CHAPTER 13

1. A large spring requires a force of 150 N to compress it only 0.010 m. What is the spring constant of the spring?

   a. 125 000 N/m
   b. 15 000 N/m
   c. 15 N/m
   d. 1.5 N/m

2. A 0.20-kg object is attached to a spring with spring constant k = 10 N/m and moves with simple harmonic motion over a horizontal frictionless surface. At the instant that it is displaced from equilibrium by –0.050 m, what is its acceleration?

   a. 1 000 m/s^2
   b. 40 m/s^2
   c. 0.1 m/s^2
   d. 2.5 m/s^2

3. A 0.20-kg object is oscillating on a spring with a spring constant of k = 15 N/m. What is the potential energy of the system when the object displacement is 0.040 m, exactly half the maximum amplitude?

   a. zero
   b. 0.006 0 J
   c. 0.012 J
   d. 2.5 J

4. A 0.20 kg object, attached to a spring with spring constant k = 10 N/m, is moving on a horizontal frictionless surface in simple harmonic motion of amplitude of 0.080 m. What is its speed at the instant when its displacement is 0.040 m? (Hint: Use conservation of energy.)

   a. 9.8 m/s
   b. 4.9 m/s
   c. 49 cm/s
   d. 24.5 cm/s

5. An object is attached to a spring and its frequency of oscillation is measured. Then another object is connected to the first object, and the resulting mass is four times the original value. By what factor is the frequency of oscillation changed?

   a. 1/4
   b. 1/2
   c. 1/16
   d. 4

6. The kinetic energy of the bob on a simple pendulum swinging in simple harmonic motion has its maximum value when the displacement from equilibrium is at what point in its swing?

   a. zero displacement
   b. 1/4 the amplitude
   c. 1/2 the amplitude
   d. equal the amplitude

7. If one could transport a simple pendulum of constant length from the Earth's surface to the Moon's, where the acceleration due to gravity is one-sixth (1/6) that on the Earth, by what factor would the pendulum frequency be changed?

   a. about 6.0
   b. about 2.5
   c. about 0.41
   d. about 0.17

8. A long string is pulled so that the tension in it increases by a factor of three. If the change in length is negligible, by what factor does the wave speed change?

   a. 3.0
   b. 1.7
   c. 0.58
   d. 0.33

9. If the frequency of a traveling wave train is increased by a factor of three in a medium where the speed is constant, which of the following is the result?

   a. amplitude is one third as big
   b. amplitude is tripled
   c. wavelength is one third as big
   d. wavelength is tripled

10. What is the phase difference when two waves, traveling in the same medium, undergo constructive interference?

   a. 270°
   b. 180°
   c. 90°
   d. 0°

11. Tripling the weight suspended vertically from a coil spring will result in a change in the displacement of the spring's lower end by what factor?

   a. 0.33
   b. 1.0
   c. 3.0
   d. 9.0

12. Tripling the displacement from equilibrium of an object in simple harmonic motion will bring about a change in the magnitude of the object's acceleration by what factor?

    a. 0.33
    b. 1.0
    c. 3.0
    d. 9.0

13. Tripling the mass of the bob on a simple pendulum will cause a change in the frequency of the pendulum swing by what factor?

    a. 0.33
    b. 1.0
    c. 3.0
    d. 9.0

14. By what factor must one change the weight suspended vertically from a spring coil in order to triple its period of simple harmonic motion?

    a. 1/9
    b. 0.33
    c. 3.0
    d. 9.0

15. By what factor should the length of a simple pendulum be changed if the period of vibration were to be tripled?

    a. 1/9
    b. 0.33
    c. 3.0
    d. 9.0

16. Which one of the following quantities is at a maximum when an object in simple harmonic motion is at its maximum displacement?

    a. speed
    b. acceleration
    c. kinetic energy
    d. frequency

17. The wavelength of a traveling wave is a function of:

    a. frequency
    b. speed
    c. amplitude
    d. Both choices A and B are valid.

18. A tiny spring, with a spring constant of 1.20 N/m, will be stretched to what displacement by a 0.005 0-N force?

    a. 4.2 mm
    b. 6.0 mm
    c. 7.2 mm
    d. 9.4 mm

19. A mass of 0.40 kg, attached to a spring with a spring constant of 80 N/m, is set into simple harmonic motion. What is the magnitude of the acceleration of the mass when at its maximum displacement of 0.10 m from the equilibrium position?

    a. zero
    b. 5 m/s^2
    c. 10 m/s^2
    d. 20 m/s^2

20. A mass of 4.0 kg, resting on a horizontal frictionless surface, is attached on the right to a horizontal spring with spring constant 20 N/m and on the left to a horizontal spring with spring constant 50 N/m. If this system is moved from equilibrium, what is the effective spring constant?

    a. 30 N/m
    b. –30 N/m
    c. 70 N/m
    d. 14 N/m

21. A mass of 0.40 kg, hanging from a spring with a spring constant of 80 N/m, is set into an up-and-down simple harmonic motion. What is the speed of the mass when moving through the equilibrium point? The starting displacement from equilibrium is 0.10 m.

    a. zero
    b. 1.4 m/s
    c. 2.0 m/s
    d. 3.4 m/s

22. A mass of 0.40 kg, hanging from a spring with a spring constant of 80 N/m, is set into an up-and-down simple harmonic motion. What is the speed of the mass when moving through a point at 0.05 m displacement? The starting displacement of the mass is 0.10 m from its equilibrium position.

    a. zero
    b. 1.4 m/s
    c. 1.7 m/s
    d. 1.2 m/s

23. A runaway railroad car, with mass 30×10^4 kg, coasts across a level track at 2.0 m/s when it collides with a spring-loaded bumper at the end of the track. If the spring constant of the bumper is 2.0×10^6 N/m, what is the maximum compression of the spring during the collision? (Assume the collision is elastic.)

    a. 0.77 m
    b. 0.58 m
    c. 0.34 m
    d. 1.07 m

24. I attach a 2.0-kg block to a spring that obeys Hooke's Law and supply 16 J of energy to stretch the spring. I release the block; it oscillates with period 0.30 s. The amplitude is:

    a. 38 cm
    b. 19 cm
    c. 9.5 cm
    d. 4.3 cm

25. A 0.20-kg block rests on a frictionless level surface and is attached to a horizontally aligned spring with a spring constant of 40 N/m. The block is initially displaced 4.0 cm from the equilibrium point and then released to set up a simple harmonic motion. What is the speed of the block when it passes through the equilibrium point?

    a. 2.1 m/s
    b. 1.6 m/s
    c. 1.1 m/s
    d. 0.57 m/s

26. A 0.20-kg block rests on a frictionless level surface and is attached to a horizontally aligned spring with a spring constant of 40 N/m. The block is initially displaced 4.0 cm from the equilibrium point and then released to set up a simple harmonic motion. A frictional force of 0.3 N exists between the block and surface. What is the speed of the block when it passes through the equilibrium point after being released from the 4.0-cm displacement point?

    a. 0.45 m/s
    b. 0.63 m/s
    c. 0.80 m/s
    d. 1.2 m/s

27. The oxygen molecule (O_2) may be regarded as two masses connected by a spring. In vibrational motion, each oxygen atom alternately approaches, then moves away from the center of mass of the system. If each oxygen atom of mass $m = 2.67 \times 10^{-26}$ kg has a vibrational energy of 1.6×10^{-21} J and the effective spring constant is 50 N/m, then what is the amplitude of oscillation of each oxygen atom?

    a. 3.2×10^{-11} m
    b. 1.6×10^{-11} m
    c. 1.1×10^{-11} m
    d. 8.0×10^{-12} m

28. A mass on a spring vibrates in simple harmonic motion at a frequency of 4.0 Hz and an amplitude of 4.0 cm. If a timer is started when its displacement is a maximum (hence $x = 4$ cm when $t = 0$), what is the speed of the mass when $t = 3$ s?

    a. zero
    b. 0.006 5 m/s
    c. 0.015 m/s
    d. 0.024 m/s

29. A mass on a spring vibrates in simple harmonic motion at a frequency of 4.0 Hz and an amplitude of 4.0 cm. If a timer is started when its displacement is a maximum (hence $x = 4$ cm when $t = 0$), what is the acceleration magnitude when $t = 3$ s?

    a. zero
    b. 8.13 m/s^2
    c. 14.3 m/s^2
    d. 25.3 m/s^2

30. A mass on a spring vibrates in simple harmonic motion at a frequency of 4.0 Hz and an amplitude of 8.0 cm. If a timer is started when its displacement is a maximum (hence $x = 8$ cm when $t = 0$), what is the displacement of the mass when $t = 3.7$ s?

    a. zero
    b. 0.025 m
    c. 0.036 m
    d. 0.080 m

31. A mass on a spring vibrates in simple harmonic motion at a frequency of 4.0 Hz and an amplitude of 8.0 cm. If the mass of the object is 0.20 kg, what is the spring constant?

    a. 40 N/m
    b. 87 N/m
    c. 126 N/m
    d. 160 N/m

32. A simple pendulum has a period of 2.0 s. What is the pendulum length? (g = 9.8 m/s^2)

    a. 0.36 m
    b. 0.78 m
    c. 0.99 m
    d. 2.4 m

33. A traveling wave train has wavelength 0.50 m, speed 20 m/s. Find the wave frequency.

    a. 0.025 Hz
    b. 20 Hz
    c. 40 Hz
    d. 10 Hz

34. A musical tone, sounded on a piano, has a frequency of 410 Hz and a wavelength in air of 0.800 m. What is the wave speed?

    a. 170 m/s
    b. 235 m/s
    c. 328 m/s
    d. 587 m/s

35. If a radio wave has speed 3.00×10^8 m/s and frequency 94.7 MHz, what is its wavelength?

    a. 8.78 m
    b. 1.20 m
    c. 2.50 m
    d. 3.17 m

36. Tripling the tension in a guitar string will result in changing the wave speed in the string by what factor?

    a. 0.58
    b. 1.00
    c. 1.73
    d. 3.00

37. Tripling the mass per unit length of a guitar string will result in changing the wave speed in the string by what factor?

    a. 0.58
    b. 1.00
    c. 1.73
    d. 3.00

38. If a wave pulse is reflected from a free boundary, which of the following choices best describes what happens to the reflected pulse?

    a. becomes inverted
    b. remains upright
    c. halved in amplitude
    d. doubled in amplitude

39. An object moving in simple harmonic motion has an amplitude of 0.020 m and a maximum acceleration of 40 m/s^2. What is the frequency of the system?

    a. 0.60 Hz
    b. 51 Hz
    c. 7.1 Hz
    d. 16 Hz

40. Suppose there is an object for which $F = +kx$. What will happen if the object is moved away from equilibrium ($x = 0$) and released?

    a. It will return to the equilibrium position.
    b. It will move further away with constant velocity.
    c. It will move further away with constant acceleration.
    d. It will move further away with increasing acceleration.

41. Which is not an example of approximate simple harmonic motion?

    a. A ball bouncing on the floor.
    b. A child swinging on a swing.
    c. A piano string that has been struck.
    d. A car's radio antenna as it waves back and forth.

42. For a wave on the ocean, the amplitude is:

    a. the distance between crests.
    b. the height difference between a crest and a trough.
    c. one half the height difference between a crest and a trough.
    d. how far the wave goes up on the beach.

43. For a mass suspended on a spring in the vertical direction, the time for one complete oscillation will depend on:

    a. the value for g (the acceleration due to gravity).
    b. the distance the mass was originally pulled down.
    c. the maximum speed of the oscillating mass.
    d. the time doesn’t depend on any of the above.

44. Suppose a 0.3-kg mass on a spring that has been compressed 0.10 m has elastic potential energy of 1 J. What is the spring constant?

    a. 10 N/m
    b. 20 N/m
    c. 200 N/m
    d. 300 N/m

45. Suppose a 0.3-kg mass on a spring that has been compressed 0.10 m has elastic potential energy of 1.0 J. How much further must the spring be compressed to triple the elastic potential energy?

    a. 0.30 m
    b. 0.20 m
    c. 0.17 m
    d. 0.07 m

46. Suppose a 0.30-kg mass on a spring-loaded gun that has been compressed 0.10 m has elastic potential energy of 1.0 J. How high above the spring's equilibrium point can the gun fire the mass if the gun is fired straight up?

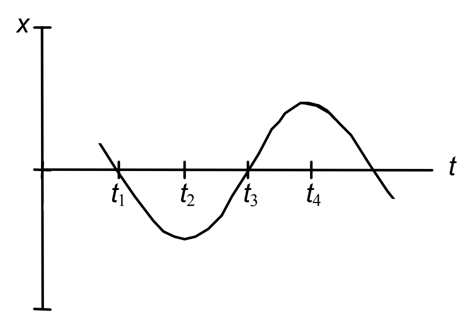
    a. 0.10 m
    b. 0.34 m
    c. 0.24 m
    d. 10 m

47. A simple pendulum of length 1.00 m has a mass of 100 g attached. It is drawn back 30.0° and then released. What is the maximum speed of the mass?

    a. 1.14 m/s
    b. 3.13 m/s
    c. 2.21 m/s
    d. 1.62 m/s

48. Consider the curve $x = A \sin(kt)$, with $A > 0$. At which point on the graph is it possible that $t = 0$?

    a. Point t_1
    b. Point t_2
    c. Point t_3
    d. Point t_4

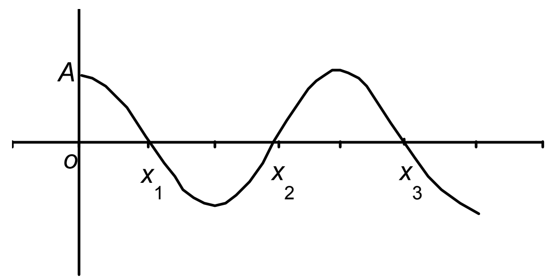


49. As a gust of wind blows across a field of grain, a wave can be seen to move across the field as the tops of the plants sway back and forth. This wave is a

    a. transverse wave
    b. longitudinal wave
    c. polarized wave
    d. interference of waves

50. Consider the curve $f(x) = A\cos(2\pi x/\lambda)$.The wavelength of the wave will be

    a. the distance *0* to *A*.
    b. twice the distance *0* to *A*.
    c. the distance x_2 to x_3.
    d. twice the distance x_2 to x_3.



51. Consider two identical and symmetrical wave pulses on a string. Suppose the first pulse reaches the fixed end of the string and is reflected back and then meets the second pulse. When the two pulses overlap exactly, the superposition principle predicts that the amplitude of the resultant pulses, at that moment, will be what factor times the amplitude of one of the original pulses?

    a. 0
    b. 1
    c. 2
    d. 4

52. An ore car of mass 4 000 kg rolls downhill on tracks from a mine. At the end of the tracks, 10.0 m lower in elevation, is a spring with k = 400 000 N/m. How much is the spring compressed in stopping the ore car? Ignore friction.

    a. 0.14 m
    b. 0.56 m
    c. 1.40 m
    d. 1.96 m

53. Bats can detect small objects such as insects that are of a size approximately that of one wavelength. If bats emit a chirp at a frequency of 60 kHz, and the speed of sound waves in air is 330 m/s, what is the smallest size insect they can detect?

    a. 1.5 mm
    b. 3.5 mm
    c. 5.5 mm
    d. 7.5 mm

54. Waves propagate at 8.0 m/s along a stretched string. The end of the string is vibrated up and down once every 1.5 s. What is the wavelength of the waves that travel along the string?

    a. 3.0 m
    b. 12 m
    c. 6.0 m
    d. 5.3 m

55. A 2.0-m long piano string of mass 10 g is under a tension of 338 N. Find the speed with which a wave travels on this string.

    a. 130 m/s
    b. 260 m/s
    c. 520 m/s
    d. 1 040 m/s

56. Transverse waves travel with a speed of 200 m/s along a taut copper wire that has a diameter of 1.50 mm. What is the tension in the wire? (The density of copper is 8.93 g/cm^3.)

    a. 1 890 N
    b. 1 260 N
    c. 631 N
    d. 315 N

57. An earthquake emits both P-waves and S-waves that travel at different speeds through the Earth. A P-wave travels at 8 000 m/s and an S-wave at 4 000 m/s. If P-waves are received at a seismic station 30.0 s before an S-wave arrives, how far is the station from the earthquake center?

    a. 2 420 km
    b. 1 210 km
    c. 240 km
    d. 120 km

58. The motion of a piston in an automobile engine is nearly simple harmonic. If the 1-kg piston travels back and forth over a total distance of 10.0 cm, what is its maximum speed when the engine is running at 3 000 rpm?

    a. 31.4 m/s
    b. 15.7 m/s
    c. 7.85 m/s
    d. 3.93 m/s

59. A simple pendulum has a mass of 0.25 kg and a length of 1.0 m. It is displaced through an angle of 30° and then released. After a time, the maximum angle of swing is only 10°. How much energy has been lost to friction?

    a. 0.29 J
    b. 0.65 J
    c. 0.80 J
    d. 1.0 J

60. A car with bad shocks bounces up and down with a period of 1.50 s after hitting a bump. The car has a mass of 1 500 kg and is supported by four springs of force constant *k*. What is *k* for each spring?

    a. 6 580 N/m
    b. 5 850 N/m
    c. 4 440 N/m
    d. 3 630 N/m

61. Which of the following is an example of a longitudinal wave?

    a. sound wave in air
    b. wave traveling in a string
    c. both a and b
    d. neither a nor b

62. For a wave traveling in a string, by what factor would the tension need to be increased to double the wave speed?

    a. 1.4
    b. 2.0
    c. 4.0
    d. 16

63. A wave is traveling in a string at 60 m/s. When the tension is then increased 20%, what will be the resulting wave speed:

    a. also 60 m/s
    b. 66 m/s
    c. 72 m/s
    d. 55 m/s

64. A wave travels in a string at 60 m/s. A second string of 20% greater linear density has the same tension applied as in the first string. What will be the resulting wave speed in the second string?

    a. also 60 m/s
    b. 66 m/s
    c. 72 m/s
    d. 55 m/s

65. Three identical springs each have the same spring constant k. If these three springs are attached end to end forming a spring three times the length of one of the original springs, what will be the spring constant of the combination?

    a. k
    b. 3 k
    c. $k/3$
    d. 1.73 k

66. A string is strung horizontally with a fixed tension. A wave of frequency 100 Hz is sent along the string, and it has a wave speed of 50.0 m/s. Then a second wave, one of frequency 200 Hz, is sent along the string. What is the wave speed of the second wave?

    a. 25.0 m/s
    b. 50.0 m/s
    c. 70.7 m/s
    d. 100 m/s

CHAPTER 13 - ANSWERS

#	Ans	Difficulty	#	Ans	Difficulty
1.	B	1	34.	C	1
2.	D	1	35.	D	1
3.	C	1	36.	C	2
4.	C	2	37.	A	2
5.	B	2	38.	B	1
6.	A	1	39.	C	2
7.	C	2	40.	D	2
8.	B	1	41.	A	1
9.	C	2	42.	C	1
10.	D	1	43.	D	2
11.	C	1	44.	C	2
12.	C	1	45.	D	2
13.	B	2	46.	C	2
14.	D	2	47.	D	2
15.	D	2	48.	C	1
16.	B	1	49.	B	1
17.	D	1	50.	D	1
18.	A	1	51.	A	2
19.	D	1	52.	C	2
20.	C	3	53.	C	2
21.	B	2	54.	B	2
22.	D	2	55.	B	2
23.	A	2	56.	C	3
24.	B	3	57.	C	2
25.	D	2	58.	B	3
26.	A	3	59.	A	3
27.	D	2	60.	A	2
28.	A	2	61.	A	1
29.	D	2	62.	C	2
30.	B	2	63.	B	3
31.	C	2	64.	D	3
32.	C	2	65.	C	2
33.	C	1	66.	B	2