Physics 7A- Spring 2006 (Lanzara)

FINAL EXAM –SECTION 2
GOOD LUCK!

This exam is closed book, but you are allowed a 8.5" x 11" (double-sided) page (double side) of handwritten notes. You may use a calculator, however NO wireless calculators are allowed. Anyone using a wireless calculator will forfeit their exam and automatically receive the score of zero.
Don't forget: a) Write your name, Discussion Section #, GSI name and SID# on the top of all materials you intend to hand in and want to be graded.
b) Remember to circle all of your final answers and to clearly explain each step of your thinking.
c) Express all numerical results to 3 significant figures. Cross out any work you decide is incorrect, with an explanation in the margin.

Read through the entire exam to start.
Work to maximize your credit – a) Start with the problems you are more familiar with. B) Try to obtain at least partial credit on every part of every problem.
- For partial credits show all relevant drawings and explain clearly your reasoning.
- If you recognize that an answer does not make physical sense and you do not have time to find your error, write that you know that the answer cannot be correct and explain how you know this to be true. (We will award some credit for recognizing there is an error.).
- Do not get bogged down in algebra - if you have enough equations to solve for your unknowns, box the equations, state how you would finish, and move on (you can go back and complete the algebra later if you have time).
And if you have questions about the interpretation of a problem, *please ask!*

Problem	Points	Score
1	10	
2	20	
3	20	
4	35	
5	20	
TOTAL	105	

(10pts) Problem 1

You push a box of mass m, which is initially at rest on a horizontal table, by a distance x, with a horizontal force F. The coefficient of kinetic friction between the box and table is μ.

a) (5pts) Find the external work done on the bock-table system
b) (2pts) Find the energy dissipated by friction
c) (3pts) Find the speed of the box

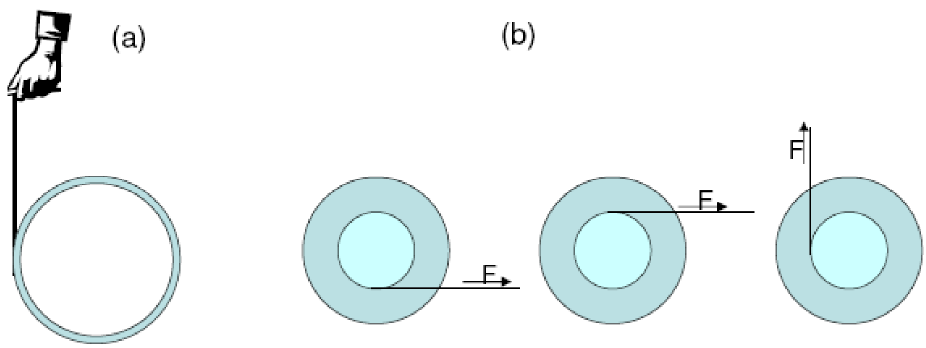
(20pts) Problem 2

A string is wrapped several times around the rim of a small hoop with radius 0.0800m and mass 0.180kg. If the free end of the string is held in place and the hoop is released from rest, calculate:

a) (5pts) The tension in the string while the hoop descends as the string unwinds.
b) (4pts) The time it takes the hoop to descend y=0.750m
c) (5pts) The angular speed of the rotating hoop after it has descended y=0.750m.

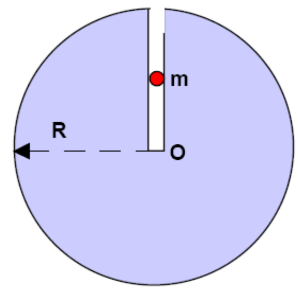
Assume now that the string is wrapped to a yo-yo that is initially at rest on a horizontal surface. We now pull the string in three different ways (see panel b).

d) (3pts) Draw the free-body diagram for each case.
e) (3pts) In what direction will each rim rotate? Explain your answer.



(20 pts) Problem 3

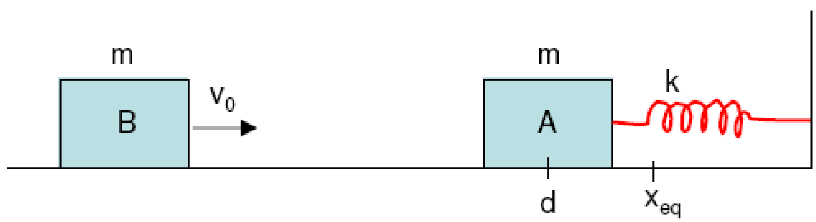
An homogeneous disc of radius R= 20cm, mass M= 2.0 kg and momentum of inertia $MR^2/2$ lies on a table and can rotate on an horizontal plane (no friction) around a vertical axis through the origin O (see figure) with initial angular velocity ω_0= 5.0s^{-1}. A particle of mass m= 0.10 kg can freely move without friction along a straight guide on the disc, that goes from the origin of the disc to the external point. Neglect the contribution of the guide to the total momentum of inertia of the disc.



Initially the particle is at rest with respect to the disc and is located at a distance R/2 from O. Once it starts moving and reaches the outer edge of the disk, find:
1) (10pts) The angular velocity of the disc (in the lab reference frame)
2) (10pts) The absolute value of the velocity of the particle.

(35 pts) Problem 4

A block A of mass *m*, resting on a horizontal friction-free surface, is attached to a massless spring of spring constant *k*, as shown in the figure below. If the mass *m* is displaced by a distance *d* to the left from its equilibrium position and then released at time t=0:
a) In a frame of reference in which the origin is taken to be the equilibrium point, describe the type of motion of the block (5pts) and write the equation of motion for the position x(t) (3pts) and the velocity v(t) (2pts) in terms of *m*, *k* and *d*.
b) (3pts) What is the period of oscillation of the block?
c) There is a force of friction proportional to velocity such that F = -bv, write the new equation of motion of the block (5pts) and find its angular frequency (ω) (2pts).
For the remaining part of the problem consider the horizontal surface friction-free. The block is now struck by another block B of equal mass *m*, moving with speed v_0 to the right. The two blocks stick together after the collision.



If this occurs when block A is at its furthest extension to the left:
d) Determine the amplitude A (3pts) and period of oscillation T (2pts), after the collision in terms of *m*, *k*, v_0 and *d*.
e) (5pts) Determine the energy lost in the collision.
If the collision occurs when block A is passing through its equilibrium position moving to the right:
f) (5pts) Determine the energy lost in the collision.

(20 pts) Problem 5

A block of mass *m* is suspended from the roof of an elevator by a light massless cord. The block is totally immersed in a bucket of water of density ρ, cross-section A, and height h, that sits on the floor of the elevator, but the rock doesn't touch the bottom or sides of the bucket.
a) (3pts) When the elevator is at rest, the tension in the cord is T. Calculate the volume of the block.
b) (2pts) Derive an expression for the tension in the cord when the elevator is accelerating upward with an acceleration of magnitude a = 1/3 g upward.

c) (2pts) Derive an expression for the tension in the cord when the elevator is accelerating downward with an acceleration of magnitude $a = 1/3\ g$ downward.

d) (3pts) What is the tension when the elevator is in free fall with a downward acceleration equal to g?

e) (10pts) Find the time it takes the beaker to empty as a function of h. Neglect the volume of the block.