

Vibrations and Waves

Problem B**SIMPLE HARMONIC MOTION OF A SIMPLE PENDULUM
PROBLEM**

Two friends in France use a pendulum hanging from the world's highest railroad bridge to exchange messages across a river. One friend attaches a letter to the end of the pendulum and releases it so that the pendulum swings across the river to the other friend. The bridge is 130.0 m above the river. How much time is needed for the letter to make one swing across the river? Assume the river is 16.0 m wide.

SOLUTION

Given: $L = 130.0 \text{ m}$ $a_g = g = 9.81 \text{ m/s}^2$

Unknown: $t = \text{time required for pendulum to cross river} = T/2 = ?$

Use the equation for the period of a simple pendulum. Then divide the period by two to find the time of one swing across the river. The width of the river is not needed to calculate the answer, but it must be small compared to the length of the pendulum in order to use the equations for simple harmonic motion.

$$T = 2\pi\sqrt{\frac{L}{a_g}} = 2\pi\sqrt{\frac{130.0 \text{ m}}{9.81 \text{ m/s}^2}} = 22.9 \text{ s}$$

$$t = \frac{T}{2} = \frac{22.9 \text{ s}}{2} = 11.4 \text{ s}$$

ADDITIONAL PRACTICE

1. An earthworm found in Africa was 6.7 m long. If this worm were a simple pendulum, what would its period be?
2. The shortest venomous snake, the spotted dwarf adder, has an average length of 20.0 cm. Suppose this snake hangs by its tail from a branch and holds a heavy prey with its jaws, simulating a pendulum with a length of 15.0 cm. How long will it take the snake to swing through one period?
3. If bamboo, which can grow 88 cm in a day, is grown for four days and then used to make a simple pendulum, what will be the pendulum's period?
4. A simple pendulum with a frequency of $6.4 \times 10^{-2} \text{ Hz}$ is as long as the largest known specimen of Pacific giant seaweed. What is this length?
5. The deepest permafrost is found in Siberia, Russia. Suppose a shaft is drilled to the bottom of the frozen layer, and a simple pendulum with a length equal to the depth of the shaft oscillates within the shaft. In 1.00 h the pendulum makes 48 oscillations. Find the depth of the permafrost.
6. Ganymede, the largest of Jupiter's moons, is also the largest satellite in the solar system. Find the acceleration of gravity on Ganymede if a simple pendulum with a length of 1.00 m has a period of 10.5 s.