Physics 7A, Section 1 (Speliotopoulos)
Second Midterm, Fall 2011
Berkeley, CA

Rules: *This midterm is closed book and closed notes. You are allowed two sides of one-half sheet of 8.5" x 11" of paper on which you may write whatever you wish. You are also allowed to use scientific calculators in general, but not ones which can communicate with other calculators through any means, nor ones that can do symbolic integration.* ***Anyone who does use a wireless-capable device will automatically receive a zero for this midterm.*** *Cell phones must be turned off during the exam, and placed in your backpacks.* ***In particular, cell-phone-based calculators cannot be used.***

Please make sure that you do the following during the midterm:

- ***Show all your work in your blue book***
- *Write your name, discussion number, ID number on all documents you hand in.*
- *Make sure that the grader knows what s/he should grade by circling your final answer.*
- *Cross out any parts of the your solutions that you do not want the grader to grade.*

Each problem is worth 20 points. We will give partial credit on this midterm*, so if you are not altogether sure how to do a problem, or if you do not have time to complete a problem, be sure to write down as much information as you can on the problem. This includes any or all of the following: Drawing a clear diagram of the problem, telling us how you would do the problem if you had the time, telling us why you believe (in terms of physics) the answer you got to a problem is incorrect, and telling us how you would mathematically solve an equation or set of equations once the physics is given and the equations have been derived. Don't get too bogged down in the mathematics; we are looking to see how much physics you know, not how well you can solve math problems.*

If at any point in the exam you have any questions, just raise your hand, and we will see if we are able to answer them.

Copy and fill in the following information on the front of your bluebook:

Name: ______________________________ *Disc Sec Number:* ________________________

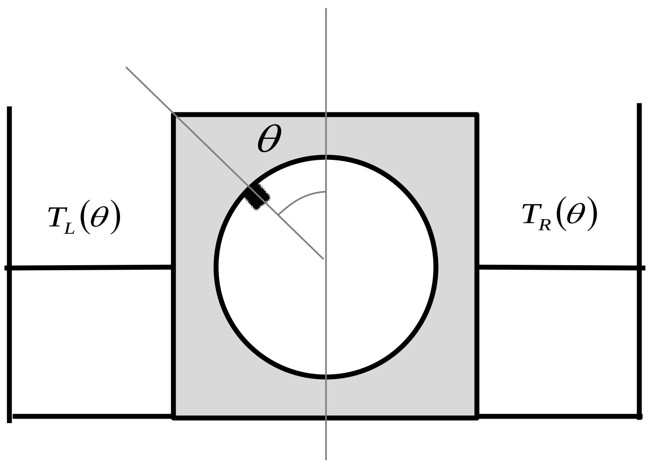
Signature: ___________________________ *Disc Sec GSI:* ___________________________

Student ID Number: ____________________

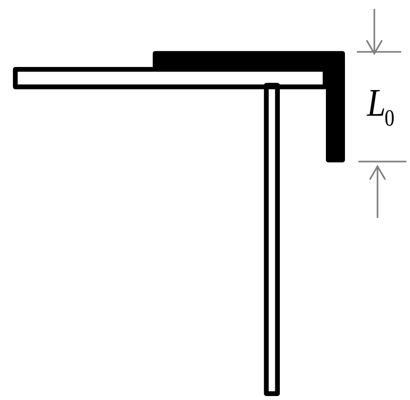
1. The potential energy of a planet with mass, *m*, orbiting the Sun with mass, *M*, at a distance, *r*, is:

$$U(r) = -\frac{GmM}{r} + \frac{L^2}{2mr^2}$$

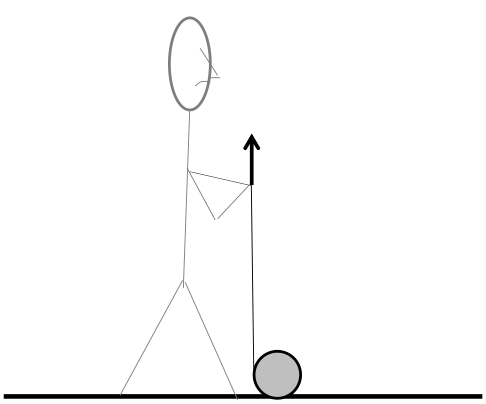
L is the angular momentum of the planet. (You don't need to know what angular momentum is to solve the problem.) In terms of the given parameters, determine the stable equilibrium radius, r_{eq}, and the turning points for a planet with energy $E = U(r_{eq})/2$.



2. The figure on the left shows a block that has a cylindrical hole with a cylinder cut out of it; the block never loses contact with the table. This block sits on a frictionless table, and is connected to side walls by two strings. A small block with mass, *m*, is sliding in a counter-clockwise direction on the inside surface of the cylinder, which is also frictionless. When the block is at the top of the cylinder, its velocity $v_0 = \sqrt{gR}$, and the tensions in the strings are zero ($T_L = 0$ and $T_R = 0$). What is $T_L(\theta)$ and $T_R(\theta)$ when the sphere is at an angle, θ, from the vertical?



3. A uniform cord with mass, *M*=0.25 kg, and length, *L*=0.5 *m*, is placed on top of a table (see figure to the right), such that a length, $L_0 = 0.20\, m$, of the cord hangs off the table. While there is friction between the cord and the table, the edge of the table is frictionless. If the cord starts to slid off the table, find the velocity of the cord, *V*, immediately after it leaves the table. Take coefficient of kinetic friction to be $\mu_k = 0.30$, and assume that the cord always hangs vertically.



4. The figure to the left shows a gentleman pulling with a force on a string wound around a disk. The disk is always in contact with the ground, and always roll without slipping. Under these conditions, what is maximum possible acceleration, a_{max}, of the disk, and what direction is it in? Express a_{max} in terms of *g*, and the coefficient of static friction between the disk and the ground is μ_s. You can assume that the man will move in such a way that the force he applies is always directed upward.

5. The figure below shows a mass, *m*, with an initial velocity, v_0, between two identical blocks with mass, *M*, that are initially at rest. If the mass collides with each block only once, what is the maximum and the minimum that the ratio m/M can be? All collisions are elastic, and all surfaces are frictionless.