CHAPTER 11: Vibrations and Waves

Problems

11–1 to 11–3 Simple Harmonic Motion

2. (I) An elastic cord is 65 cm long when a weight of 75 N hangs from it but is 85 cm long when a weight of 180 N hangs from it. What is the “spring” constant *k* of this elastic cord?

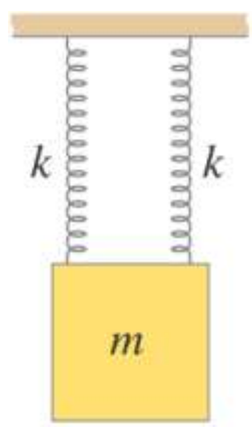
4. (II) A fisherman’s scale stretches 3.6 cm when a 2.7-kg fish hangs from it. (*a*) What is the spring stiffness constant and (*b*) what will be the amplitude and frequency of vibration if the fish is pulled down 2.5 cm more and released so that it vibrates up and down?

8. (II) A mass *m* at the end of a spring vibrates with a frequency of 0.88 Hz. When an additional 680-g mass is added to *m*, the frequency is 0.60 Hz. What is the value of *m*?

9. (II) A 0.60-kg mass at the end of a spring vibrates 3.0 times per second with an amplitude of 0.13 m. Determine (*a*) the velocity when it passes the equilibrium point, (*b*) the velocity when it is 0.10 m from equilibrium, (*c*) the total energy of the system, and (*d*) the equation describing the motion of the mass, assuming that *x* was a maximum at $t = 0$.

16. (II) A 0.60-kg mass vibrates according to the equation $x = 0.45 \cos 6.40t$, where *x* is in meters and *t* is in seconds. Determine (*a*) the amplitude, (*b*) the frequency, (*c*) the total energy, and (*d*) the kinetic energy and potential energies when $x = 0.30\,\text{m}$.

20. (II) A block of mass *m* is supported by two identical parallel vertical springs, each with spring stiffness constant *k* (Fig. 11–49). What will be the frequency of vibration?



26. (III) A 25.0-g bullet strikes a 0.600-kg block attached to a fixed horizontal spring whose spring stiffness constant is $7.70 \times 10^3\ \text{N/m}$. The block is set into vibration with an amplitude of 21.5 cm. What was the speed of the bullet before impact if the bullet and block move together after impact?

11–4 Simple Pendulum

30. (I) A pendulum has a period of 0.80 s on Earth. What is its period on Mars, where the acceleration of gravity is about 0.37 that on Earth?

35. (III) A clock pendulum oscillates at a frequency of 2.5 Hz. At $t = 0$, it is released from rest starting at an angle of 15º to the vertical. Ignoring friction, what will be the position (angle) of the pendulum at (*a*) $t = 0.25\,\text{s}$, (*b*) $t = 1.60\,\text{s}$, and (*c*) $t = 500\,\text{s}$? [*Hint*: Do not confuse the angle of swing θ of the pendulum with the angle that appears as the argument of the cosine.]

11–7 and 11–8 Waves

41. (II) A cord of mass 0.65 kg is stretched between two supports 28 m apart. If the tension in the cord is 150 N, how long will it take a pulse to travel from one support to the other?

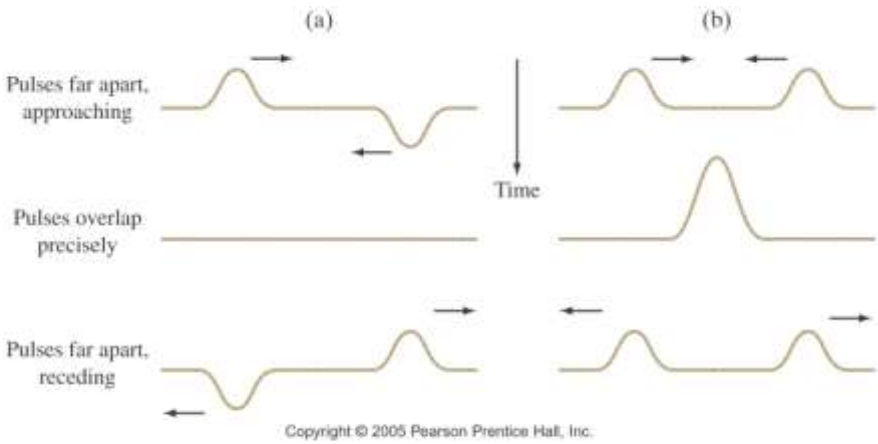
42. (II) A ski gondola is connected to the top of a hill by a steel cable of length 620 m and diameter 1.5 cm. As the gondola comes to the end of its run, it bumps into the terminal and sends a wave pulse along the cable. It is observed that it took 16 s for the pulse to return. (*a*) What is the speed of the pulse? (*b*) What is the tension in the cable?

11–9 Wave Energy

47. (II) The intensity of an earthquake wave passing through the Earth is measured to be $2.0\times10^{6}\ \text{J/m}^{2}$. at a distance of 48 km from the source. (*a*) What was its intensity when it passed a point only 1.0 km from the source? (*b*) At what rate did energy pass through an area of $5.0\,\text{m}^{2}$ at 1.0 km?

11–12 Interference

51. (I) The two pulses shown in Fig. 11–52 are moving toward each other. (*a*) Sketch the shape of the string at the moment they directly overlap. (*b*) Sketch the shape of the string a few moments later. (*c*) In Fig. 11–36a, at the moment the pulses pass each other, the string is straight. What has happened to the energy at this moment?



11–13 Standing Waves; Resonance

56. (II) If two successive overtones of a vibrating string are 280 Hz and 350 Hz, what is the frequency of the fundamental?

59. (II) One end of a horizontal string is attached to a small-amplitude mechanical 60-Hz vibrator. The string's mass per unit length is $3.9\times10^{-4}\ \mathrm{kg/m}$. The string passes over a pulley, a distance $L = 1.50\ \mathrm{m}$ away, and weights are hung from this end, Fig. 11–53. What mass *m* must be hung from this end of the string to produce (*a*) one loop, (*b*) two loops, and (*c*) five loops of a standing wave? Assume the string at the vibrator is a node, which is nearly true.