveling toward the right has a positive amplitude, while the one traveling toward the left has an equal amplitude in the negative direction. At the point that they occupy the same region of space at the same time

A) constructive interference occurs.

B) destructive interference occurs.

C) a standing wave is produced.

D) a traveling wave is produced.

Answer: B

Diff: 1 *Page Ref: Sec. 11.12*

46) Resonance in a system, such as a string fixed at both ends, occurs when

A) it is oscillating in simple harmonic motion.

B) its frequency is the same as the frequency of an external source.

C) its frequency is greater than the frequency of an external source.

D) its frequency is smaller than the frequency of an external source.

Answer: B

Diff: 2 *Page Ref: Sec. 11.13*

47) If one doubles the tension in a violin string, the fundamental frequency of that string will increase by a factor of

A) 2.

B) 4.

C) 1.4.

D) 1.7.

Answer: C

Diff: 2 *Page Ref: Sec. 11.13*

Quantitative Problems

1) What is the spring constant of a spring that stretches 2.00 cm when a mass of 0.600 kg is suspended from it?

A) 0.300 N/m

B) 30.0 N/m

C) 2.94 N/m

D) 294 N/m

Answer: D

Diff: 1 *Page Ref: Sec. 11.1–11.3*

2) A mass is attached to a spring of spring constant 60 N/m along a horizontal, frictionless surface. The spring is initially stretched by a force of 5.0 N on the mass and let go. It takes the mass 0.50 s to go back to its equilibrium position when it is oscillating. What is the amplitude?

A) 0.030 m

B) 0.083 m

C) 0.30 m

D) 0.83 m

Answer: B
Diff: 1 *Page Ref: Sec. 11.1–11.3*

3) A mass is attached to a spring of spring constant 60 N/m along a horizontal, frictionless surface. The spring is initially stretched by a force of 5.0 N on the mass and let go. It takes the mass 0.50 s to go back to its equilibrium position when it is oscillating. What is the period of oscillation?

A) 0.50 s

B) 1.0 s

C) 1.5 s

D) 2.0 s

Answer: D
Diff: 1 *Page Ref: Sec. 11.1–11.3*

4) A mass is attached to a spring of spring constant 60 N/m along a horizontal, frictionless surface. The spring is initially stretched by a force of 5.0 N on the mass and let go. It takes the mass 0.50 s to go back to its equilibrium position when it is oscillating. What is the frequency of oscillation?

A) 0.50 Hz

B) 1.0 Hz

C) 1.5 Hz

D) 2.0 Hz

Answer: A
Diff: 1 *Page Ref: Sec. 11.1–11.3*

5) A mass on a spring undergoes SHM. It goes through 10 complete oscillations in 5.0 s. What is the period?

A) 0.020 s

B) 0.50 s

C) 2.0 s

D) 50 s

Answer: B
Diff: 1 *Page Ref: Sec. 11.1–11.3*

6) A mass vibrates back and forth from the free end of an ideal spring of spring constant 20 N/m with an amplitude of 0.30 m. What is the kinetic energy of this vibrating mass when it is 0.30 m from its equilibrium position?

A) zero

B) 0.90 J

C) 0.45 J

D) It is impossible to give an answer without knowing the object's mass.

Answer: A
Diff: 1 *Page Ref: Sec. 11.1-11.3*

7) A 0.50-kg mass is attached to a spring of spring constant 20 N/m along a horizontal, frictionless surface. The object oscillates in simple harmonic motion and has a speed of 1.5 m/s at the equilibrium position. What is the total energy of the system?

A) 0.27 J

B) 0.56 J

C) 0.65 J

D) 1.1 J

Answer: B
Diff: 1 *Page Ref: Sec. 11.1-11.3*

8) A mass undergoes SHM with amplitude of 4 cm. The energy is 8.0 J at this time. The mass is cut in half, and the system is again set in motion with amplitude 4.0 cm. What is the energy of the system now?

A) 2.0 J

B) 4.0 J

C) 8.0 J

D) 16 J

Answer: C
Diff: 2 *Page Ref: Sec. 11.1-11.3*

9) A 0.50-kg mass is attached to a spring of spring constant 20 N/m along a horizontal, frictionless surface. The object oscillates in simple harmonic motion and has a speed of 1.5 m/s at the equilibrium position. What is the amplitude of vibration?

A) 0.024 m

B) 0.058 m

C) 0.24 m

D) 0.58 m

Answer: C
Diff: 2 *Page Ref: Sec. 11.1-11.3*

10) A 0.50-kg mass is attached to a spring of spring constant 20 N/m along a horizontal, frictionless surface. The object oscillates in simple harmonic motion and has a speed of 1.5 m/s at the equilibrium position. At what location are the kinetic energy and the potential energy the same?

A) 0.017 m

B) 0.029 m

C) 0.12 m

D) 0.17 m

Answer: D
Diff: 2 *Page Ref: Sec. 11.1-11.3*

11) A 2.0-kg mass is attached to the end of a horizontal spring of spring constant 50 N/m and set into simple harmonic motion with an amplitude of 0.10 m. What is the total mechanical energy of this system?

A) 0.020 J

B) 25 J

C) 0.25 J

D) 1.0 J

Answer: C
Diff: 2 *Page Ref: Sec. 11.1-11.3*

12) A 2.0-kg mass is attached to the end of a horizontal spring of spring constant 50 N/m and set into simple harmonic motion with an amplitude of 0.10 m. What is the total mechanical energy of this system?

A) 0.020 J

B) 25 J

C) 0.25 J

D) 1.0 J

Answer: C
Diff: 2 *Page Ref: Sec. 11.1-11.3*

13) A mass vibrates back and forth from the free end of an ideal spring of spring constant 20.0 N/m with an amplitude of 0.250 m. What is the maximum kinetic energy of this vibrating mass?

A) 2.50 J

B) 1.25 J

C) 0.625 J

D) It is impossible to give an answer since kinetic energy cannot be determined without knowing the object's mass.

Answer: C
Diff: 2 *Page Ref: Sec. 11.1-11.3*

14) The mass of a mass–and–spring system is displaced 10 cm from its equilibrium position and released. A frequency of 4.0 Hz is observed. What frequency would be observed if the mass had been displaced only 5.0 cm and then released?

A) 2.0 Hz
B) 4.0 Hz
C) 8.0 Hz
D) none of the above

Answer: B
Diff: 1 Page Ref: Sec. 11.1–11.3

15) A 4.0–kg object is attached to a spring of spring constant 10 N/m. The object is displaced by 5.0 cm from the equilibrium position and let go. What is the period of vibration?

A) 2.0 s
B) 4.0 s
C) 8.0 s
D) 16 s

Answer: B
Diff: 1 Page Ref: Sec. 11.1–11.3

16) A 4.0–kg object is attached to a spring of spring constant 10 N/m. The object is displaced by 5.0 cm from the equilibrium position and let go. What is the frequency of vibration?

A) 0.25 Hz
B) 0.50 Hz
C) 1.0 Hz
D) 2.0 Hz

Answer: A
Diff: 1 Page Ref: Sec. 11.1–11.3

17) A 2.0–kg mass is hung from a spring of spring constant 18 N/m, displaced slightly from its equilibrium position, and released. What is the frequency of its vibration?

A) 0.48 Hz
B) 0.95 Hz
C) 1.5 Hz
D) none of the above

Answer: A
Diff: 2 Page Ref: Sec. 11.1–11.3

18) A mass is attached to a spring. It oscillates at a frequency of 1.27 Hz when displaced a distance of 2.0 cm from equilibrium and released. What is the maximum velocity attained by the mass?

A) 0.02 m/s

B) 0.04 m/s

C) 0.08 m/s

D) 0.16 m/s

Answer: D
Diff: 2 *Page Ref: Sec. 11.1-11.3*

19) Two masses, A and B, are attached to different springs. Mass A vibrates with amplitude of 8.0 cm at a frequency of 10 Hz and mass B vibrates with amplitude of 5.0 cm at a frequency of 16 Hz. How does the maximum speed of A compare to the maximum speed of B?

A) Mass A has the greater maximum speed.

B) Mass B has the greater maximum speed.

C) They are equal.

D) There is not enough information to determine.

Answer: C
Diff: 2 *Page Ref: Sec. 11.1-11.3*

20) A 0.30-kg mass is suspended on a spring. In equilibrium the mass stretches the spring 2.0 cm downward. The mass is then pulled an additional distance of 1.0 cm down and released from rest. Calculate the period of oscillation.

A) 0.14 s

B) 0.28 s

C) 0.020 s

D) 0.078 s

Answer: B
Diff: 2 *Page Ref: Sec. 11.1-11.3*

21) A 0.30-kg mass is suspended on a spring. In equilibrium the mass stretches the spring 2.0 cm downward. The mass is then pulled an additional distance of 1.0 cm down and released from rest. Calculate the total energy of the system.

A) 0.0074 J

B) 0.015 J

C) 0.022 J

D) 0.030 J

Answer: A
Diff: 2 *Page Ref: Sec. 11.1-11.3*

22) A 0.30–kg mass is suspended on a spring. In equilibrium the mass stretches the spring 2.0 cm downward. The mass is then pulled an additional distance of 1.0 cm down and released from rest. Write down its equation of motion.

A) y = (0.01 m) cos (22.1 t)

B) y = (0.01 m) sin (22.1 t)

C) y = (0.03 m) cos (22.1 t)

D) y = (0.03 m) sin (22.1 t)

Answer: A

Diff: 2 *Page Ref: Sec. 11.1–11.3*

23) An object in simple harmonic motion obeys the following position versus time equation: y = (0.50 m) sin (π/2 t). What is the amplitude of vibration?

A) 0.25 m

B) 0.50 m

C) 0.75 m

D) 1.0 m

Answer: B

Diff: 1 *Page Ref: Sec. 11.1–11.3*

24) An object in simple harmonic motion obeys the following position versus time equation: y = (0.50 m) sin (π/2 t). What is the period of vibration?

A) 1.0 s

B) 2.0 s

C) 3.0 s

D) 4.0 s

Answer: D

Diff: 2 *Page Ref: Sec. 11.1–11.3*

25) An object in simple harmonic motion obeys the following position versus time equation: y = (0.50 m) sin (π/2 t). What is the maximum speed of the object?

A) 0.13 m/s

B) 0.26 m/s

C) 0.39 m/s

D) 0.79 m/s

Answer: D

Diff: 2 *Page Ref: Sec. 11.1–11.3*

26) A mass attached to the free end of a spring executes simple harmonic motion according to the equation y = (0.50 m) sin (18π t) where y is in meters and t is seconds. What is the period of vibration?

A) 9.0 s

B) 18 s

C) 1/9 s

D) 1/18 s

Answer: C
Diff: 2 *Page Ref: Sec. 11.1–11.3*

27) A 1.5–kg mass attached to spring with a force constant of 20.0 N/m oscillates on a horizontal, frictionless track. At t= 0, the mass is released from rest at x= 10.0 cm. (That is, the spring is stretched by 10.00 cm.)
(a) Determine the frequency of the oscillations.
(b) Determine the maximum speed of the mass. Where does the maximum speed occur?
(c) Determine the maximum acceleration of the mass. Where does the maximum acceleration occur?
(d) Determine the total energy of the oscillating system.
(e) Express the displacement as a function of time.

Answer: (a) 0.58 Hz
(b) 0.37 m/s, at the equilibrium position
(c) 1.3 m/s^2, at maximum displacement
(d) 0.10 J
(e) $x = (0.10\text{ m})\cos(3.7t)$
Diff: 2 *Page Ref: Sec. 11.1–11.3*

28) A pendulum makes 12 complete swings in 8.0 s. (a) What are its frequency and period on Earth?

A) 1.5 Hz, 0.67 s

B) 0.67 Hz, 1.5 s

C) 0.24 Hz, 4.2 s

D) 4.2 Hz, 0.24 s

Answer: A
Diff: 1 *Page Ref: Sec. 11.4*

29) A 3.00–kg pendulum is 28.84 m long. What is its period on Earth?

A) 10.78 s

B) 7.891 s

C) 4.897 s

D) 0.09278 s

Answer: A
Diff: 1 *Page Ref: Sec. 11.4*

30) A pendulum has a period of 2.0 s on Earth. What is its length?
A) 2.0 m
B) 1.0 m
C) 0.70 m
D) 0.50 m

Answer: B
Diff: 1 *Page Ref: Sec. 11.4*

31) The pendulum of a grandfather clock is 1.0 m long. What is its period on the Earth?
A) 1.0 s
B) 2.0 s
C) 4.0 s
D) 8.0 s

Answer: B
Diff: 1 *Page Ref: Sec. 11.4*

32) The pendulum of a grandfather clock is 1.0 m long. What is its period on the Moon where the acceleration due to gravity is only 1.7 m/s^2?
A) 1.2 s
B) 2.4 s
C) 4.8 s
D) 23 s

Answer: C
Diff: 1 *Page Ref: Sec. 11.4*

33) A simple pendulum consists of a 0.25–kg spherical mass attached to a massless string. When the mass is displaced slightly from its equilibrium position and released, the pendulum swings back and forth with a frequency of 2.0 Hz. What frequency would have resulted if a 0.50–kg mass (same diameter sphere) had been attached to the string instead?
A) 1.0 Hz
B) 2.0 Hz
C) 1.4 Hz
D) none of the above

Answer: B
Diff: 1 *Page Ref: Sec. 11.4*

34) A simple pendulum consisting of a 20–g mass has initial angular displacement of 8.0°. It oscillates with a period of 3.00 s.
(a) Determine the length of the pendulum.
(b) Does the period of the pendulum depend on the initial angular displacement?
(c) Does the period of the pendulum depend on the mass of the pendulum?
(d) Does the period of the pendulum depend on the length of the pendulum?
(e) Does the period of the pendulum depend on the acceleration due to gravity?

Answer: (a) 2.2 m
(b) No
(c) No
(d) Yes
(e) Yes
Diff: 1 *Page Ref: Sec. 11.4*

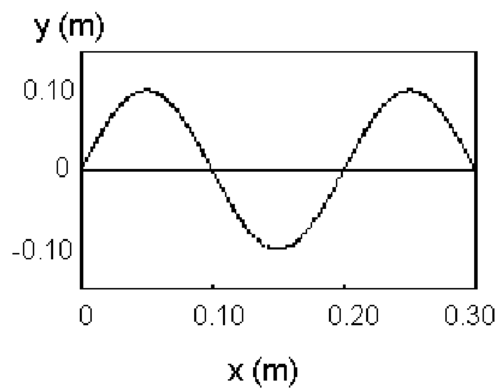

FIGURE 11–2

35) Figure 11–2 is a "snapshot" of a wave at a given time. The frequency of the wave is 120 Hz. What is the amplitude?

A) 0.05 m
B) 0.10 m
C) 0.15 m
D) 0.20 m

Answer: B
Diff: 1 *Page Ref: Sec. 11.7–11.8*

36) Figure 11–2 is a "snapshot" of a wave at a given time. The frequency of the wave is 120 Hz. What is the wavelength?

A) 0.05 m
B) 0.10 m
C) 0.20 m
D) 0.30 m

Answer: C
Diff: 1 *Page Ref: Sec. 11.7–11.8*

37) Figure 11–2 is a "snapshot" of a wave at a given time. The frequency of the wave is 120 Hz. What is the wave speed?

A) 12 m/s

B) 24 m/s

C) 36 m/s

D) 48 m/s

Answer: B
Diff: 1 *Page Ref: Sec. 11.7–11.8*

38) What is the frequency of a wave which has a period of 6.00 ms?

A) 16.7 Hz

B) 167 Hz

C) 1.67 kHz

D) 16.7 kHz

Answer: B
Diff: 1 *Page Ref: Sec. 11.7–11.8*

39) What is the period of a wave with a frequency of 1500 Hz?

A) 0.67 μs

B) 0.67 ms

C) 0.67 s

D) 6.7 s

Answer: B
Diff: 1 *Page Ref: Sec. 11.7–11.8*

40) What is the wave speed if a wave has a frequency of 12 Hz and a wavelength of 3.0 m?

A) 4.0 m/s

B) 9.0 m/s

C) 15 m/s

D) 36 m/s

Answer: D
Diff: 1 *Page Ref: Sec. 11.7–11.8*

41) What is the velocity of a wave that has a wavelength of 3.0 m and a frequency of 12 Hz?

A) 4.0 m/s

B) 9.0 m/s

C) 15 m/s

D) 36 m/s

Answer: D
Diff: 1 *Page Ref: Sec. 11.7–11.8*

42) What is the frequency of a 2.5 m wave traveling at 1400 m/s?

A) 178 Hz

B) 1.78 kHz

C) 560 Hz

D) 5.6 kHz

Answer: C

Diff: 1 *Page Ref: Sec. 11.7–11.8*

43) A piano string of linear mass density 0.0050 kg/m is under a tension of 1350 N. What is the wave speed?

A) 130 m/s

B) 260 m/s

C) 520 m/s

D) 1040 m/s

Answer: C

Diff: 1 *Page Ref: Sec. 11.7–11.8*

44) A string of linear density 6.0 g/m is under a tension of 180 N. What is the velocity of propagation of transverse waves along the string?

A) 2.9×10^4 m/s

B) 1.7×10^2 m/s

C) 13 m/s

D) 5.8×10^{-3} m/s

Answer: B

Diff: 2 *Page Ref: Sec. 11.7–11.8*

45) A wave whose wavelength is 0.500 m is traveling down a 500 m long wire whose total mass is 25.0 kg. The wire is under a tension of 2000 N.
(a) Determine the velocity of the wave on the wire.
(b) Determine the frequency of this wave.

Answer: (a) 200 m/s
(b) 400 Hz

Diff: 2 *Page Ref: Sec. 11.7–11.8*

46) The velocity of propagation of a transverse wave on a 2.0–m long string fixed at both ends is 200 m/s. Which one of the following is not a resonant frequency of this string?

A) 25 Hz

B) 50 Hz

C) 100 Hz

D) 200 Hz

Answer: A

Diff: 2 *Page Ref: Sec. 11.13*

47) If a guitar string has a fundamental frequency of 500 Hz, which one of the following frequencies can set the string into resonant vibration?

A) 250 Hz

B) 750 Hz

C) 1500 Hz

D) 1750 Hz

Answer: C
Diff: 2 *Page Ref: Sec. 11.13*

48) A stretched string is observed to have four equal segments in a standing wave driven at a frequency of 480 Hz. What driving frequency will set up a standing wave with five equal segments?

A) 600 Hz

B) 360 Hz

C) 240 Hz

D) 120 Hz

Answer: A
Diff: 2 *Page Ref: Sec. 11.13*

49) A string, fixed at both ends, vibrates at a frequency of 12 Hz with a standing transverse wave pattern containing 3 loops. What frequency is needed if the standing wave pattern is to contain 4 loops?

A) 48 Hz

B) 36 Hz

C) 16 Hz

D) 12 Hz

Answer: C
Diff: 2 *Page Ref: Sec. 11.13*

50) A string of linear density 1.5 g/m is under a tension of 20 N. What should its length be if its fundamental resonance frequency is 220 Hz?

A) 0.26 m

B) 0.96 m

C) 1.1 m

D) 1.2 m

Answer: A
Diff: 3 *Page Ref: Sec. 11.13*

51) Find the first three harmonics of a string of linear mass density 2.00 g/m and length 0.600 m when it is subjected to tension of 50.0 N.

A) 132 Hz, 264 Hz, 396 Hz

B) 66 Hz, 132 Hz, 198 Hz

C) 264 Hz, 528 Hz, 792 Hz

D) none of the above

Answer: A
Diff: 3 Page Ref: Sec. 11.13

52) A string of length 2.5 m is fixed at both ends. When the string vibrates at a frequency of 85 Hz, a standing wave with five loops is formed.
(a) Determine the distance between two adjacent nodes.
(b) Determine the wavelength of the waves that travel on the string.
(c) Determine the velocity of waves.
(d) Determine the fundamental frequency of this string.

Answer: (a) 0.50 m
(b) 1.0 m
(c) 85 m/s
(d) 17 Hz
Diff: 2 Page Ref: Sec. 11.13

Chapter 12 Sound

Conceptual Questions

1) Which of the following is a false statement?

A) Sound waves are longitudinal pressure waves.

B) Sound can travel through a vacuum.

C) Light travels very much faster than sound.

D) The transverse waves on a vibrating string are different from sound waves.

E) "Pitch" (in music) and frequency have approximately the same meaning.

Answer: B
Diff: 1 *Page Ref: Sec. 12.1*

2) In general, sound is conducted fastest through

A) gases.

B) liquids.

C) solids.

D) a vacuum.

Answer: C
Diff: 1 *Page Ref: Sec. 12.1*

3) What is the speed of sound in a steel rod?

A) 1500 m/s

B) 3000 m/s

C) 5000 m/s

D) 8000 m/s

Answer: C
Diff: 2 *Page Ref: Sec. 12.1*

4) As the temperature of the air increases, what happens to the velocity of sound? (Assume that all other factors remain constant.)

A) It increases.

B) It decreases.

C) It does not change.

D) It increases when atmospheric pressure is high and decreases when the pressure is low.

Answer: A
Diff: 1 *Page Ref: Sec. 12.1*

5) Compared to the velocity of a 400 Hz sound, the velocity of a 200 Hz sound through air is
   A) twice as great.
   B) the same.
   C) one-half as great.
   D) none of the above

   Answer: B
   Diff: 1 Page Ref: Sec. 12.1

6) Compared to the wavelength of a 400 Hz sound, the wavelength of a 200 Hz sound in air is
   A) twice as long.
   B) the same.
   C) one-half as long.
   D) none of the above

   Answer: A
   Diff: 1 Page Ref: Sec. 12.1

7) Sound vibrations with frequencies greater than 20,000 Hz are called
   A) infrasonics.
   B) ultrasonics.
   C) supersonics.
   D) none of the above

   Answer: B
   Diff: 1 Page Ref: Sec. 12.1

8) Sound vibrations with frequency less than 20 Hz are called
   A) infrasonics.
   B) ultrasonics.
   C) supersonics.
   D) none of the above

   Answer: A
   Diff: 1 Page Ref: Sec. 12.1

9) Suppose that a sound source is emitting waves uniformly in all directions. If you move to a point twice as far away from the source, the frequency of the sound will be
   A) unchanged.
   B) half as great.
   C) one-fourth as great.
   D) twice as great.

   Answer: A
   Diff: 1 Page Ref: Sec. 12.2

10) For spherically diverging waves, intensity is proportional to

A) R^2.

B) R.

C) 1/R.

D) $1/R^2$.

Answer: D
Diff: 1 *Page Ref: Sec. 12.2*

11) The intensity of a point source at a distance d from the source is I. What is the intensity at a distance 2d from the source?

A) 4I

B) 2I

C) I/2

D) I/4

Answer: D
Diff: 2 *Page Ref: Sec. 12.2*

12) You double your distance from a sound source that is radiating equally in all directions. What happens to the intensity of the sound? It reduces to

A) one-half its original value.

B) one-fourth its original value.

C) one-sixteenth its original value.

D) none of the above

Answer: B
Diff: 1 *Page Ref: Sec. 12.2*

13) You double your distance from a sound source that is radiating equally in all directions. What happens to the intensity level of the sound? It drops by

A) 2 dB.

B) 3 dB.

C) 6 dB.

D) 8 dB.

Answer: C
Diff: 2 *Page Ref: Sec. 12.2*

14) Which of the following increases as a sound becomes louder?
    A) frequency
    B) wavelength
    C) amplitude
    D) period
    E) velocity

    Answer: C
    Diff: 1 Page Ref: Sec. 12.3

15) You move slowly toward a speaker emitting a pure tone. What characteristic of the sound increases?
    A) frequency
    B) amplitude
    C) wavelength
    D) period

    Answer: B
    Diff: 1 Page Ref: Sec. 12.4

16) What determines "loudness" of a musical note?
    A) frequency
    B) velocity
    C) phase
    D) amplitude

    Answer: D
    Diff: 1 Page Ref: Sec. 12.4

17) What determines the "pitch" of a musical note?
    A) amplitude
    B) wavelength
    C) frequency
    D) phase

    Answer: C
    Diff: 1 Page Ref: Sec. 12.4

18) When sound passes from air into water
    A) its wavelength does not change.
    B) its frequency does not change.
    C) its velocity does not change.
    D) all of the above

    Answer: B
    Diff: 1 Page Ref: Sec. 12.4

19) Pressure and displacement waves are
  A) in phase.
  B) 45° out of phase.
  C) 90° out of phase.
  D) 180° out of phase.

Answer: C
Diff: 2 Page Ref: Sec. 12.4

20) Consider the standing wave on a guitar string and the sound wave generated by the guitar as a result of this vibration. What do these two waves have in common?
  A) They have the same wavelength.
  B) They have the same velocity.
  C) They have the same frequency.
  D) More than one of the above is true.
  E) None of the above is true.

Answer: C
Diff: 2 Page Ref: Sec. 12.4

21) In a resonating pipe which is open at both ends, there
  A) are displacement nodes at each end.
  B) are displacement antinodes at each end.
  C) is a displacement node at one end and a displacement antinode at the other end.
  D) none of the above

Answer: B
Diff: 2 Page Ref: Sec. 12.4

22) Consider an open pipe of length L. What are the wavelengths of the three lowest tones produced by this pipe?
  A) 4L, 2L, L
  B) 2L, L, L/2
  C) 2L, L, 2L/3
  D) 4L, 4L/3, 4L/5

Answer: C
Diff: 2 Page Ref: Sec. 12.4

23) The lowest tone to resonate in an open pipe of length L is 200 Hz. Which one of the following frequencies will not resonate in the same pipe?

A) 400 Hz

B) 600 Hz

C) 800 Hz

D) 900 Hz

Answer: D
Diff: 2 *Page Ref: Sec. 12.4*

24) An open pipe of length L is resonating at its fundamental frequency. Which statement is correct?

A) The wavelength is 2L and there is a displacement node at the pipe's midpoint.

B) The wavelength is 2L and there is a displacement antinode at the pipe's midpoint.

C) The wavelength is L and there is a displacement node at the pipe's midpoint.

D) The wavelength is L and there is a displacement antinode at the pipe's midpoint.

Answer: A
Diff: 2 *Page Ref: Sec. 12.4*

25) In a resonating pipe which is open at one end and closed at the other, there

A) are displacement nodes at each end.

B) are displacement antinodes at each end.

C) is a displacement node at the open end and a displacement antinode at the closed end.

D) is a displacement node at the closed end and a displacement antinode at the open end.

Answer: D
Diff: 2 *Page Ref: Sec. 12.4*

26) Consider a closed pipe of length L. What are the wavelengths of the three lowest tones produced by this pipe?

A) 4L, 2L, L

B) 2L, L, L/2

C) 2L, L, 2L/3

D) 4L, 4L/3, 4L/5

Answer: D
Diff: 2 *Page Ref: Sec. 12.4*

27) The lowest tone to resonate in a closed pipe of length L is 200 Hz. Which of the following frequencies will not resonate in that pipe?

A) 400 Hz

B) 600 Hz

C) 1000 Hz

D) 1400 Hz

Answer: A

Diff: 2 Page Ref: Sec. 12.4

28) A pipe of length L closed at one end is resonating at its fundamental frequency. Which statement is correct?

A) The wavelength is 4L and there is a displacement node at the pipe's open end.

B) The wavelength is 4L and there is a displacement antinode at the pipe's open end.

C) The wavelength is L and there is a displacement node at the pipe's open end.

D) The wavelength is L and there is a displacement antinode at the pipe's open end.

Answer: B

Diff: 2 Page Ref: Sec. 12.4

29) A person stands between two speakers driven by the same source. Each speaker produces a tone with a frequency of 200 Hz on a day when the speed of sound is 330 m/s. The person is 1.65 m from one speaker and 4.95 m from the other. What type of interference does the person sense?

A) constructive

B) destructive

C) both constructive and destructive

D) neither constructive nor destructive

Answer: A

Diff: 2 Page Ref: Sec. 12.6

30) In order to produce beats, the two sound waves should have

A) the same amplitude.

B) slightly different amplitudes.

C) the same frequency.

D) slightly different frequencies.

Answer: D

Diff: 1 Page Ref: Sec. 12.6

31) Two pure tones are sounded together and a particular beat frequency is heard. What happens to the beat frequency if the frequency of one of the tones is increased?

A) It increases.

B) It decreases.

C) It does not change.

D) It could either increase or decrease.

Answer: D
Diff: 2 *Page Ref: Sec. 12.6*

32) The Doppler shift explains

A) why the siren on a police car changes its pitch as it races past us.

B) why a sound grows quieter as we move away from the source.

C) how sonar works.

D) the phenomenon of beats.

E) why it is that our hearing is best near 3000 Hz.

Answer: A
Diff: 1 *Page Ref: Sec. 12.7*

33) A sound source approaches a stationary observer. The frequency heard by the observer is

A) higher than the source.

B) lower than the source.

C) the same as that of the source.

D) equal to zero.

Answer: A
Diff: 1 *Page Ref: Sec. 12.7*

34) A sound source departs from a stationary observer. The frequency heard by the observer is

A) higher than the source.

B) lower than the source.

C) the same as that of the source.

D) equal to zero.

Answer: B
Diff: 1 *Page Ref: Sec. 12.7*

35) If a jet plane were to double its MACH–speed, its half–angle will decrease by a factor of:

A) 1/2

B) 2

C) $\sin^{-1}(1/2)$

D) none of the above

Answer: D
Diff: 3 *Page Ref: Sec. 12.8*

Quantitative Problems

1) The speed of an ultrasonic sound of frequency 45 kHz in air is 352 m/s. What is the air temperature?

A) 33°C

B) 34°C

C) 35°C

D) 36°C

Answer: C
Diff: 1 Page Ref: Sec. 12.1

2) What is the ratio of the speed of sound in air at 0°C to the speed at 100°C?

A) 0.75

B) 0.85

C) 0.95

D) 1.1

Answer: B
Diff: 2 Page Ref: Sec. 12.1

3) On a day when the speed of sound in air is 340 m/s, a bat emits a shriek whose echo reaches it 0.0250 s later. How far away was the object that reflected back the sound?

A) 4.25 m

B) 8.50 m

C) 0.425 m

D) 0.850 m

Answer: A
Diff: 1 Page Ref: Sec. 12.1

4) You shout at a cliff, and hear the echo in 4.00 s. The temperature is 0°C. How far away is the cliff?

A) 662 m

B) 680 m

C) 1320 m

D) 1760 m

Answer: A
Diff: 1 Page Ref: Sec. 12.1

5) If you hear thunder 5.0 s after seeing a flash of lightning, the distance to the lightning strike is about
   A) 600 m.
   B) 1200 m.
   C) 1700 m.
   D) 2200 m.

   Answer: C
   Diff: 1 *Page Ref: Sec. 12.1*

6) An echo is heard 2.0 s from a cliff on a day the temperature is 15°C. Approximately how far is the cliff from the observer?
   A) 85 m
   B) 170 m
   C) 340 m
   D) 680 m

   Answer: C
   Diff: 2 *Page Ref: Sec. 12.1*

7) On a 30°C day, there is an explosion. The sound is heard 3.4 s after seeing the flash. How far away was the explosion?
   A) 0.10 km
   B) 0.75 km
   C) 1.2 km
   D) 1.5 km

   Answer: C
   Diff: 2 *Page Ref: Sec. 12.1*

8) You drop a stone into a deep well and hear the splash 2.5 s later. How deep is the well? (Ignore air resistance, and assume the velocity of sound is 340 m/s.)
   A) 25 m
   B) 27 m
   C) 29 m
   D) 31 m

   Answer: C
   Diff: 3 *Page Ref: Sec. 12.1*

9) The wavelength in air of a sound wave of frequency 500 Hz is

A) 0.69 m.

B) 0.75 m.

C) 1.5 m.

D) 1.8 m.

Answer: A
Diff: 1 *Page Ref: Sec. 12.1*

10) Sound traveling in air at 23°C enters a cold front where the air temperature is 2°C. If the sound frequency is 1500 Hz, determine the wavelength in the warmer air and in the colder air.

A) 0.230 m, 0.221 m

B) 0.221 m, 0.230 m

C) 0.321 m, 0.254 m

D) 0.254 m, 0.321 m

Answer: A
Diff: 2 *Page Ref: Sec. 12.1*

11) What is the intensity level of a sound with intensity 10^{-3} W/m^2?

A) 30 dB

B) 60 dB

C) 90 dB

D) 96 dB

Answer: C
Diff: 1 *Page Ref: Sec. 12.2*

12) What is the intensity of a 70-dB sound?

A) 10^{-4} W/m^2

B) 10^{-5} W/m^2

C) 10^{-6} W/m^2

D) 10^{-7} W/m^2

Answer: B
Diff: 1 *Page Ref: Sec. 12.2*

13) What is the ratio of the intensities of two sounds with intensity levels of 70 dB and 40 dB?

A) 10:1

B) 100:1

C) 1000:1

D) 10,000:1

Answer: C
Diff: 2 *Page Ref: Sec. 12.2*

14) The intensity level by 15 engines in a garage is 100 dB. What is the intensity level generated by one engine?

A) 67 dB

B) 13 dB

C) 44 dB

D) 88 dB

Answer: D
Diff: 2 *Page Ref: Sec. 12.2*

15) The intensity at a distance of 6.0 m from a source that is radiating equally in all directions is 6.0×10^{-10} W/m^2. What is the power emitted by the source?

A) 2.1×10^{-8} W

B) 2.7×10^{-7} W

C) 2.1×10^{-6} W

D) 2.7×10^{-5} W

Answer: B
Diff: 2 *Page Ref: Sec. 12.2*

16) The intensity at a distance of 6.0 m from a source that is radiating equally in all directions is 6.0×10^{-10} W/m^2. What is the intensity level in dB?

A) 18 dB

B) 23 dB

C) 28 dB

D) 32 dB

Answer: C
Diff: 2 *Page Ref: Sec. 12.2*

17) A barking dog delivers about 1 mW of power, which is assumed to be uniformly distributed in all directions. What is the intensity level at a distance 5.00 m from the dog?

A) 61 dB

B) 63 dB

C) 65 dB

D) 68 dB

Answer: C
Diff: 2 *Page Ref: Sec. 12.2*

18) The intensity level is 65 dB at a distance 5.00 m from a barking dog. What would be the intensity level if two identical dogs very close to each other are barking?

A) 65 dB

B) 68 dB

C) 130 dB

D) 136 dB

Answer: B
Diff: 3 *Page Ref: Sec. 12.2*

19) At a distance of 15 m from a sound source the intensity level is 60 dB. What is the intensity level (in dB) at a point 2.0 m from the source? Assume that the source radiates equally in all directions.

A) 55.7 dB

B) 57.5 dB

C) 75.5 dB

D) 77.5 dB

Answer: D
Diff: 3 *Page Ref: Sec. 12.2*

20) The sound intensity level 5.0 m from a point source is 95 dB. At what distance will it be 75 dB?

A) 25 m

B) 50 m

C) 75 m

D) 225 m

Answer: B
Diff: 3 *Page Ref: Sec. 12.2*

21) The third harmonic of a complex tone has a frequency of 1200 Hz. What is the frequency of the fourth harmonic?

A) 400 Hz

B) 900 Hz

C) 1600 Hz

D) 4800 Hz

Answer: C
Diff: 1 *Page Ref: Sec. 12.4*

22) The frequency of the third harmonic of an open pipe is 900 Hz. What is the length of the pipe?

A) 0.189 m

B) 0.283 m

C) 0.567 m

D) 1.13 m

Answer: C
Diff: 2 *Page Ref: Sec. 12.4*

23) The lowest tone to resonate in an open pipe of length L is 400 Hz. What is the frequency of the lowest tone that will resonate in an open pipe of length 2L?

A) 800 Hz

B) 200 Hz

C) 1600 Hz

D) 100 Hz

Answer: B
Diff: 2 *Page Ref: Sec. 12.4*

24) An organ pipe open at both ends has a length of 0.80 m. If the velocity of sound in air is 340 m/s, what is the frequency of the second harmonic?

A) 213 Hz

B) 425 Hz

C) 638 Hz

D) 850 Hz

Answer: B
Diff: 2 *Page Ref: Sec. 12.4*

25) A 3.00–m long pipe is in a room where the temperature is 20°C. What is the fundamental frequency if the pipe is open at both ends?

A) 57 Hz

B) 114 Hz

C) 29 Hz

D) none of the above

Answer: A
Diff: 2 *Page Ref: Sec. 12.4*

26) The fundamental frequency in a pipe closed at one end is 330 Hz. What is the frequency of the third harmonic?

A) 110 Hz

B) 220 Hz

C) 660 Hz

D) 990 Hz

Answer: D
Diff: 1 *Page Ref: Sec.12.4*

27) What is the length of the shortest pipe closed on one end that will have a fundamental frequency of 60 Hz on a day when the velocity of sound is 340 m/s?

A) 1.24 m

B) 1.42 m

C) 2.14 m

D) 4.12 m

Answer: B
Diff: 2 *Page Ref: Sec. 12.4*

28) A 3.00–m long pipe is in a room where the temperature is 20°C. What is the fundamental frequency if the pipe is closed at one end?

A) 57 Hz

B) 114 Hz

C) 29 Hz

D) none of the above

Answer: C
Diff: 2 *Page Ref: Sec. 12.4*

29) A 3.00–m long pipe is in a room where the temperature is 20°C. What is the frequency of the second harmonic if the pipe is closed at one end?

A) 57 Hz

B) 114 Hz

C) 29 Hz

D) none of the above

Answer: D
Diff: 2 *Page Ref: Sec. 12.4*

30) A closed organ pipe of length 0.75 m is played when the speed of sound in air is 340 m/s. What is the fundamental frequency?

A) 57 Hz

B) 113 Hz

C) 170 Hz

D) 227 Hz

Answer: B
Diff: 2 *Page Ref: Sec. 12.4*

31) Consider two pipes of the same length: one is open and the other is closed on one end. If the fundamental frequency of the open pipe is 300 Hz, what is the fundamental frequency of the closed pipe?

A) 150 Hz

B) 300 Hz

C) 450 Hz

D) 600 Hz

Answer: A
Diff: 2 *Page Ref: Sec. 12.4*

32) Two adjacent sources each emit a frequency of 800 Hz in air where the velocity of sound is 340 m/s. How much farther back would source 1 have to be moved so an observer in front of the sources would hear no sound?

A) 0.123 m

B) 0.321 m

C) 0.213 m

D) 0.312 m

Answer: C
Diff: 2 *Page Ref: Sec. 12.6*

33) Two speakers are placed side by side and driven by the same frequency of 500 Hz. If the distance from a person to one speaker is 5.00 m and the person detects little or no sound, which of the following is a possible the distance from the person to the other speaker? (The sound speed is 340 m/s.)

A) 7.7 m

B) 8.1 m

C) 8.4 m

D) 9.1 m

Answer: B
Diff: 2 *Page Ref: Sec. 12.6*

34) Two tunes have frequencies of 440 Hz and 444 Hz. What is the beat frequency?

A) 4 Hz

B) 442 Hz

C) 884 Hz

D) none of the above

Answer: A
Diff: 1 *Page Ref: Sec. 12.6*

35) A music tuner uses a 550–Hz tuning fork to tune the frequency of a musical instrument. If the tuner hears a beat frequency of 2 Hz, what is the frequency of the instrument?

A) It must be 552 Hz.

B) It must be 548 Hz.

C) It could be either 552 Hz or 548 Hz.

D) It is neither 552 Hz or 548 Hz.

Answer: C
Diff: 1 *Page Ref: Sec. 12.6*

36) The wavelengths of the sounds produced by two horns are 6 m and 7 m respectively. What beat frequency is heard when the horns are sounded on a day when the velocity of sound is 340 m/s?

A) 5 Hz

B) 6 Hz

C) 7 Hz

D) 8 Hz

Answer: D
Diff: 2 *Page Ref: Sec. 12.6*

37) The corresponding violin strings on two violins in an orchestra are found to produce a beat frequency of 2 Hz when a frequency of 660 Hz is played. What percentage change in the tension of one of the strings would bring them to the same frequency?

A) 0.2%

B) 0.4%

C) 0.6%

D) 0.8%

Answer: C
Diff: 3 *Page Ref: Sec. 12.6*

38) An observer approaches a stationary 1000–Hz sound source at twice the speed of sound. The observer hears a frequency of

A) 4000 Hz.

B) 2000 Hz.

C) 500 Hz.

D) none of the above

Answer: D
Diff: 2 *Page Ref: Sec. 12.7*

39) A sound source (normal frequency of 1000 Hz) approaches a stationary observer at one–half the speed of sound. The observer hears a frequency of

A) 2000 Hz.

B) 500 Hz.

C) 1500 Hz.

D) none of the above

Answer: A
Diff: 2 *Page Ref: Sec. 12.7*

40) A sound has a frequency of 1000 Hz. If a listener moves with a speed of 30 m/s away from the source, what is the frequency heard by the observer? (The sound speed is 340 m/s.)

A) 912 Hz

B) 919 Hz

C) 1000 Hz

D) 1090 Hz

Answer: A
Diff: 2 *Page Ref: Sec. 12.7*

41) A police car has an 800–Hz siren. It is traveling at 35 m/s on a day when the speed of sound through air is 340 m/s. The car approaches and passes an observer who is standing along the roadside. What change of frequency does the observer hear?

A) zero

B) 82 HZ

C) 166 Hz

D) 249 Hz

Answer: C
Diff: 2 *Page Ref: Sec.12.7*

42) What is the frequency heard by a stationary observer when a train approaches with a speed of 30 m/s. The frequency of the train horn is 600 Hz and the speed of sound is 340 m/s.

A) 551 Hz

B) 600 Hz

C) 653 Hz

D) 658 Hz

Answer: D
Diff: 2 *Page Ref: Sec. 12.7*

43) A train is traveling toward you at 120 km/h. The train blows its 400–Hz whistle. Take the speed of sound to be 340 m/s. What frequency do you hear?

A) 444 Hz

B) 439 Hz

C) 364 Hz

D) 361 Hz

Answer: A
Diff: 2 *Page Ref: Sec. 12.7*

44) You are moving at 120 km/h toward a stationary train. The train blows its 400–Hz whistle. Take the speed of sound to be 340 m/s. What frequency do you hear?

A) 444 Hz

B) 439 Hz

C) 364 Hz

D) 361 Hz

Answer: B
Diff: 2 *Page Ref: Sec. 12.7*

45) A train is traveling away from you at 120 km/h. The train blows its 400–Hz whistle. Take the speed of sound to be 340 m/s. What frequency do you hear?

A) 444 Hz

B) 439 Hz

C) 364 Hz

D) 361 Hz

Answer: C
Diff: 2 *Page Ref: Sec. 12.7*

46) A train is traveling away from you at 120 km/h. It blows its whistle, and you hear a tone of 400 Hz. Take the speed of sound to be 340 m/s. What is the actual frequency of the whistle?

A) 444 Hz

B) 439 Hz

C) 364 Hz

D) 361 Hz

Answer: B
Diff: 2 *Page Ref: Sec. 12.7*

47) The frequency of a train horn is 500 Hz. Assume the speed of sound in air is 340 m/s. What is the frequency heard by an observer if the observer is moving away from the train with a speed of 30.0 m/s?

A) 500 Hz

B) 456 Hz

C) 548 Hz

D) none of the above

Answer: B
Diff: 2 *Page Ref: Sec. 12.7*

48) The frequency of a train horn is 500 Hz. Assume the speed of sound in air is 340 m/s. What is the frequency heard by an observer if the observer is approaching the train with a speed of 30.0 m/s?

A) 456 Hz

B) 500 Hz

C) 544 Hz

D) none of the above

Answer: C
Diff: 2 *Page Ref: Sec. 12.7*

49) Sonar is used to determine the speed of an object. A 40-kHz signal is sent out, and a 42-kHz signal is returned. Assume the speed of sound is 345 m/s. How fast is the object moving?

A) 6.9 m/s

B) 8.4 m/s

C) 331 m/s

D) 347 m/s

Answer: B
Diff: 2 *Page Ref: Sec. 12.7*

50) The half angle of the conical shock wave produced by a supersonic aircraft is 60°. What is the Mach number of the aircraft?

A) 0.87

B) 1.2

C) 1.7

D) 2.0

Answer: B

Diff: 2 *Page Ref: Sec. 12.8*

51) A jet flies at a speed of Mach 1.4. What is the half–angle of the conical shock wave formed?

A) 30°

B) 36°

C) 44°

D) 46°

Answer: D

Diff: 2 *Page Ref: Sec. 12.8*

52) The Concord airplane flies from the United States to Europe with a Mach number of 1.05 where the air temperature is 5.0°C. What is the speed of the plane?

A) 334 m/s

B) 337 m/s

C) 351 m/s

D) 359 m/s

Answer: C

Diff: 2 *Page Ref: Sec. 12.8*