Physics 7A- Section 1, Fall 2004 (Lanzara)

1st MIDTERM

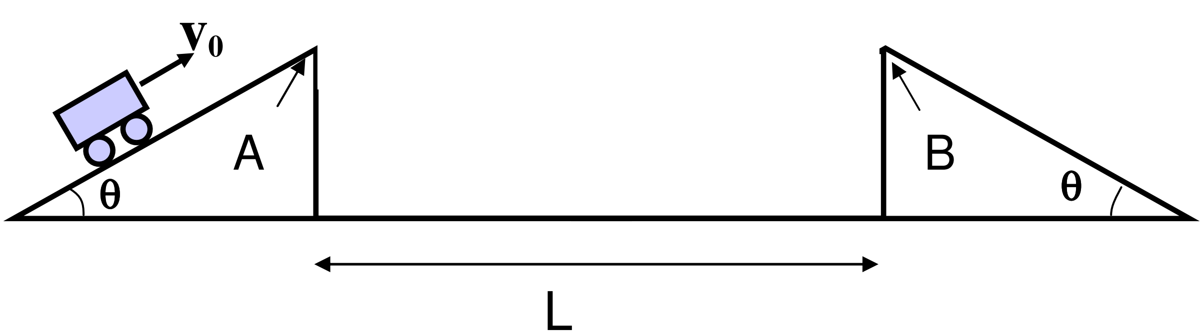
Monday October 4, 2004 6:00-8.00 pm CLOSED BOOK

GOOD LUCK!

1. This is a closed book exam. You are allowed to bring along only one 8.5”x 11” “cheat sheet,” pens, pencils, scientific calculator, and blue books.
2. 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.
3. Circle your final answers. Show all your work in the blue book. If you do not show relevant work for part of a problem, you will not be awarded any credit for that part, even if the answer is correct. 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 why. For full credit explain your reasoning carefully, and show all steps.
4. While cleanliness and legibility of your handwriting will not get you extra credit, they will help to make sure that your answers get the credit they deserve. In case you make mistakes, be sure to cross them out so they will not be mistaken as your answer.
5. Express all numerical results to 3 significant figures. Cross out any work you decide is incorrect, with an explanation in the margin.

Problem 1- [30 points]

A car jumps between two identical ramps on a horizontal surface. As shown in the figure below, the car is launched from the point A on the first ramp that is at a distance L from the landing point B on the second ramp. Both ramps are tilted with the same angle θ from the horizontal.

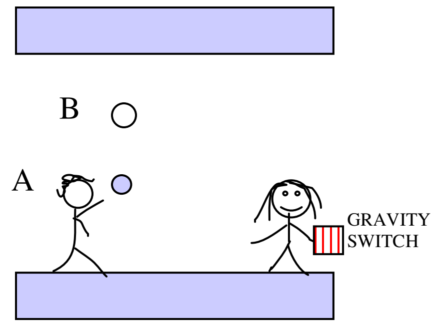


a) [20 points] Write equations for the x and y position of the car as a function of time using the launch point A as the origin.
b) [10 points] Calculate the magnitude of the initial velocity $\mathbf{v_0}$ of the car needed to complete the jump successfully in terms of L, θ, **g**.

Problem 2- [15 points]

I toss a ball straight up, and just as it reaches what would have been the top of its trajectory at point A, a friend flips the gravity switch so that the acceleration due to gravity is now 9.80 m/s^2 UPWARDS. The ball bounces once off the ceiling, but it is not very good rubber, so after it hits the ceiling the first time it only bounces back down as far as point B. Then it falls back up to the ceiling and sticks. Point A is halfway between the floor and the ceiling, and point B is ¼ of the way down from the ceiling.

Draw the acceleration (5pts), velocity (5pts) and position (5pts) of the ball in the y direction as a function of time. Label the plots so we know which is which! Take y=0 at the floor, with y becoming positive upwards. DO NOT switch the coordinate system when gravity switches. Assume I let go of the ball at floor level (y=0), and assume that the action of the switch and the bounce are instantaneous.



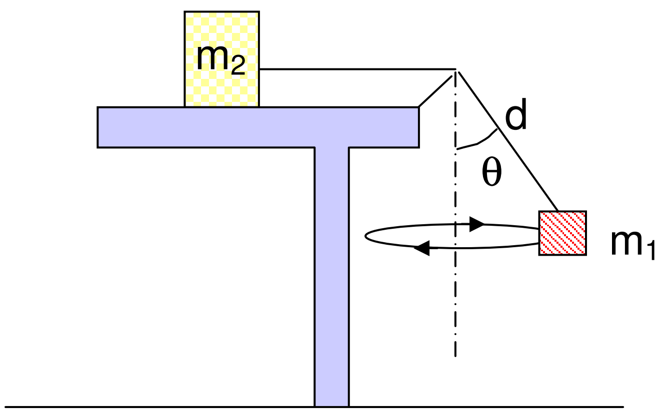
Problem 3- [30 points]

A mass m_2 rests on a table. A massless rope is tied to the box and runs through a pulley, and a mass m_1 is hung from the other end. (See figure.) The distance from the pulley to m_1 is d. The coefficient of static friction between m_2 and the table is μ_s ($\mu_s = 0.500$). m_1 revolves in a circle so that the section of the rope hanging from the pulley makes a constant angle θ with the vertical.

Draw a free body diagram for both masses.

Find the maximum θ such that m_2 does not move. (Let $m_2 = 4m_1 = 1.00$ kg).

How long does it take for m_1 to make one revolution?

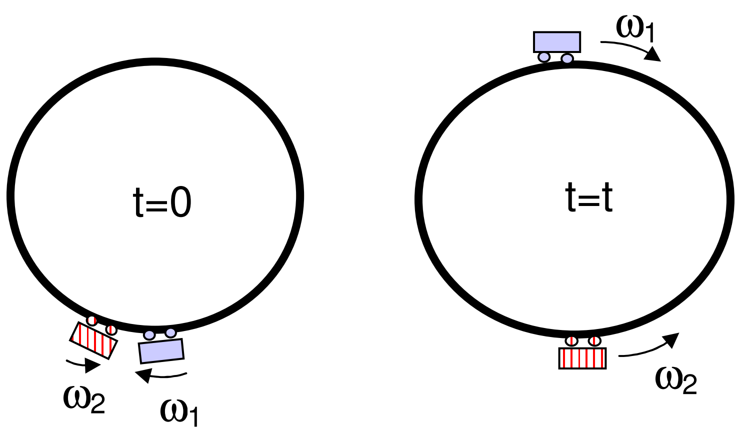


Problem 4- [20 points]

Two cars move along a circular path of radius R = 15.0 cm (see figure). At a time t = 0 the two cars will occupy the same place and then each one will proceed, in opposite directions with angular velocity $\omega_1 = K_1 t + \omega_0$ and $\omega_2 = K_2 t + \omega_0$.

(K_1 = 10.0 rad/s^2; K_2 = 5.00 rad/s^2; ω_{01} = 2.00 rad/s; ω_{02} = 4.00 rad/s .)

a) [10 pts] At what time will the cars meet again?
b) [5 pts] How far will each car have traveled by this time? (Give your answer in radians.)
c) [5 pts] Find the magnitude of the centripetal acceleration for each of the cars at the meeting time solved for in (a).



Problem 5- [25 points]

At t = 0 two blocks of the same mass M, composed of different materials, are released from rest down an inclined plane. The blocks are initially separated by a distance L. The coefficient of kinetic friction between the plane and the lower block is μ_2, while that between the plane and the upper block is μ_1. Suppose $\mu_1 < \mu_2$. The upper and lower blocks both start to accelerate after release, with accelerations a_1 and a_2 respectively. At $t = t_1$ they collide, while still traveling down the plane.

a) [5 points] Draw a free body diagram for each block, applicable for any time in the interval $0 < t < t_1$.
b) [10 points] Derive expressions for a_1 and a_2 in terms of the given variables: M, g, L, θ, m_1 and m_2.
c) [10 points] What is t_1 in terms of these same variables?