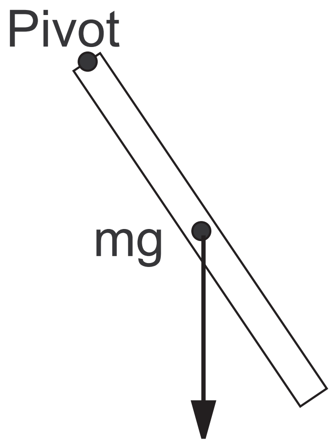
Chapter 13   Problem 45 [†]



Given
$t = 5974\ cycles$
$m = 8.65\ g = 8.65 \times 10^{-3}\ kg$
$L = 18.8\ cm = 0.188\ m$

Solution
Find the length of the lecture.

The pencil is a physical pendulum and has a natural frequency determined by the equation

$$\omega = \sqrt{\frac{mgl}{I}} \tag{1}$$

Assuming the pencil has a uniform distribution of mass, $l = L/2$. The moment of inertia of the pencil is that of a rod rotated about one end. From Table 10.2 the moment of inertia is

$$I = \tfrac{1}{3}mL^2$$

Substituting these relationships into equation 1 gives

$$\omega = \sqrt{\frac{mgl}{\frac{1}{3}mL^2}} = \sqrt{\frac{mgL/2}{\frac{1}{3}mL^2}} = \sqrt{\frac{3g}{2L}}$$

The time period is

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\frac{3g}{2L}}} = 2\pi\sqrt{\frac{2L}{3g}} = 2\pi\sqrt{\frac{2(0.188\ m)}{3(9.8\ m/s^2)}}$$

$$T = 0.7106\ s$$

Since there are 5974 time periods during this lecture, the lecture must be

$$t = (5974\ cycles)(0.7106\ s/cycle) = 4245\ s$$

$$t = 70.8\ min$$

[†]Problem from Essential University Physics, Wolfson