1. A clown is rocking on a rocking chair in the dark. His glowing red nose moves back and forth a distance of 0.42 m exactly 30 times a minute, in a simple harmonic motion.

   a. What is the amplitude of this motion?

   b. What is the period of this motion?

   c. What is the frequency of this motion?

   d. The top of the clown’s hat contains a small light bulb that shines a narrow light beam. The beam makes a spot on the wall that goes back and forth between two dots placed 1.00 m apart as the clown rocks. What are the amplitude, period, and frequency of the spot’s motion?

2. A 5.00 kg block hung on a spring causes a 10.0 cm elongation of the spring.

   a. What is the restoring force exerted on the block by the spring?

   b. What is the spring constant?

   c. What force is required to stretch this spring 8.50 cm horizontally?

   d. What will the spring’s elongation be when pulled by a force of 77.7 N?
1. A spring-mass system vibrates exactly 10 times per second. Find its period and its frequency.

2. A pendulum swings with a period of 0.20 seconds.
   a. What is its frequency?
   b. How many times does it pass the lowest point on its path in 1.0 second? in 7.0 seconds?

3. A spring-mass system completes 20.0 vibrations in 5.0 seconds, with a 2.0 cm amplitude.
   a. Find its frequency and its period.
   b. The same mass is pulled 5.0 cm away from the equilibrium position, then released. What will the period, the frequency, and the amplitude be?

4. A pendulum completes 30.0 oscillations per minute. Find its frequency, its period, and its length.

5. A spring has a $2.000 \times 10^3$ N/m spring constant.
   a. What mass will make it oscillate 5.0 times per second? 10.0 times per second?
   b. You want the mass-spring system to operate at a higher frequency. Should you increase or decrease the mass?
1. Radio waves travel at the speed of light ($3.00 \times 10^8$ m/s). An amateur radio system can receive radio signals at frequencies between 8.00 MHz and 1.20 MHz. What is the range of the wavelengths this system can receive?

2. Graph (a) below describes the density versus time of a pressure wave traveling through an elastic medium. Graph (b) describes the density versus distance for the same wave.

(a) Time (s) | (b) Distance (m)
---|---
0.00 | 0.00
0.01 | 20.00
0.02 | 40.00
0.03 | 60.00
0.04 | 80.00

a. Use graph (a) to find the period of oscillation of this wave and its frequency.

b. Use graph (b) to find the wavelength and the speed.
1. A wave of 0.25 cm amplitude traveling on a string interferes with a wave of 0.35 cm amplitude that was generated at the other end with the same frequency. Their maxima occur at the same points on the string.

   a. Sketch a graph of each individual wave traveling through the same area of the string for one period on the grids labeled (a) and (b).

   b. Sketch a graph of the wave shape resulting from interference on the grid labeled (c).

2. A 15.0 m long string is tied at one end (point B) and shaken repeatedly at the other end (point A) with a 2.00 Hz frequency. This generates waves that travel at 20.0 m/s in the string.

   a. How long does it take for each pulse to travel from A to B and return to A?

   b. What is the wavelength of these waves?

   c. Are the pulses inverted when reflected from B?
1. A pendulum with a mass of 0.100 kg was released. The string made a 7.0° angle with the vertical. The bob of the pendulum returns to its lowest point every 0.10 s.

   a. What is its period? What is its frequency?

   b. The pendulum is replaced by one with a mass of 0.300 kg and set to swing with a 15° angle. Do the following quantities increase, decrease, or remain the same?

      period ________________________________
      frequency ________________________________
      total energy ________________________________
      speed at the lowest point ________________________________

2. A narrow, flat steel rod is anchored at its lower end, with a 0.500 kg ball welded to the top end. A force of 6.00 N is required to hold the ball 10.0 cm away from its central position.

   If this arrangement is modeled as an oscillating horizontal mass-spring system, vibrating with a simple harmonic motion, find

   a. the force constant, \( k \), of the spring.

   b. the period and frequency of the oscillations.

3. Find the acceleration due to gravity at a place where a simple pendulum 0.150 m long completes \( 1.00 \times 10^2 \) oscillations in \( 3.00 \times 10^2 \) seconds. Could this place be on Earth?
4. Consider the first two cycles of a pendulum swinging from position $A$ with a period of 2.00 s.

a. At which times is the bob found at positions $A$, $B$, and $C$ during the first two cycles?

b. At which times and locations is gravitational potential energy at a maximum? At which times is kinetic energy at a maximum?

c. At which times and locations is the velocity at a maximum? the restoring force? the acceleration?

5. The frequency of a pressure wave is $1.00 \times 10^2$ Hz. Its wavelength is 3.00 m. Find the speed of wave propagation.

6. A pressure wave of 0.50 m wavelength propagates through a 3.00 m long coil spring at a speed of 2.00 m/s. How long does it take for the wave to travel from one end of the coil to the other? How many wavelengths fit in the coil?