PRACTICE B

Simple Harmonic Motion of a Simple Pendulum

1. If the period of the pendulum in the preceding sample problem were 24 s, how tall would the tower be?
2. You are designing a pendulum clock to have a period of 1.0 s. How long should the pendulum be?
3. A trapeze artist swings in simple harmonic motion with a period of 3.8 s. Calculate the length of the cables supporting the trapeze.
4. Calculate the period and frequency of a 3.500 m long pendulum at the following locations:
   a. the North Pole, where $a_g = 9.832\ \text{m/s}^2$
   b. Chicago, where $a_g = 9.803\ \text{m/s}^2$
   c. Jakarta, Indonesia, where $a_g = 9.782\ \text{m/s}^2$

Period of a mass-spring system depends on mass and spring constant

Now consider the period of a mass-spring system. In this case, according to Hooke's law, the restoring force acting on the mass is determined by the displacement of the mass and by the spring constant ($F_{elastic} = -kx$). The magnitude of the mass does not affect the restoring force. So, unlike in the case of the pendulum, in which a heavier mass increased both the force on the bob and the bob's inertia, a heavier mass attached to a spring increases inertia without providing a compensating increase in force. Because of this increase in inertia, a heavy mass has a smaller acceleration than a light mass has. Thus, a heavy mass will take more time to complete one cycle of motion. In other words, the heavy mass has a greater period. Thus, as mass increases, the period of vibration increases when there is no compensating increase in force.

Why it Matters

Conceptual Challenge

1. Pendulum on the Moon

The free-fall acceleration on the surface of the moon is approximately one-sixth of the free-fall acceleration on the surface of Earth. Compare the period of a pendulum on the moon with that of an identical pendulum set in motion on Earth.

2. Pendulum Clocks

Why is a wound mainspring often used to provide energy to a pendulum clock in order to prevent the amplitude of the pendulum from decreasing?