#38 Pendula Post-class

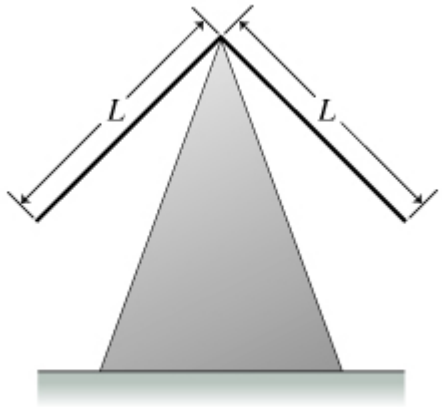
Due: 11:00am on Wednesday, November 21, 2012

Note: You will receive no credit for late submissions. To learn more, read your instructor's Grading Policy

Oscillations of a Balanced Object

Two identical thin rods, each of mass m and length L, are joined at right angles to form an L-shaped object. This object is balanced on top of a sharp edge . If the object is displaced slightly, it oscillates.

Assume that the magnitude of the acceleration due to gravity is g.



Part A

Find ω, the angular frequency of oscillation of the object.

Your answer for the angular frequency may contain the given variables m and L as well as g.

Hint 1. Determine the angular frequency of a physical pendulum

This L-shaped object is an example of a physical pendulum. What is ω_p, the angular frequency of small-amplitude oscillations for a physical pendulum?

Answer in terms of d, the distance between the center of mass and the pivot point, I, the moment of inertia of the object, and other

given variables.

ANSWER:

$\omega_p = \sqrt{\frac{2mgd}{I}}$

Hint 2. Calculate d

What is the distance d between the pivot point (the corner of the "L") and the center of mass of the object?

Express your answer in terms of L.

Hint 1. How to look at the problem

First, think about where the center of mass of each of the two rods is located. Because of symmetry, the center of mass of the object is located in the middle of a line connecting the centers of mass of the two rods.

ANSWER:

$d = \frac{\frac{L}{2}}{\sqrt{2}}$

Hint 3. Find the moment of inertia

What is I, the moment of inertia of this L-shaped pendulum measured about the pivot point?

Express your answer in terms of m and L

Hint 1. Consider a simpler problem

What is I_{rod}, the moment of inertia of a single rod rotating around an axis at its end?

Express your answer in terms of the mass of the rod m and the length of the rod L.

ANSWER:

$I_{\text{rod}} = \frac{1}{3}m(L)^2$

ANSWER:

$I = \frac{2}{3}mL^2$

ANSWER:

$\omega = \sqrt{\left(\frac{3}{2}\right)\frac{g}{L}\frac{1}{2}\sqrt{2}}$

Correct

± Gravity on Another Planet

After landing on an unfamiliar planet, a space explorer constructs a simple pendulum of length 48.0 cm . The explorer finds that the pendulum completes 101 full swing cycles in a time of 127 s .

Part A

What is the magnitude of the gravitational acceleration on this planet?

Express your answer in meters per second per second.

Hint 1. How to approach the problem

Calculate the period of the pendulum, and use this to calculate the magnitude of the gravitational acceleration on the planet.

Hint 2. Calculate the period

Calculate the period T of the pendulum.

Express your answer in seconds.

ANSWER:

T = 1.26 s

Hint 3. Equation for the period

The period of a simple pendulum is given by the equation $T = 2\pi\sqrt{L/g_{\text{planet}}}$, where L is the length of the pendulum and g_{planet} is the magnitude of the gravitational acceleration on the planet.

ANSWER:

g_{planet} = 12.0 m/s^2

Correct

Exercise 14.45

You pull a simple pendulum of length 0.255 m to the side through an angle of $3.50°$ and release it.

Part A

How much time does it take the pendulum bob to reach its highest speed?

Take free fall acceleration to be 9.80 $\mathrm{m/s^2}$.

ANSWER:

t = 0.253 s

Correct

Part B

How much time does it take if the pendulum is released at an angle of $1.75°$ instead of $3.50°$?

ANSWER:

t = 0.253 s

Correct

Exercise 14.56

A holiday ornament in the shape of a hollow sphere with mass $2.0\times10^{-2}\,\mathrm{kg}$ and radius $4.5\times10^{-2}\,\mathrm{m}$ is hung from a tree limb by a small loop of wire attached to the surface of the sphere. If the ornament is displaced a small distance and released, it swings back and forth as a physical pendulum.

Part A

Calculate its period. (You can ignore friction at the pivot. The moment of inertia of the sphere about the pivot at the tree limb is $5MR^2/3$.)

Take the free fall acceleration to be 9.80$\mathrm{m/s^2}$. Express your answer using two significant figures.

ANSWER:

T = 0.55 s

Correct

Score Summary:

Your score on this assignment is 101%.
You received 40.4 out of a possible total of 40 points.