

Vibrations and Waves

Problem C**SIMPLE HARMONIC MOTION OF A MASS-SPRING SYSTEM****PROBLEM**

A large pearl was found in the Philippines in 1934. Suppose the pearl is placed on a spring scale whose spring constant is 362 N/m. If the scale's platform oscillates with a frequency of 1.20 Hz, what is the mass of the pearl?

SOLUTION

Given: $k = 362 \text{ N/m}$ $f = 1.20 \text{ Hz}$

Unknown: $m = ?$

Use the equation for the period of a mass-spring system. Then express the period in terms of frequency ($T = 1/f$).

$$T = 2\pi\sqrt{\frac{m}{k}} = \frac{1}{f}$$

$$m = \frac{k}{4\pi^2 f^2} = \frac{362 \text{ N/m}}{4\pi^2 (1.20 \text{ Hz})^2} = 6.37 \text{ kg}$$

ADDITIONAL PRACTICE

- The hummingbird makes a humming sound with its wings, which beat with a frequency of 90.0 Hz. Suppose a mass is attached to a spring with a spring constant of $2.50 \times 10^2 \text{ N/m}$. How large is the mass if its oscillation frequency is 3.00×10^{-2} times that of a hummingbird's wings?
- In 1986, a $35 \times 10^3 \text{ kg}$ watch was demonstrated in Canada. Suppose this watch is placed on a huge trailer that rests on a lightweight platform, and that oscillations equal to 0.71 Hz are induced. Find the trailer's mass if the platform acts like a spring scale with a spring constant equal to $1.0 \times 10^6 \text{ N/m}$.
- A double coconut can grow for 10 years and have a mass of 20.0 kg. If a 20.0 kg double coconut oscillates on a spring 42.7 times each minute, what is the spring constant of the spring?
- The monument commemorating the Battle of San Jacinto in Texas stands almost $2.00 \times 10^2 \text{ m}$ and is topped by a $2.00 \times 10^5 \text{ kg}$ star. Imagine that a $2.00 \times 10^5 \text{ kg}$ mass is placed on a spring platform. The platform requires 0.80 s to oscillate from the top to the bottom positions. What is the spring constant of the spring supporting the platform?
- Suppose a 2662 kg giant seal is placed on a scale and produces a 20.0 cm compression. If the seal and spring system are set into simple harmonic motion, what is the period of the oscillations?
- On average, a newborn human's mass is just over 3.0 kg. However, in 1955, a 10.2 kg boy was born in Italy. Suppose this baby is placed in a crib hanging from springs with a total spring constant of $2.60 \times 10^2 \text{ N/m}$. If the cradle is rocked with simple harmonic motion, what is its period?