Physics 7A, Section 1 (Prof. Hallatschek)
First Midterm, Spring 2015
Berkeley, CA

Rules: *This midterm is closed book and closed notes. You are allowed one side of a sheet of 8.5" x 11" of paper on which you can note whatever you wish.* ***You are not allowed to use scientific calculators.*** *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 three significant figures.*

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 problems, just raise your hand, and we will see if we are able to answer it.

Name: ______________________ *Disc Sec Number:* ______________

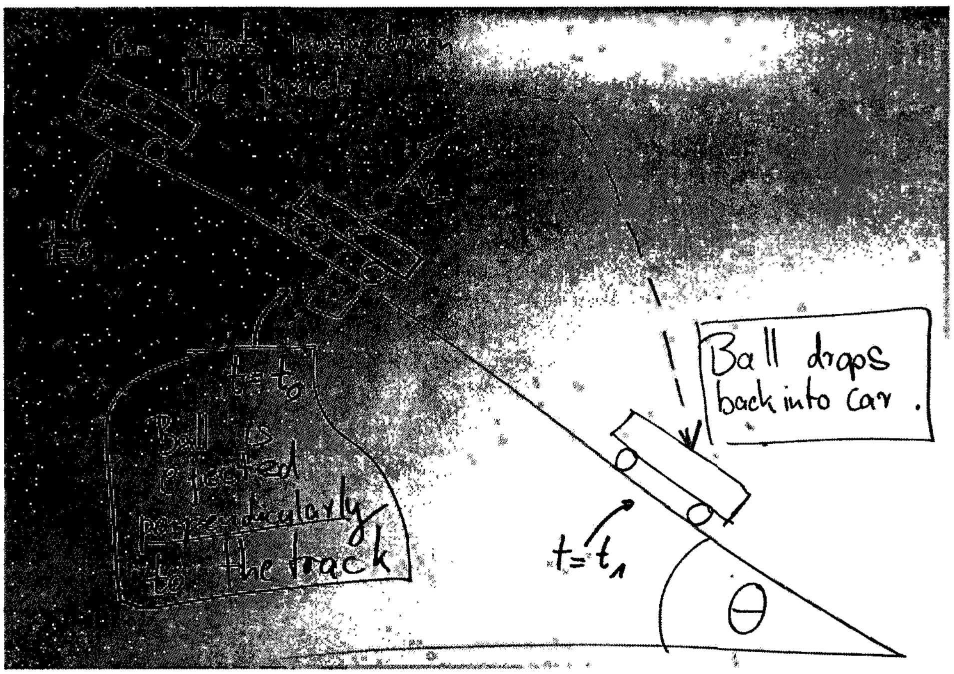
Signature: ______________________ *Disc Sec GSI:* ______________

Student ID Number: ______________

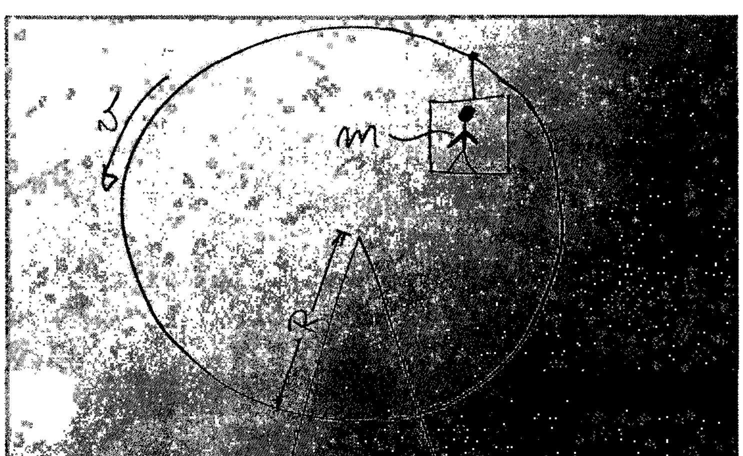
Problem	***Possible***	***Score***
1	20	
2	20	
3	20	
4	20	
5	20	
Total	100	

1. **Ballistic car: Ball ejected from rolling car drops back in.** A frictionless car, carrying a ball, starts moving down an inclined track at time $t=0$. The track is inclined at an angle θ w.r.t the horizontal plane. At time t_0, the ball gets ejected exactly perpendicular to the track. Right after the ejection, the ball has a velocity $v_\perp$ in the direction perpendicular to the track. At some later point t_1, the ball falls right back into the car.
   a. Why does the ball fall back into the cart?
   b. At what time t_1 do ball and car collide?
   c. How far does the car move between t_0 and t_1?

   In b and c, express your answers in terms of t_0, θ and g.
   Treat the motion of the car as if it was sliding without friction. Ignore drag and friction.

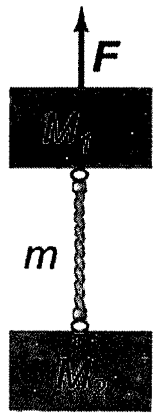


2. **Ferris wheel**: A person of mass m is standing on a scale in a cabin of a Ferris wheel of radius R. The wheel is rotating in a circle at constant speed. At the lowest point, the scale reads $1.5mg$.
   a. What would the scale read (in terms of mg) at the highest point?
   b. What is the speed v (in terms of g, R) with which the cabin is rotating around the center of the wheel?
   c. What is the maximal rotation speed v_{max} (in terms of g, R) of the Ferris wheel if we require that the person shall never become weightless (scale reads 0) during the rotation?



3. **Truck and crate:** A truck is traveling at a speed v. A crate of mass m, containing delicate glassware, rests on the flat, horizontal bed of the truck. The coefficient of static friction between the crate and the truck bed is μ_s. The crate is not fastened to the truck bed in any way. Thus, if the crate were to slide forward or backward, the glassware would break.
The driver suddenly notices that a deer is standing on the road. He decelerates at a constant rate and comes to a halt after a stopping distance L. What does the static friction coefficient μ_s need to be at least, for the glassware to survive?

4. **Two Blocks connected by a rope**: The two blocks M_1 and M_2 in the figure are connected by a heavy uniform rope with a mass m. An upward force of ***F***, is applied as shown. (a) Draw the free-body diagrams, one for each of the three bodies. For each force, indicate what body exerts that force. (b) What is the acceleration of the system? (c) What is the tension at the top of the heavy rope? (d) What is the tension at the midpoint of the rope? (e) If the maximum tension the rope can sustain without breaking is F_c, determine the maximum value of the hanging mass M_2 that the rope can safely support for a given pulling force F and masses m and M_1.



5. **Block in cylinder:** A cylinder is cut out of a large block with mass M sitting on a table. A small block of negligible size and mass m is place within the hole (see figure). The coefficient of static friction between the small block and the large block is μ_s, and you may assume that the friction between the large block and the table is negligible. What is the minimum and maximum value of F so that θ does not change?