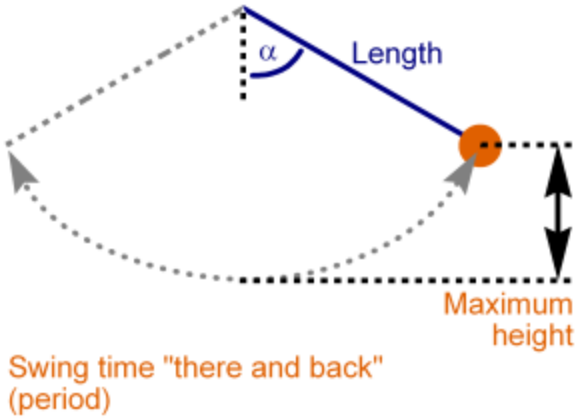
Answer on Question #45369, Physics, Mechanics | Kinematics | Dynamics

A 100 g mass on a 1.0 m long string is pulled 8.0° to one side and released. How long does it take for the pendulum to reach 4.0° on the opposite side?

Solution:

The motion of a simple pendulum is like simple harmonic motion.



For small amplitudes, the period (swing time "there and back") of such a pendulum can be approximated by:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

where L is the length of the pendulum and g = 9.81 m/s^2.

Thus, in our case

$$T = 2 \cdot 3.14\sqrt{\frac{1.0}{9.81}} = 2 \text{ s}$$

The time to reach equilibrium position from 8.0° is

$$t_0 = \frac{T}{4} = 0.5 \text{ s}$$

The motion of a simple pendulum is like simple harmonic motion in that the equation for the angular displacement is

$$\theta = \theta_{max} \sin\sqrt{\frac{g}{L}}t$$

The time to reach 4.0° from equilibrium position is

$$t_1 = \sqrt{\frac{L}{g}}\sin^{-1}\left(\frac{\theta}{\theta_{max}}\right) = \sqrt{\frac{1.0}{9.81}} \cdot \sin^{-1}\left(\frac{4}{8}\right) = 0.167 \approx 0.17 \text{ s}.$$

Thus, the time to reach 4.0° on the opposite side is

$$t = t_0 + t_1 = 0.5 + 0.17 = 0.67 \text{ s}.$$

Answer: $t = 0.67$ s.