Physics 7A, Spring 2012, Sections 2 and 3, Instructor: Professor Adrian Lee
Midterm Examination, Tuesday, February 21, 2012

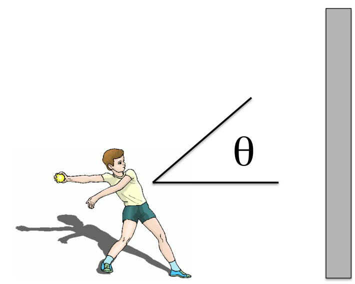
Please do work in your greenbooks. Show your reasoning carefully so that we can be sure that you derived the answer rather than guessing it or relying on memory; in addition, this enables us to give partial credit. You may use one double-sided 3.5 x 5 index cards of notes. Test duration is 110 minutes. Calculators are not allowed.

1 Solo game of catch [25 pts. total]

You are playing catch with a rubber ball, by throwing it against a vertical wall a distance L away. You throw the ball with speed v_0 at an angle θ such that it flies through the air, hits the wall and comes back to you without touching the ground. The wall is perfectly smooth and the collision perfectly elastic, so the the velocity component perpendicular to the wall is reversed, while the tangential component is unaffected.

a) Make a sketch of the ball's trajectory. Find the relationship between v_0 and θ such that the ball will come back to you. [15 pts.]

b) If the hardest you can throw the ball is with speed ν_{max}, what is the maximum distance the wall can be and still have the ball return to you? What is θ in this case? [10 pts.]



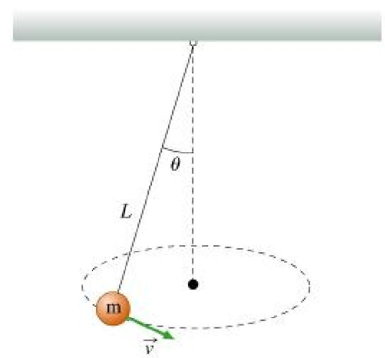
2 Conical Pendulum, Similar to Giancoli Ex. 5-13 [25 pts. total]

A small ball of mass m, suspended by a string of length L, revolves in a circle where θ is the angle the string makes with the vertical.

a) Make a free-body diagram. [5 pts.]

b) Calculate the speed and period of the ball in terms of m, L, θ, and g (note: the answer may not use all of these). [15 pts.]

c) What is the tension in the string? What is magnitude and direction of the ball's acceleration? [5 pts.]

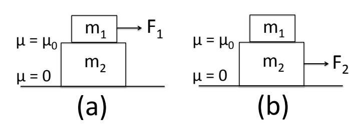


3 Similar to Giancoli 5-32 [25 pts. total]

Consider a small mass with $m = m_1$ sitting on top of a larger mass with $m = m_2$ which in turn sits on a table. Between the two blocks, the coefficient of static friction is equal to the coefficient of kinetic friction which are both equal to μ. There is no friction between the lower block and the table.

a) Make a free-body diagram. How much force can be applied to the top block with $m = m_1$ before slipping between the blocks occurs? [15 pts.]

b) Make a free-body diagram. How much force can be applied to the bottom block with $m = m_2$ before slipping between the blocks occurs? [10 pts.]



4 Similar to Giancoli 4-55 [25 pts. total]

A small block of mass m rests on the sloping side of a triangular block of mass M which itself rests on a horizontal table as shown in the figure above. Assume all surfaces are frictionless.

a) Make a free-body diagram. Determine the magnitude of horizontal force applied to the mass M so that the mass m remains in a fixed position relative to M [15 pts.]

b) Now assume there is no horizontal force and the masses both start at rest. Make a free-body diagram. What are the x and y accelerations of both blocks? [10 pts.]