Ch2 HW3 (1410411)

Current Score:	0/25.5	Due:	Fri Sep 10 2010 09:00 AM EDT

Question	1	2	3	Total
Points	0/6.5	0/1	0/18	0/25.5

Description

Spring force; Gravitational force near earth's surface; Iteratively applying the momentum principle

Instructions

Reading: Sec 2.5

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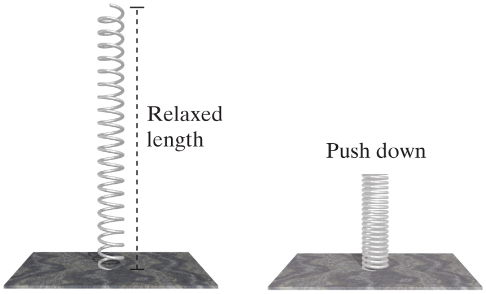
1. 0/6.5 points MI3 2.5.X.014. [1544831]

A spring of stiffness 115 N/m, and with relaxed length 0.18 m, stands vertically on a table, as shown in the figure. Instead of compressing the spring with a heavy block, with your hand you push straight down on the spring until your hand is only 0.13 m above the table. (Assume that the positive *y*-axis points upward and is normal to the table.)



(a) What is now the vector $\vec{L}$, with the spring compressed?

$\vec{L}$ = [ ] $< 0, 0.130, 0 >$ m

(b) What is the magnitude of $\vec{L}$?

$|\vec{L}|$ = [ ] 0.13 m

(c) What is the unit vector $\hat{L}$?

$\hat{L}$ = [ ] $< 0, 1.00, 0 >$

(d) What is the stretch, *s*, including the correct sign?

s = [ ] -0.05 m

(e) What is the force $\vec{F}$ exerted on your hand by the spring?

$\vec{F}$ = [ ] $< 0, 5.75, 0 >$ N

2. 0/1 points MI3 2.5.X.047. [1250468]

Near the surface of the Earth, what is the magnitude of the gravitational force acting on a 5 kg mass?

F_{grav} = [ ] 49 N

Acting on a 50 kg mass?

F_{grav} = [ ] 490 N

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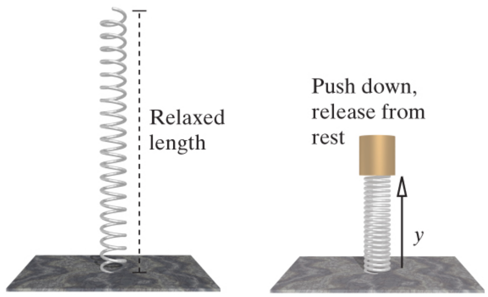
3. 0/18 points MI3 2.5.P.047.01 [1336763]



A spring has a relaxed length of 26 cm (0.26 m) and its spring stiffness is 9 N/m. You glue a 67 gram block (0.067 kg) to the top of the spring, and push the block down, compressing the spring so its total length is 12 cm. You make sure the block is at rest, then at time t = 0 you quickly move your hand away. The block begins to move upward, because the upward force on the block by the spring is greater than the downward force on the block by the Earth. Calculate approximately y vs. time for the block during a 0.24-second interval after you release the block, by applying the Momentum Principle in three steps each of 0.08-second duration.

To avoid buildup of small errors causing you to lose credit, in Step 2 we use your answers to Step 1 even if they are not correct, and in Step 3 we use your answers to Step 2 even if they are not correct.

We will only consider the y components in the following calculations, because there is no change in x or z.

STEP 1

Force: Just after releasing the block, calculate the force exerted on the block by the spring, the force exerted on the block by the Earth, and the net force:

$F_{spring,y}$ = [ ] 1.26 N

$F_{Earth,y}$ = [ ] -0.657 N

$F_{net,y}$ = [ ] 0.603 N

Momentum update: Just after releasing the block, the momentum of the block is zero. Approximate the average net force during the next time interval by the force you just calculated. At t = 0.08 seconds, what will the new momentum and velocity of the block be?

p_y = [ ] 0.0483 kg · m/s

v_y = [ ] 0.72 m/s

Position update: Initially the bottom of the block is at y = 0.12 m. Approximating the average velocity in the first time interval by the final velocity, what will be the new position of the bottom of the block at time t = 0.08 seconds?

y = [ ] 0.178 m

STEP 2

Force: At the new position, calculate the force exerted on the block by the spring, the force exerted on the block by the Earth, and the net force:

$F_{spring,y}$ = [ ] 2.34 N

$F_{Earth,y}$ = [ ] -0.657 N

$F_{net,y}$ = [ ] 1.68 N

Momentum update: Approximate the average net force during the next time interval by the force you just calculated. At time $t = 2 \times 0.08 = 0.16$ seconds, what will the new momentum and velocity of the block be?

p_y = [ ] 0.135 kg · m/s
v_y = [ ] 2.01 m/s

Position update: Approximating the average velocity in the second time interval by the final velocity, what will be the new position of the bottom of the block at time t = 2 × 0.08 = 0.16 seconds?
y = [ ] 0.161 m

STEP 3

Force: At the new position, calculate the force exerted on the block by the spring, the force exerted on the block by the Earth, and the net force:
$F_{\text{spring},y}$ = [ ] 2.34 N
$F_{\text{Earth},y}$ = [ ] -0.657 N
$F_{\text{net},y}$ = [ ] 1.68 N

Momentum update: Approximate the average net force during the next time interval by the force you just calculated. At time t = 3 × 0.08 = 0.24 seconds, what will the new momentum and velocity of the block be?
p_y = [ ] 0.135 kg · m/s
v_y = [ ] 2.01 m/s

Position update: Approximating the average velocity in the third time interval by the final velocity, what will be the new position of the bottom of the block at time t = 3 × 0.08 = 0.24 seconds?
y = [ ] 0.161 m

Applying the Momentum Principle in this way to predict motion is a "numerical integration" -- adding up the cumulative effects of many impulses in a succession of time intervals. As you can see, this can be very tedious if done by hand, and this task is much more easily carried out by programming a computer to do all the repetitive operations. However, it is important to do some calculations by hand to understand in detail the procedure that you would program a computer to carry out.

Assignment Details