Welcome back, Bill Wiecking

>>Working in AP Physics B (SC651)

Current Course
Course Home
Edit Course Info
Syllabus/Assignments
Grades
Student administration
Instructor administration

My Courses
AP Physics B
AP Physics C
Honors Physics
ePhysicsC
ePhysicsE

My Account
Change password
Manage courses

Homework Home
Logout

ch 15 SHM

Chapter 15: Oscillations and Harmonic Motion

Conceptual problems

15.C.1 (5.00) A bouncing ball returns to the same height each time. Is this an example of simple harmonic motion? Explain your answer.

○ Yes ○ No

15.C.2 (5.00) Consider the displacement, velocity, and acceleration vectors of an object moving in SHM. Which pair of these vectors always point in opposite directions?

☐ Displacement
☐ Velocity
☐ Acceleration

15.C.3 (5.00) In old pocket watches, a balance wheel acts as a torsional pendulum, rotating with a fixed period. If a pocket watch is running slow, the period of the balance wheel is too long. Would you add or remove mass from the outer edge of the balance wheel to correct it?

○ Remove mass
○ Add mass

15.C.4 (7.00) For a physical pendulum, what happens to the period as the pivot point gets very close to the center of mass? Justify your answer using the equation for the period of a physical pendulum.

15.C.5 (5.00) What are the units for the damping coefficient constant?

○ N/m
○ kg/s
○ kg/s^2

Section 0: Introduction

15.0.1 **(5.00)** Using the simulation in the interactive problem in Section 15.0, answer the following questions. (a) If you increase the amplitude, does the period increase, decrease, or stay the same? (b) What does the shape of the curve look like?

(a)
(b)

Section 3: Period and frequency

15.3.1 **(5.00)** Consider the minute hand on a clock. (a) Compute the frequency of its motion in cycles per second. State your answer to three significant digits. (b) Do the same for the hour hand.

(a) Hz
(b) Hz

15.3.2 **(5.00)** A graph of the displacement of an object moving in SHM is shown. Determine the frequency of the object's motion. (Assume you can read the graph points to two significant figures.)

Hz

Section 4: Angular frequency

15.4.1 **(5.00)** What is the angular frequency of the second hand on a clock? (State your answer using three significant figures.)

rad/s

Section 5: Amplitude

15.5.1 **(5.00)** What is the amplitude of an object moving in SHM if its displacement in meters is described by:

(a) $x(t) = 5\cos(t - \pi/2)$
(b) $x(t) = 4\cos(2\pi t) - \cos(2\pi t)$
(c) $x(t) = 4\cos^2(\pi t) - 4\sin^2(\pi t)$

(a) m
(b) m

(c) m

15.5.2 **(5.00)** The displacement of an object moving in SHM is graphed as shown. What is its amplitude of motion? (Assume you can read the graph points to two significant figures.)

m

15.5.3 **(5.00)** An object moving in SHM has an amplitude of 3.5 m and a period of 4.0 s. Which of the following equations could describe its displacement over time?

- $x(t) = 2.0 \cos (3.5t)$
- $x(t) = 3.5 \cos (t + 2.0)$
- $x(t) = 3.5 \cos ((\pi/2)t + 2.0)$
- $x(t) = 3.5 \cos (2.0\pi t)$

15.5.4 **(5.00)** The displacement of an object in meters is described by the function $x(t) = 4.4 \cos (7.4\pi t + \pi/2)$ where t is measured in seconds. What are the (a) amplitude, (b) frequency, (c) period of the object's motion?

(a) m

(b) Hz

(c) s

Section 6: Interactive problem: match the curve

15.6.1 **(5.00)** Using the simulation in the interactive problem in Section 15.6, what (a) amplitude and (b) period should be used to match the graph?

(a) m

(b) s

Section 7: Phase and phase constant

15.7.1 **(5.00)** The displacement graph of an object moving in SHM is shown. Which of the following describe the phase j for the object's motion?

- 0< j < π/2
- π/2 < j < π
- π < j < 3π/2
- 3π/2 < j < 2π

Section 8: Sample problem: graph equation

15.8.1 **(5.00)** An object moving in SHM has its most negative displacement at time t = 0 s. If the amplitude of the motion is 7.8 m and the angular frequency is 5.6 rad/s, which of these equations describes the motion?

- $x(t) = 7.8 \cos (5.6t)$
- $x(t) = 7.8 \cos (5.6\pi t)$
- $x(t) = 7.8 \cos (5.6t + \pi/2)$
- $x(t) = 7.8 \cos (5.6t + \pi)$

15.8.3 **(5.00)** An object moving in SHM has maximum (positive) displacement at time t = 0 s. If the amplitude of the motion is 2.1 m and the period is 6.4 s, what is the displacement at time t = 2.8 s?

_____ m

Section 9: Velocity

15.9.1 **(5.00)** In a car engine, a piston moves in SHM with an amplitude of *A* m. The engine is running at 2400 rpm, which is an angular frequency of 251 rad/s. What is the maximum speed of the piston?

_____ m/s

15.9.2 **(7.00)** The equation for the displacement in meters of an object moving in SHM is $x(t) = 1.50 \cos (4.20t)$ where t is in seconds. (a) What is the maximum speed of the object? (b) At what time does it **first** reach the maximum **speed**?

(a) _____ m/s

(b) _____ s

Section 11: Acceleration

15.11.1 **(5.00)** A ball on a spring moves in SHM. At time t = 0 s, its displacement is 0.50 m and its acceleration is −0.72 m/s^2. The phase constant for its motion is 0.84 rad. What is the ball's displacement at t = 3.4 s?

m

Section 13: Summary of simple harmonic motion

15.13.1 (5.00) A particle moves in SHM, with displacement defined by the equation $x(t) = 0.0018 \cos(2\pi t)$, where x is measured in meters and t in seconds. (a) What is the particle's maximum speed? (b) What is its maximum acceleration? (c) What is its acceleration when $x = 0.0013$ m?

(a) m/s

(b) m/s^2

(c) m/s^2

15.13.2 (5.00) A block attached to a spring moves in SHM on a frictionless surface. The acceleration of the block is given by the equation $a(t) = -3.6\ x(t)$, where x is measured in meters and t in seconds. (a) What is the angular frequency of the block's motion? (b) When the block has maximum acceleration, its displacement is −2.3 m. What is the amplitude of the block's motion?

(a) rad/s

(b) m

Section 14: Simple harmonic motion and uniform circular motion

15.14.1 (5.00) A particle moves in a circle of radius 0.45 m at a constant speed, completing one revolution every 1.2 s. The particle is on the positive x axis at time $t = 0$ s. Write an equation for the y displacement of the particle as a function of time.

- $y(t) = 0.45 \cos((2\pi/1.2)t)$
- $y(t) = 0.45 \sin((2\pi/1.2)t)$
- $y(t) = 0.45 \cos(1.2t)$
- $y(t) = 0.45 \sin(1.2t)$

Section 15: Period, spring constant, and mass

15.15.1 (5.00) A block with mass 0.55 kg on a frictionless surface is attached to a spring with spring constant *k* N/m. The block is pulled from the equilibrium position and released. What is the period of the system?

s

15.15.2 (5.00) A 0.683 kg mass moves in SHM at the end of a spring. It takes 1.41 s to move from the position with the spring fully extended to the position with the spring fully compressed. What is the spring constant?

N/m

15.15.4 (7.00) A 1.20 kg mass is attached to the end of a spring of unknown spring constant. The spring is compressed a distance of 0.300 meters, and when it is released, the mass oscillates horizontally on a frictionless surface. When

the mass is 0.100 m from equilibrium, it is seen to be moving at a speed of 2.00 m/s. (a) What is the amplitude of the motion? (b) Find the spring constant, *k*. (c) What is the maximum speed of the mass?

(a) _____ m

(b) _____ N/m

(c) _____ m/s

Section 16: Interactive problem: match the curve again

15.16.1 **(5.00)** A block at the end of a horizontal spring moves in SHM as shown by the graph. The mass of the block is 0.38 kg. Assume you can read the graph points to two significant figures. (a) What is the spring constant? (b) What is the block's maximum acceleration?

(a) _____ N/m

(b) _____ m/s^2

Section 18: Work and the potential energy of a spring

15.18.1 **(5.00)** A motor pulls a spring 0.73 m away from its equilibrium position, doing 3.5 J of work on the spring in the process. What is the spring constant?

_____ N/m

Section 19: Total energy

15.19.1 **(5.00)** A block with mass 0.67 kg, resting on a horizontal frictionless surface, is attached to the end of a spring with spring constant *k* N/m. The block is released from rest at a distance 0.035 m from the equilibrium position. What is the total energy of the system?

_____ J

Section 20: Interactive checkpoint: spring energy and period

15.20.1 **(5.00)** A 4.6 kg block is attached to a spring with a spring constant of k = 6.3 N/m. It oscillates in SHM with an amplitude of 1.8 m. What is the maximum speed of the block?

_____ m/s

Section 21: Sample problem: falling block on a spring

15.21.1 **(5.00)** A 2.7 kg block hangs from a vertical spring whose upper end is fixed. The spring constant is 93 N/m. Define the *PE* of the system to be zero when the block is at the equilibrium position. The block is then set into motion and oscillates with an amplitude of 3.8 m. When the block is at its lowest position, what is the potential energy stored in the spring?

J

Section 22: A torsional pendulum

15.22.1 **(5.00)** An irregularly-shaped 1.4 kg object is suspended from a wire with a known torsion constant of 0.49 N·m/rad. The object's period is *T* seconds. What is the object's moment of inertia for rotations about this axis?

$kg \cdot m^2$

Section 23: A simple pendulum

15.23.1 **(5.00)** You need to know the height of a room, but you have no tape measure. You fasten one end of a string to the ceiling of the room, and tie a small rock at the other end so it almost touches the floor. You start this simple pendulum swinging slightly, and measure its period, which is *T* seconds. How tall is the room?

m

15.23.3 **(7.00)** It is the year 2305 and the tallest structure in the world has an insane height of 3.19×10^6 m above the surface of the Earth. A pendulum clock that keeps perfect time on the surface of the Earth is placed at the top of the tower. How long does the clock take to register one elapsed hour? The radius of the Earth is 6.38×10^6 m and its mass is 5.97×10^{24} kg.

minutes

Section 24: Interactive problem: a pendulum

15.24.1 **(5.00)** Using the simulation in the interactive problem in Section 15.24, what is the length of string needed to achieve the desired period for the pendulum?

m

Section 25: Period of a physical pendulum

15.25.1 **(7.00)** A flat circular disk with diameter 0.36 m and mass 0.43 kg is suspended so it can swing freely from a pivot 0.12 m from its center. (The axis of rotation is perpendicular to the plane of the disk.) What is its period of oscillation?

s

Section 26: Sample problem: meter-stick pendulum

15.26.1 **(5.00)** A thin square slab of material is suspended so that it can rotate freely around one of its edges, which is parallel to the ground. The slab is uniform in

density and has mass 0.78 kg. The length of each side is 0.67 m. What is the slab's period?

s

Back to assignments list

Current server time is: 2008-02-17 16:32