Physics 8, Fall 2015, Homework #12.

Due at start of class on Friday, December 8, 2017

Problems marked with (*) must include your own drawing or graph representing the problem and at least one complete sentence describing your reasoning.

Remember **online response** at `positron.hep.upenn.edu/wja/jitt/?date=2017-12-08`

(Mazur Chapter 15 problems)

1. (a) When I hang a 15.0 kg mass from the end of a spring (the other end of which is attached to the ceiling), the spring stretches 1.25 m beyond its relaxed length. What is the spring constant k? (b) If I now pull the mass down a bit further and release it, what are the frequency (f, in hertz, i.e. cycles per second) and the period (T, in seconds) of the resulting periodic motion?

2*. A 6.5 kg object is suspended from the ceiling by a strong spring, which stretches 0.18 m when the object is attached. The object is lifted 0.050 m from this equilibrium position and released. Find the amplitude and period of the resulting simple harmonic motion.

3. A block of mass $m_1 = 2.5$ kg hangs on a vertical spring and oscillates with frequency $f = 1.0$ Hz. With an additional block of mass m_2 added to the spring, the frequency is half as large: 0.5 Hz. What is m_2? (Be careful to answer "What is m_2," not "What is $m_1 + m_2$.")

4*. You measure the oscillation frequency f_{whole} of a vertical block-spring system to be 2.0 Hz. You then cut the spring in half (leaving a spring with half the original length), hang the same block from one of the halves, and measure the frequency f_{half}. What is f_{half} ? (To answer this question, it helps to know that when two springs of spring constant k_1 and k_2 are connected head-to-tail (one in series with the other), the combined spring constant is $k = k_1 k_2/(k_1 + k_2)$. So putting two identical springs of spring constant k_1 in series would result in $k = k_1/2$. Therefore, cutting a spring of spring constant k_1 in half (half the length) leaves a spring with spring constant $k = 2k_1$.)

5. A pendulum is swinging with period $T = 1.0$ s in a stationary elevator. What happens to the period when the elevator (a) accelerates upward at $a_y = +2.0$ m/s^2 ? (b) accelerates downward at $a_y = -2.0$ m/s^2 ? (c) travels downward at constant velocity $v_y = -5.0$ m/s ? (d) travels downward and gradually slows to a stop ($|a_y| = 0.5$ m/s^2 — should it be positive or negative)? The easiest way to analyze this problem is to notice that when you are on an elevator, the constant "g" is effectively replaced by a value that combines g with the vertical acceleration — combines how? (Think of what happens when you are standing on a bathroom scale while riding an elevator.)

6. (a) To form a pendulum, I put a 1.50 kg mass at the end of a 0.248 m long cable. If I give the pendulum a small kick and then let it move back and forth freely, what is the period of oscillation? (b) If I replace the 1.50 kg mass with a 15.0 kg mass, how does this affect the

period of oscillation? (c) If I wanted to make the period of oscillation twice as large, how long would I have to make the cable?

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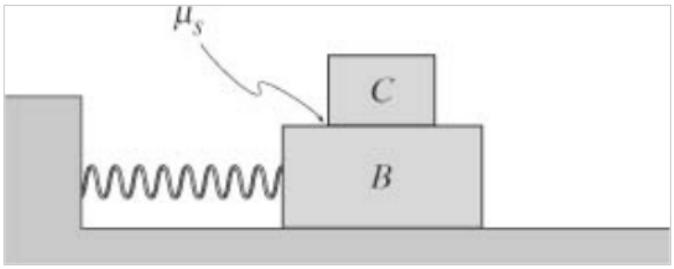
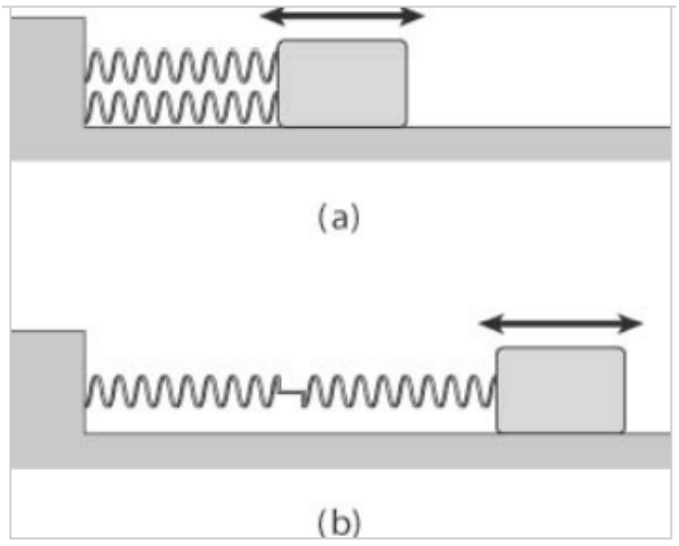
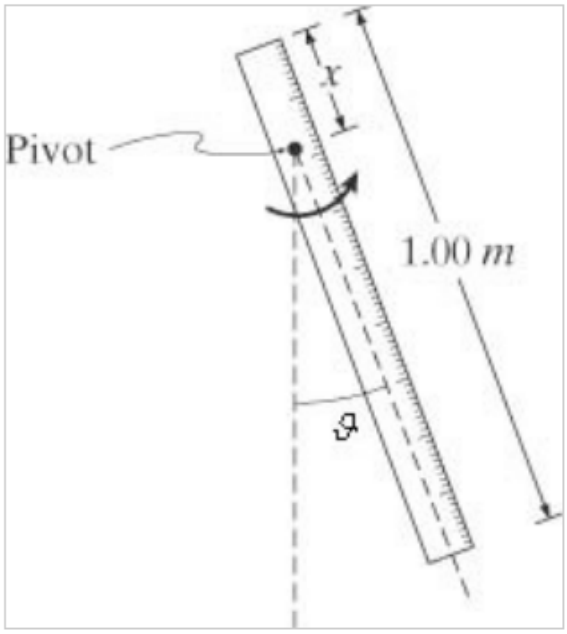
XC1*. Optional/extra-credit. Block B in the figure below is free to slide (with negligible friction) on the horizontal surface. With block C placed on top of B, the system undergoes simple harmonic motion with an amplitude of 0.10 m. Block B has a speed of 0.24 m/s at a displacement of 0.06 m from equilibrium. (a) Find the period of the motion. (b) What minimum value for the coefficient of static friction μ_s between B and C is needed if C is never to slip?



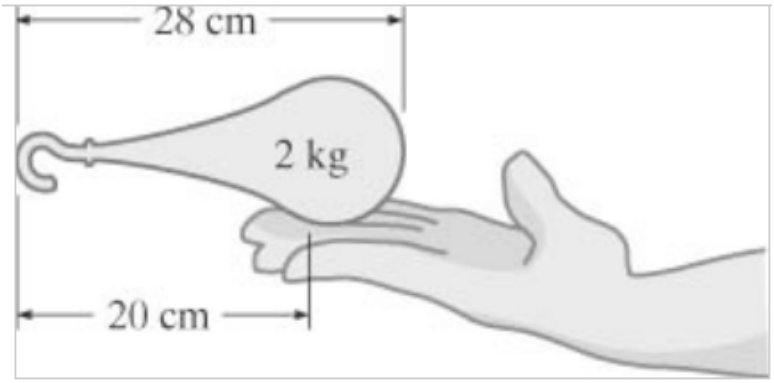
XC2*. Optional/extra-credit. A horizontal spring-block system made up of one block and one spring has an oscillation frequency $f = 1.5$ Hz. A second spring, identical to the first, is added to the system. (a) What is the new oscillation frequency when the two springs are connected as shown in figure **a** below? (b) What is the frequency when the springs are arranged as in figure **b** below?





XC3*. Optional/extra-credit. A meter stick is free to pivot around a point located a distance x below its top end, where 0 m $< x <$ 0.5 m. (See figure above.) (a) What is the frequency f of its oscillation if it moves as a pendulum? (b) To what position should you move the pivot if you want to minimize the period?

XC4*. Optional/extra-credit. You have a teardrop-shaped 2 kg object that is 0.28 m long along its longest axis and has a hook at one end. When you try to balance it on your fingers, you find it balances when your fingers are 0.20 m from the hook end. Then you hang the object by the hook and set it into simple harmonic motion. You find that it oscillates 10 cycles in 13 s. What is its rotational inertia I?



Physics 008 2017 homework #12 score sheet

Problem 1: _____ /4

Problem 2: _____ /4

Problem 3: _____ /4

Problem 4: _____ /4

Problem 5: _____ /4

Problem 6: _____ /4

The following 4 points reflect your maintaining good habits for all of the above problems:

Reasonable number of significant digits reported in answers: _____ /2

Sufficient level of explanation for reasoning behind answers: _____ /2
(You can earn 3 out of 2 for consistently clear presentation/explanation of your answers.)

Total (out of 28): _____

+ Extra credit (if any): _____

scoring guideline (for each problem):
4 = complete and correct solution
3 = good but minor error or minor omission
2 = serious error or omission but shows decent effort
1 = we can't make sense of what is written down
0 = no serious attempt to solve problem

Please write your name only on the bottom edge of this sheet (not on your own solutions), and staple the sheet to your own solutions, so that we don’t know whose paper we are grading until after we have finished grading it.

Name: _____