UC Berkeley, Physics 7A, Summer 2015 (Reinsch)
First Midterm Exam

This midterm is closed book and closed notes. You are allowed two sides of a sheet of 8.5" x 11" paper containing hand-written notes. Calculators are not allowed.

Please make sure that you do the following:

- *Write your name, discussion number, ID number on your bluebook/greenbook.*
- *Make sure that the grader knows what he should grade by circling your final answer.*

Problem 1

A car traveling on a straight road is waiting at a red traffic light. At time $t = 0$, the light turns green and the driver immediately steps on the gas and accelerates with constant acceleration a. At time $t = t_1$ the driver removes his/her foot from the gas pedal, and the car rolls without friction or air resistance (thus zero acceleration). At time $t = t_2$ the driver again steps on the gas pedal so the car accelerates with the same constant acceleration as before, a. For $t > t_2$ find the velocity v and the distance traveled x, measured relative to the traffic light. Throughout this problem we measure time relative to the $t = 0$ event when the light turned green. Note that as per the wording above, we have $t_2 > t_1 > 0$.

Problem 2

A tall tower of height H is located on a horizontal plane. A rock is thrown from the top of the tower, with its initial velocity vector pointing at an angle θ above the horizontal. The initial speed is v_0.

(a) How long does it take for the rock to hit the ground?

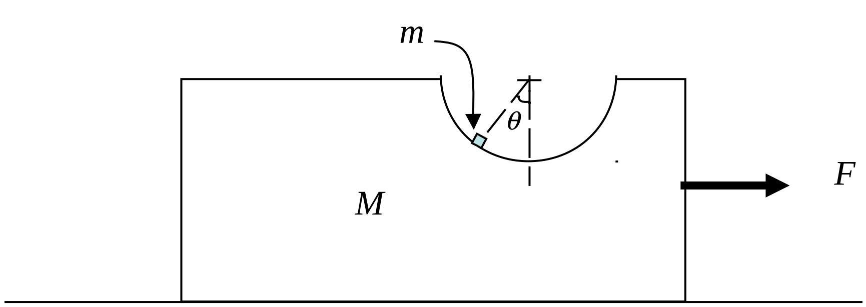
(b) At the instant before the rock hits the ground, what are the horizontal and vertical components of its velocity vector?

Problem 3

Half of a cylinder is cut out of a large block with mass M sitting on a table. The side view is shown below. A small block of negligible size and mass m is placed as shown in the diagram. 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.

(a) If the large block is motionless and the applied force $\boldsymbol{F}$ is zero, what is the largest value of θ possible so that the small block remains motionless?

(b) Assuming θ is less than the value you computed above, what is the maximum value of F so that θ does not change (that is, the small block does not move relative to the large block)?

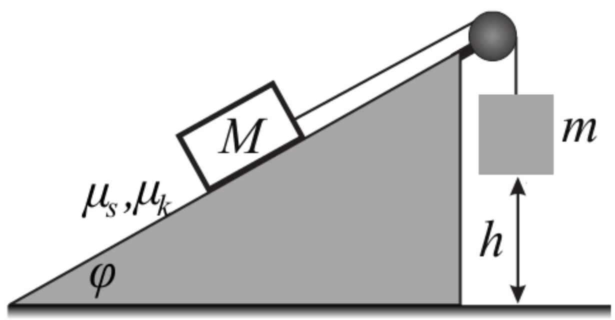


Problem 4

The masses of the two blocks shown in the diagram are M and m. The string and pulley are massless. The coefficients of kinetic and static friction are shown in the diagram. The ramp does not move.

(a) If the blocks are motionless and do not accelerate, what is the largest value of m possible?

(b) If m is large enough so that static friction cannot hold M in place and M accelerates up the ramp (while m accelerates downwards) how long does it take for m to hit the ground? Assume m was initially a distance h above the ground as shown in the diagram and assume all velocities were initially zero.



Problem 5

For both parts (a) and (b), you must draw free body diagrams and use Newton's Second Law even if you have the answer or something similar on your formula sheet.

(a) A ball is attached by a string to a post, and is being whirled around with speed v_0. The length of the string is L. When the post is held still, we have an angle θ_0 as shown in Figure (a). Find the relationship between this angle and the speed.

(b) Now the experiment is repeated in an elevator accelerating upwards with acceleration a, and the angle decreases to θ_{acc} as shown in Figure (b). Again, find the relationship between this angle and the speed. The speed is the same as in part (a), and this time it is measured by scientists in the elevator. You are not allowed to use the Principle of Equivalence, although this is a hint as to how your answers to parts (a) and (b) should be related.

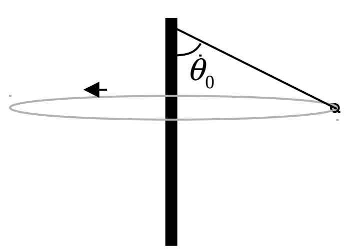


Figure a

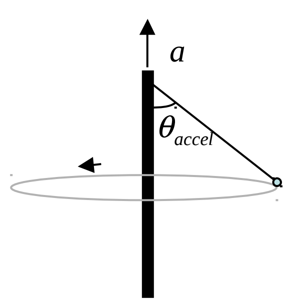


Figure b