Physics 7A, Sections 2, 3 (Speliotopoulos)
Second Midterm, Spring 2013
Berkeley, CA

Rules: *This midterm is closed book and closed notes. You are allowed two sides of one sheet of 8.5" x 11" of paper for notes. You are also allowed to use scientific calculators in general, but not ones which can communicate with other calculators through any means.* ***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:

- *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.*
- *Answer all questions that require a numerical answer to two significant figures.*
- *Cross out any parts of 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.* ***In addition, we will not be concerned with whether your answer has the correct number of significant figures.***

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:* ______________

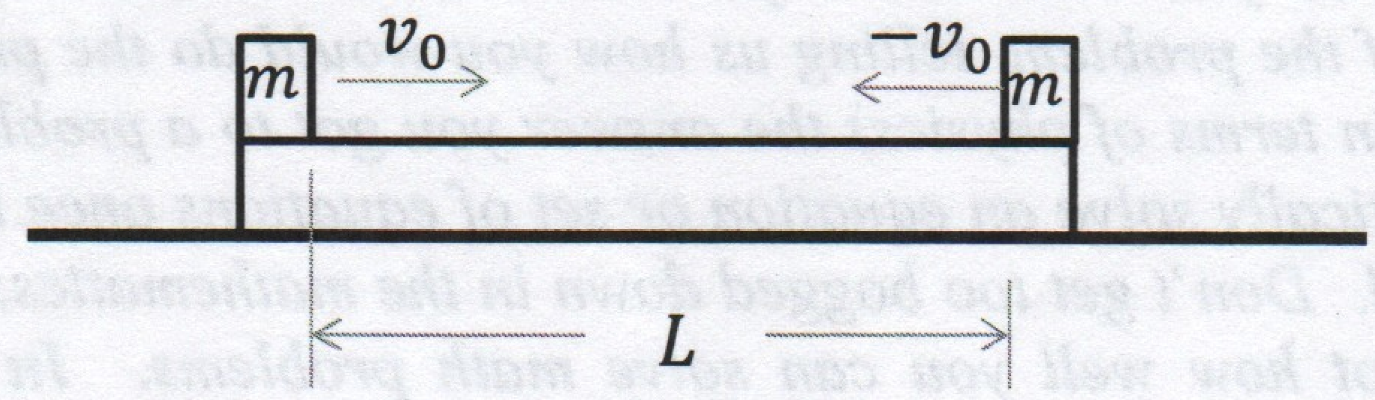
Student ID Number: ______________________

1. A particle with mass, $m = 0.25\ kg$, is acted on with a force that has the following potential energy with $U_0 = 12$ J:

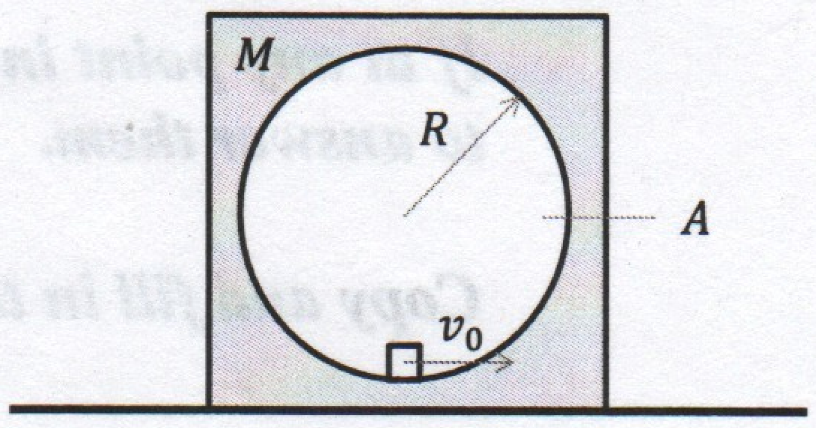
$$U(x) = U_0\left(-\frac{1}{2}x^2 + \frac{1}{3}x^3 + \frac{1}{4}x^4\right),$$

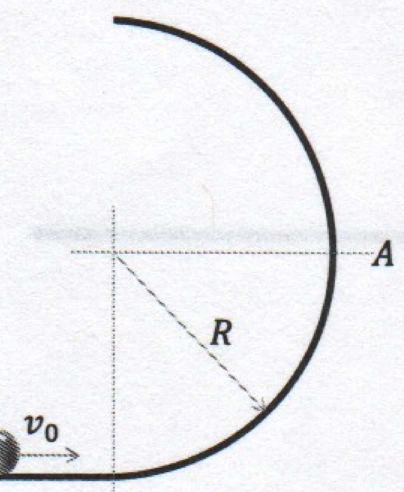
   a. There are two stable equilibrium points, a and b, and one unstable equilibrium point, c, for the potential. Determine the values of the stable and unstable equilibrium points. In this part, graphical solutions will not be accepted.
   b. Call a the stable equilibrium point which is the global minimum point of $U(x)$, so that $U(a) < U(b)$. Find $U(a)$, $U(b)$, $U(c)$.
   c. The particle is located at $x = b$ and has a total energy, $E = U(b)$. If the particle is given a velocity greater than v_{min}, it will be able to travel to the point $x = a$. What is v_{min}? (One way to solve this problem would be to sketch a graph of $U(x)$.)

2. The figure below shows identical blocks on top of a large slab. The block on the left has an initial velocity v_0, while the one on the right has an initial velocity $-v_0$. This slab is at rest on a *frictionless* table, and has a length, L. The two blocks travel along the slab, and come to rest right before they collide. What is the coefficient of kinetic friction, μ_K between the blocks and the slab in terms of v_0, g, and L. ?



3. The figure on the right shows a small block with mass, m, with an initial speed, $v_0 = 2\sqrt{gR}$, in a cylindrical hole with radius, R, drilled through a larger block with mass, $M = 2m$. This larger block is initially at rest. What is the velocity (magnitude and direction) of the small block when it reaches point A in the figure? Express this velocity in terms of g and R. All surfaces are frictionless, and assume that the small block never loses contact with the large block.





4. The figure on the left shows a solid sphere with mass, m, radius, r, and initial velocity, v_0, rolling without slipping at the bottom of a semi-circular ramp that has radius, R.
   a. The particle continues to roll without slipping even when it reaches the point A in the figure. What is the minimum velocity, v, it can have at this point? Express this v in terms of R, r, g, and the coefficient of static friction between the sphere and the ramp μ_S.
   b. What, then, must the minimum initial velocity, v_0, of the sphere be?

5. The figure on the right shows a disk with mass, m, is on top of a long slab with mass, M, which lies on a frictionless table. A force, F, is applied to the disk through an axle at the center of the disk. The coefficient of static friction between the disk and the slab is μ_S. If the disk rolls without sliding on the slab, what is the maximum acceleration, a, that the disk can have when it is on the slab? Express a in terms of m, M, g, and μ_S.