Quiz 4 PRACTICE--Ch 11 Simple Harmonic Motion and Waves

Multiple Choice

Identify the choice that best completes the statement or answers the question.

1. Two waves traveling in opposite directions on a rope meet and undergo complete destructive interference. Which of the following best describes the waves a moment after the waves meet and coincide?
   a. The waves continue unchanged.  b. A single wave continues along the rope.  c. The waves no longer exist.
   d. The waves reflect and travel backward.

2. For a system in simple harmonic motion, which of the following is the time required to complete a cycle of motion?
   a. frequency  b. amplitude  c. period  d. revolution

3. Tripling the displacement from equilibrium of an object in simple harmonic motion will change the magnitude of the object’s maximum acceleration by what factor?
   a. one-third  b. 1  c. 9  d. 3

4. A pendulum swings through a total of 28°. If the displacement is equal on each side of the equilibrium position, what is the amplitude of this vibration? (Disregard frictional forces acting on the pendulum.)
   a. 56°  b. 7.0°  c. 28°  d. 14°

5. How are frequency and period related in simple harmonic motion?
   a. They are directly related.  b. Both measure the number of cycles per unit of time.  c. Their sum is constant.
   d. They are inversely related.

6. What is the fewest number of nodes a standing wave can have?
   a. 4  b. 3  c. 1  d. 2

7. Vibration of an object about an equilibrium point is called simple harmonic motion when the restoring force is proportional to
   a. a spring constant.  b. displacement.  c. time.  d. mass.

8. By what factor should the length of a simple pendulum be changed in order to triple the period of vibration?
   a. 27  b. 6  c. 3  d. 9

9. The standing wave shown in the diagram above would be produced on a string of length $L$ by a wave having wavelength
   a. $1/2 L$.  b. $4 L$.  c. $L$.  d. $2 L$.

10. Which of the following wavelengths would produce standing waves on a string approximately 3.5 m long?
    a. 2.33 m  b. 4.55 m  c. 3.75 m  d. 2.85 m
11. Each stretched region in the waveform of the longitudinal wave shown above corresponds to what feature of the transverse wave below it?
   a. troughs  b. crests  c. wavelength  d. amplitude

12. Each compression in the waveform of the longitudinal wave shown above corresponds to what feature of the transverse wave below it?
   a. troughs  b. amplitude  c. wavelength  d. crests

13. A mass-spring system can oscillate with simple harmonic motion because a compressed or stretched spring has which kind of energy?
   a. gravitational potential  b. elastic potential  c. mechanical  d. kinetic

14. A wave travels through a medium. As the wave passes, the particles of the medium vibrate in a direction perpendicular to the direction of the wave’s motion. The wave is
   a. longitudinal  b. transverse  c. a pulse  d. electromagnetic.

15. One end of a taut rope is fixed to a post. What type of wave is produced if the free end is quickly raised and lowered one time?
   a. longitudinal wave  b. pulse wave  c. sine wave  d. periodic wave

16. How many nodes and antinodes are shown in the standing wave above?
   a. one-third node and one antinode  b. three nodes and two antinodes  c. two nodes and three antinodes  d. one node and two antinodes

17. The superposition of mechanical waves can be observed in the movement of
   a. violin bows in an orchestra  b. bumper cars  c. electromagnetic radiation  d. water waves in a ripple tank.
18. For a system in simple harmonic motion, which of the following is the number of cycles or vibrations per unit of time?
   a. frequency  b. amplitude  c. revolution  d. period

19. How many nodes and antinodes are shown in the standing wave above?
   a. five nodes and four antinodes  b. four nodes and three antinodes  c. four nodes and four antinodes  d. four nodes and five antinodes

20. A child on a playground swings through a total of 32°. If the displacement is equal on each side of the equilibrium position, what is the amplitude of this vibration? (Disregard frictional forces acting on the swing.)
   a. 8.0°  b. 32°  c. 16°  d. 64°

21. Standing waves are produced by periodic waves of
   a. any amplitude and wavelength traveling in the same direction.  b. the same frequency, amplitude, and wavelength traveling in opposite directions.  c. the same amplitude and wavelength traveling in the same direction.  d. any amplitude and wavelength traveling in opposite directions.

22. When two mechanical waves coincide, the amplitude of the resultant wave is always ____ the amplitudes of each wave alone.
   a. greater than  b. less than  c. the same as  d. the sum of

23. Which of the following is a single nonperiodic disturbance?
   a. sine wave  b. pulse wave  c. periodic wave  d. transverse wave

24. Two mechanical waves meet and coincide. One wave has a positive displacement from the equilibrium position, and the other wave has a negative displacement. What kind of interference occurs?
   a. constructive  b. destructive  c. complete constructive  d. none

25. Which of the following types of interference will occur when the pulses in the figure above meet?
   a. complete constructive interference  b. partial interference  c. no interference  d. complete destructive interference

26. Which of the following is not an example of approximate simple harmonic motion?
   a. a car’s radio antenna waving back and forth  b. a piano wire that has been struck  c. a child swinging on a swing  d. a ball bouncing on the floor
27. Suppose that two sound waves passing through the same medium have different wavelengths. Which of the following is most likely to be the reason for the differing wavelengths?
   a. the type of wave  b. differences in amplitude  c. differences in frequency  d. the nature of the medium

28. Two mechanical waves can occupy the same space at the same time because waves
   a. are matter.  b. do not cause interference patterns.  c. cannot pass through one another.  d. are displacements of matter.

29. For a mass hanging from a spring, the maximum displacement the spring is stretched or compressed from its equilibrium position is the system’s
   a. period.  b. frequency.  c. amplitude.  d. acceleration.

30. Which of the following features of a given pendulum changes when the pendulum is moved from Earth’s surface to the moon?
   a. the mass  b. the equilibrium position  c. the length  d. the restoring force

31. A mass attached to a spring vibrates back and forth. At maximum displacement, the spring force and the
   a. velocity reach a maximum.  b. acceleration reach zero.  c. velocity reach zero.  d. acceleration reach a maximum.

32. Which of the following types of interference will occur when the pulses in the figure above meet?
   a. no interference  b. total interference  c. destructive interference  d. constructive interference

33. Which of the following types of interference will occur when the pulses in the figure above meet?
   a. no interference  b. total interference  c. destructive interference  d. constructive interference

34. Two mechanical waves that have positive displacements from the equilibrium position meet and coincide. What kind of interference occurs?
   a. complete destructive  b. none  c. destructive  d. constructive

35. A mass attached to a spring vibrates back and forth. At the equilibrium position, the
   a. acceleration reaches a maximum.  b. velocity reaches zero.  c. net force reaches a maximum.  d. velocity reaches a maximum.
36. A mass on a spring that has been compressed 0.1 m has a restoring force of 20 N. What is the spring constant?

37. Radio waves from an FM station have a frequency of 103.1 MHz. If the waves travel with a speed of $3.00 \times 10^8$ m/s, what is the wavelength?

38. A mass on a spring vibrates in simple harmonic motion at an amplitude of 8.0 cm. If the mass of the object is 0.20 kg and the spring constant is 130 N/m, what is the frequency?

39. What is the period of a 4.12 m long pendulum with a bob of mass 75.0 kg?

40. A musical tone sounded on a piano has a frequency of 261.6 Hz and a wavelength of 1.31 m. What is the speed of the sound wave?

41. Bats chirp at high frequencies that humans cannot hear. They use the echoes to detect small objects, such as insects, as small as one wavelength. If a bat emits a chirp at a frequency of 60.0 kHz and the speed of sound waves in air is 340 m/s, what is the size in millimeters of the smallest insect that the bat can detect?

42. How much displacement will a coil spring with a spring constant of 120 N/m achieve if it is stretched by a 60 N force?

43. Imagine that you could transport a simple pendulum from Earth to the moon, where the free-fall acceleration is one-sixth that on Earth. By what factor would the pendulum’s frequency be changed? Express the answer with one significant figure.

44. On the planet Xenos, an astronaut observes that a 1.00 m long pendulum has a period of 1.50 s. What is the free-fall acceleration on Xenos?

45. A 0.20 kg mass suspended from a spring moves with simple harmonic motion. At the instant the mass is displaced from equilibrium by –0.050 m, what is its acceleration? (The spring constant is 10.0 N/m.)

46. Vibration of a certain frequency produces a standing wave on a stretched string that is 2.0 m long. The standing wave has 7 nodes and 5 antinodes. What is the wavelength of the wave that produces this standing wave?

47. If a force of 50 N stretches a spring 0.10 m, what is the spring constant?

48. An amusement park ride has a frequency of 0.05 Hz. What is the ride’s period?

49. A periodic wave has a wavelength of 0.50 m and a speed of 20 m/s. What is the wave frequency?

50. An amusement park ride swings back and forth once every 40.0 s. What is the ride’s frequency?
Quiz 4 PRACTICE--Ch 11 Simple Harmonic Motion and Waves
Answer Section

MULTIPLE CHOICE

1. ANS: A  PTS: 1  DIF: II  OBJ: 11-4.1
2. ANS: C  PTS: 1  DIF: I  OBJ: 11-2.2
3. ANS: D  PTS: 1  DIF: II  OBJ: 11-1.2
4. ANS: D  PTS: 1  DIF: II  OBJ: 11-2.1
5. ANS: D  PTS: 1  DIF: I  OBJ: 11-2.2
6. ANS: D  PTS: 1  DIF: I  OBJ: 11-4.5
7. ANS: B  PTS: 1  DIF: II  OBJ: 11-1.1
8. ANS: D  PTS: 1  DIF: IIIB  OBJ: 11-2.3
9. ANS: C  PTS: 1  DIF: II  OBJ: 11-4.4
10. ANS: A  PTS: 1  DIF: IIIC  OBJ: 11-4.4
11. ANS: A  PTS: 1  DIF: I  OBJ: 11-3.3
12. ANS: D  PTS: 1  DIF: I  OBJ: 11-3.3
13. ANS: B  PTS: 1  DIF: II  OBJ: 11-1.2
14. ANS: B  PTS: 1  DIF: I  OBJ: 11-3.1
15. ANS: B  PTS: 1  DIF: I  OBJ: 11-3.2
16. ANS: B  PTS: 1  DIF: I  OBJ: 11-4.5
17. ANS: D  PTS: 1  DIF: I  OBJ: 11-4.1
18. ANS: A  PTS: 1  DIF: I  OBJ: 11-2.2
20. ANS: C  PTS: 1  DIF: II  OBJ: 11-2.1
21. ANS: B  PTS: 1  DIF: I  OBJ: 11-4.4
22. ANS: D  PTS: 1  DIF: I  OBJ: 11-4.2
23. ANS: B  PTS: 1  DIF: I  OBJ: 11-3.2
24. ANS: B  PTS: 1  DIF: I  OBJ: 11-4.2
25. ANS: D  PTS: 1  DIF: I  OBJ: 11-4.2
26. ANS: D  PTS: 1  DIF: I  OBJ: 11-1.1
27. ANS: C  PTS: 1  DIF: II  OBJ: 11-3.4
28. ANS: D  PTS: 1  DIF: I  OBJ: 11-4.1
29. ANS: C  PTS: 1  DIF: I  OBJ: 11-2.1
30. ANS: D  PTS: 1  DIF: IIIA  OBJ: 11-2.3
31. ANS: D  PTS: 1  DIF: I  OBJ: 11-1.2
32. ANS: D  PTS: 1  DIF: I  OBJ: 11-4.2
33. ANS: C  PTS: 1  DIF: I  OBJ: 11-4.2
34. ANS: D  PTS: 1  DIF: I  OBJ: 11-4.2
35. ANS: D  PTS: 1  DIF: I  OBJ: 11-1.2
PROBLEM

36. ANS:
200 N/m

\textit{Given}
\[ x = -0.1 \text{ m} \]
\[ F_{\text{elastic}} = 20 \text{ N} \]

\textit{Solution}
\[ F_{\text{elastic}} = -kx \]
\[ k = -\frac{F_{\text{elastic}}}{x} = -\frac{20 \text{ N}}{-0.1 \text{ m}} \]
\[ k = 200 \text{ N/m} \]

PTS: 1 DIF: IIIB OBJ: 11-1.3

37. ANS:
2.91 m

\textit{Given}
\[ f = 103.1 \text{ MHz} \]
\[ v = 3.00 \times 10^8 \text{ m/s} \]
\[ f = 103.1 \text{ MHz} = 1.031 \times 10^8 \text{ Hz} \]

\textit{Solution}
\[ v = f\lambda \]
\[ \lambda = \frac{v}{f} = (3.00 \times 10^8 \text{ m/s})/(1.031 \times 10^8 \text{ Hz}) = 2.91 \text{ m} \]

PTS: 1 DIF: IIIA OBJ: 11-3.4
38. **ANS:**
   4.0 Hz

   *Given*
   
   $x = 8.0$ cm (This value is not relevant to the problem.)
   
   $m = 0.20$ kg
   
   $k = 130$ N/m

   *Solution*

   $$T = 2\pi \sqrt{\frac{m}{k}} \quad \text{and} \quad f = \frac{1}{T}, \text{ so}$$

   $$f = \frac{1}{2\pi} \sqrt{\frac{k}{m}} = \frac{1}{2\pi} \sqrt{\frac{130 \text{ N/m}}{0.20 \text{ kg}}} = 4.1 \text{ Hz}$$

   **PTS:** 1  \hspace{1cm} **DIF:** IIIB  \hspace{1cm} **OBJ:** 11-2.3

39. **ANS:**
   4.07 s

   *Given*
   
   $L = 4.12$ m
   
   $m = 75.0$ kg (This mass is not relevant to the problem.)

   *Solution*

   $$T = 2\pi \sqrt{\frac{L}{a_g}} = 2\pi \sqrt{\frac{4.12 \text{ m}}{9.81 \text{ m/s}^2}} = 4.07 \text{ s}$$

   **PTS:** 1  \hspace{1cm} **DIF:** IIIB  \hspace{1cm} **OBJ:** 11-2.3

40. **ANS:**
   343 m/s

   *Given*
   
   $f = 261.6$ Hz
   
   $\lambda = 1.31$ m

   *Solution*

   $$v = f\lambda$$

   $$v = (261.6 \text{ Hz})(1.31 \text{ m}) = 343 \text{ m/s}$$

   **PTS:** 1  \hspace{1cm} **DIF:** IIIA  \hspace{1cm} **OBJ:** 11-3.4
41. ANS:
5.7 mm

*Given*
\( f = 60.0 \text{ kHz} \)
\( v = 340 \text{ m/s} \)

*Solution*
\( v = f \lambda \)
\( f = 60.0 \text{ kHz} = 6.00 \times 10^4 \text{ Hz} \)
\( \lambda = \frac{v}{f} = \frac{(340 \text{ m/s})/(6.00 \times 10^4 \text{ Hz})}{0.0057 \text{ m}} = 5.7 \text{ mm} \)

PTS: 1  DIF: IIIB  OBJ: 11-3.4

42. ANS:
–0.5 m

*Given*
\( k = 120 \text{ N/m} \)
\( F_{\text{elastic}} = 60 \text{ N} \)

*Solution*
\( F_{\text{elastic}} = -kx \)
\( x = -\frac{F_{\text{elastic}}}{k} = -\frac{60 \text{ N}}{120 \text{ N/m}} \)
\( x = -0.5 \text{ m} \)

PTS: 1  DIF: IIIA  OBJ: 11-1.3
43. ANS: 0.4

Given
\[ a_g = \frac{1}{6} g \]

Solution
\[ T = 2\pi \sqrt{\frac{L}{a_g}} \]

Because \( L \) and \( 2\pi \) remain constant when the pendulum is moved to the moon, \( T_{\text{moon}} \propto \sqrt{\frac{1}{a_g}} \), where \( a_g \) is the gravitational acceleration of the moon.

\[
\frac{T_{\text{moon}}}{T_{\text{earth}}} = \sqrt{\frac{1}{a_g} \cdot \frac{1}{g}} = \sqrt{\frac{1}{6}} = 0.4
\]

PTS: 1  DIF: IIIB  OBJ: 11-2.3

44. ANS: 17.6 m/s²

Given
\( L = 1.00 \) m
\( T = 1.50 \) s

Solution
\[ T = 2\pi \sqrt{\frac{L}{a_g}} \], so \( T^2 = 4\pi^2 \left( \frac{L}{a_g} \right) \)

\[
a_g = \frac{4\pi^2 L}{T^2} = 4\pi^2 \left( \frac{1.00 \text{ m}}{(1.50 \text{ s})^2} \right) = 17.6 \text{ m/s}^2
\]

PTS: 1  DIF: IIIB  OBJ: 11-2.3
45. ANS: 2.5 m/s²

Given
m = 0.20 kg
k = 10.0 N/m
x = –0.050 m

Solution
F = –kx and F = ma
ma = –kx

\[ a = \frac{-kx}{m} = \frac{-(10.0 \text{ N/m})(-0.050 \text{ m})}{0.20 \text{ kg}} \]

\[ a = 2.5 \text{ N/kg} = 2.5 \text{ m/s}^2 \]

PTS: 1 DIF: IIIA OBJ: 11-1.3

46. ANS: 0.80 m

Given
L = 2.0 m
The standing wave has 5 antinodes, i.e., 5 loops.

Solution
A single loop (antinode) is produced by a wavelength equal to 2L. Two loops (one complete wavelength) are produced by a wavelength of L. A wavelength of 2/3 L results in 3 antinodes. The following pattern emerges.

<table>
<thead>
<tr>
<th>Loops</th>
<th>( \lambda )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>( \lambda = 2L/1 = 2L )</td>
</tr>
<tr>
<td>2</td>
<td>( \lambda = 2L/2 = L )</td>
</tr>
<tr>
<td>3</td>
<td>( \lambda = 2L/3 = 2/3 L )</td>
</tr>
<tr>
<td>4</td>
<td>( \lambda = 2L/4 = 1/2 L )</td>
</tr>
<tr>
<td>5</td>
<td>( \lambda = 2L/5 = 2/5 L )</td>
</tr>
</tbody>
</table>

\[ 2/5 \times 2.0 \text{ m} = 0.80 \text{ m} \]

PTS: 1 DIF: IIIC OBJ: 11-4.5
47. ANS: 500 N/M

Given
\( F_{\text{elastic}} = 50 \text{ N} \)
\( x = -0.10 \text{ m} \)

Solution
\( F_{\text{elastic}} = -kx \)
\[ k = -\frac{F_{\text{elastic}}}{x} = -\frac{50 \text{ N}}{-0.10 \text{ m}} \]
\[ k = 500 \text{ N/m} \]

PTS: 1    DIF: IIIA    OBJ: 11-1.3

48. ANS: 20 s

Given
\( f = 0.05 \text{ Hz} \)

Solution
\[ T = \frac{1}{f} = \frac{1}{0.05 \text{ Hz}} \]
\[ T = 20 \text{ s} \]

PTS: 1    DIF: IIIA    OBJ: 11-2.3

49. ANS: 40 Hz

Given
\( v = 20 \text{ m/s} \)
\( \lambda = 0.50 \text{ m} \)

Solution
\( v = f\lambda \)
\[ f = \frac{v}{\lambda} = \frac{20 \text{ m/s}}{0.50 \text{ m}} = 40 \text{ Hz} \]

PTS: 1    DIF: IIIA    OBJ: 11-3.4
50. ANS:

\[ 2.50 \times 10^{-2} \text{ Hz} \]

*Given*

\[ T = 40.0 \text{ s} \]

*Solution*

\[ f = \frac{1}{T} = \frac{1}{40.0 \text{ s}} = 2.50 \times 10^{-2} \text{ Hz} \]

PTS: 1  DIF: IIIA  OBJ: 11-2.3