Physics 2211A/B Test form **746** Name ____________

Fall 2017

Test 4 Recitation Section (see cover page): ________

A

1) Print your name, test form number (above), and nine-digit student number in the section of the answer card labeled "STUDENT IDENTIFICATION".

2) Bubble your test form number (**ABOVE**) in columns 1-3, skip column 4, then bubble in your student number in columns 5-13.

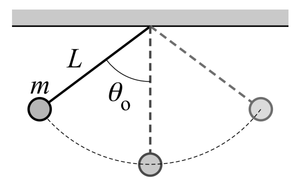
3) For each free-response question, show all relevant work supporting your answer. **Clearly box or underline your final answer.** "Correct" answers which are not supported by adequate calculations and/or reasoning will be counted wrong.

4) For each multiple-choice question, select the answer most nearly correct, **circle this answer on your test**, and bubble it in on your answer card. **Show all relevant work on your quiz.**

5) Be prepared to present your Buzzcard as you turn in your test. Scores will be posted to WebAssign after they have been been graded. **Test grades become final when the next quiz is given.**

6) You may use a simple scientific calculator capable of logarithms, exponentials, and trigonometric functions. **Programmable engineering calculators with text or graphical capabilities are not allowed. Wireless devices are prohibited.**

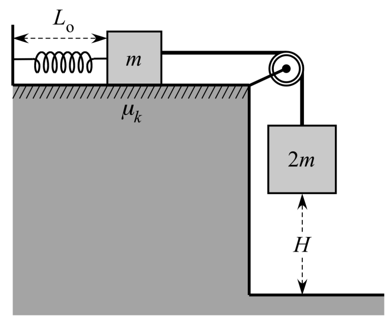
[I] *(20 points)* A simple pendulum consists of a ball of mass m attached to a string of length L. The mass is raised to an angle θ_o = 53.1° from the vertical, and released from rest. What should be the test strength (i.e. the maximum tension the cord can sustain) in order for the mass to swing through a full arc without breaking? Express your answer as a multiple of the ball's weight, mg.



Hint: use conservation of energy as part of your solution.

The following problem will be hand-graded. Show all your work for this problem. Make no marks and leave no space on your answer card for it.

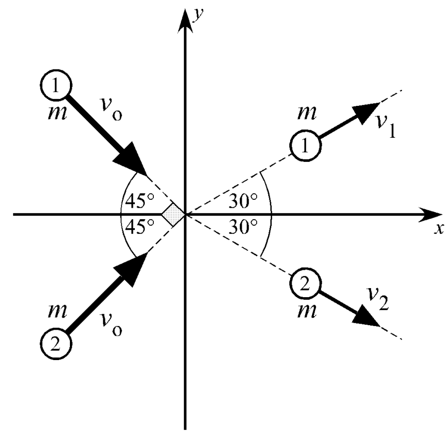
[II] *(20 points)* In the figure at right, block m rests on a rough surface with coefficient of friction μ_k = 0.25. Block m is attached to the wall by a spring that is initially at its natural length L_o. It is also attached, via an ideal cord, to a hanging block of mass $2m$ that is a height H above the ground. The blocks are released from rest and begin to move—picking up speed at first, but eventually slowing to a stop at the exact moment block $2m$ reaches the ground.



Use the Work-Energy Principle to determine the elastic constant of the spring. Express your answer in terms of g, m and H.

The following problem will be hand-graded. Show all your work for this problem. Make no marks and leave no space on your answer card for it.

[III] *(20 points)* Two identical pucks are sliding along a surface. At the moment they collide, they are moving at right angles to one another as shown, having the same speed v_0. After the collision, they are seen to be travelling with velocities directed at angles of 30.0° above and below the x-axis.



Determine the amount of kinetic energy **lost** in this collision (where $K_{lost} = |\Delta K| = |K_f - K_i|$). Express your answer as a fraction of the initial kinetic energy of the system—for example: "$K_{lost} = (3/7)K_i$".

Hint: start by thinking about the y-direction…

The next two questions involve the following situation:
A particle moves in 2D while subject to only a single conservative force, with a potential energy given by the expression

$$U(x,y) = Ax^3y^2 - 2Ax^2y^3$$

Question value 4 points
(1) What is the x-component of the force on the particle when it is at position $\langle x, y\rangle = \langle -d, +d\rangle$?

(a) $\vec{F}_x = \langle +3Ad^4\rangle$

(b) $\vec{F}_x = \langle +7Ad^4\rangle$

(c) $\vec{F}_x = \langle 0\rangle$

(d) $\vec{F}_x = \langle -3Ad^4\rangle$

(e) $\vec{F}_x = \langle -7Ad^4\rangle$

Question value 4 points
(2) What is the y-component of the force on the particle when it is at position $\langle x, y\rangle = \langle -d, +d\rangle$?

(a) $\vec{F}_y = \langle +3Ad^4\rangle$

(b) $\vec{F}_y = \langle +8Ad^4\rangle$

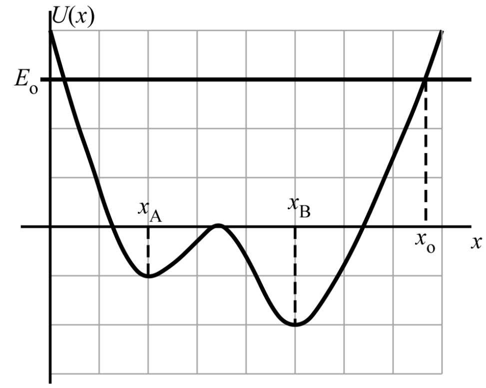
(c) $\vec{F}_y = \langle -3Ad^4\rangle$

(d) $\vec{F}_y = \langle -8Ad^4\rangle$

(e) $\vec{F}_y = \langle 0\rangle$

Question value 8 points

(3) Georgia Tech researcher George P. Burdell has designed the "Asymmetric Bistable Sprang". It acts very much lik a regular spring, but has two stable equilibrium lengths, x_A and x_B. The potential energy curve for the sprang is shown at right. A mass m is attached to the sprang, and then stretched out to position x_o, where the total energy of the system is E_o. If the mass is released from rest, what will be its maximum kinetic energy as it oscillates back and forth?



(a) $-\frac{2}{5}E_o$

(b) E_o

(c) $-\frac{2}{3}E_o$

(d) $\frac{5}{3}E_o$

(e) $\frac{4}{3}E_o$

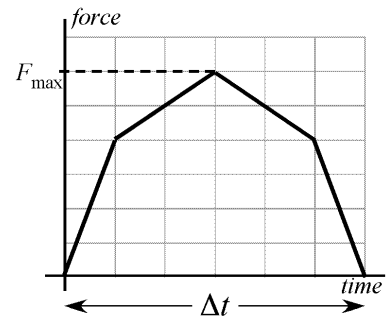
Question value 8 points

(4) You are on the interstate, driving due south at speed v. You enter a broad, uphill left turn, and emerge traveling due east at at speed ¾ v. What was the direction q of the impulse delivered to the car during the turn?

(a) θ = due east
(b) θ = 53° north of east
(c) θ = 45° north of east
(d) The impulse cannot be determined because the elapsed time Δt is unknown.
(e) θ = 37° south of west

Question value 8 points

(5) A rubber ball of mass m is thrown against a wall. It strikes the wall perpendicularly moving with speed v, and rebounds perpendicularly with speed $v/2$. The force by the wall on the tennis ball is graphed as a function of time at right. The <u>total</u> time spent in contact with the wall is Δt. What is the magnitude of the average force exerted by the wall on the ball?



(a) $F_{av} = \frac{mv}{2\,\Delta t}$

(b) $F_{av} = \frac{2}{3}F_{max}$

(c) $F_{av} = \frac{3}{2}F_{max}$

(d) $F_{av} = \frac{3mv}{\Delta t}$

(e) $F_{av} = \frac{1}{2}F_{max}$

Question value 8 points

(6) Consider the four springs, a–d, at right. Rank, from greatest to least (where large positive > small positive > zero > small negative > large negative), the elastic potential energy stored in each spring.

(a) $U_d = U_c > U_b > 0 > U_a$

(b) $U_c > U_d = U_b > 0 > U_A$

(c) $U_d = U_c > U_b = U_a > 0$

(d) $U_d > U_c > U_a = U_b > 0$

(e) $U_a > 0 > U_b > U_c > U_d$