Homework 1.1 Physics 419

Due: Sept. 1

1. A box (mass M) on an inclined plane is connected to a string which passes over a pulley and a second freely hanging mass (m) is hanging from the other end as shown in the figure. If the coefficient of kinetic friction between the box and the incline is μ_k, at what angle of incline will the box slide at constant speed? Hints: This is a generalized form of MT 2-32. It is convenient (and acceptable) to report the answer as a formula for $\sin\theta$. You should begin by deciding what conditions are required of the forces on the box.

2. In class we discussed this question: The driver of a car on a steady downhill grade slams on his brakes and skids to a halt over distance L, under the influence of the cars weight and a frictional force governed by μ_k. How is L related to the car's initial speed v and the angle of the grade θ? Redo the problem working directly with forces instead of energy.

3. Why you would want to know this, I can't imagine, but it's kind of amusing.

   (a) If a projectile is fired into the air at a very nearly vertical angle, its distance from the gun increases for awhile and then decreases. If it is fired nearly horizontally, the distance will always increase. Picture that, either in your head or on paper. Neglecting drag, what is the maximum angle θ_c from the horizontal at which we can fire such that the projectile is always moving farther away? Hints: Above the critical angle, there is a time at which the derivative of distance (wrt t) passes through zero. The formula for this "turning time" has real solutions only above θ_c.

   (b) You may have been surprised to find that the answer does not depend on g or the initial velocity v_0 of the projectile. Try to articulate why this is so. Go back to your equations for the horizontal and vertical positions [$x(t)$ and $y(t)$] of the projectile and write them in a dimensionless form by finding a distance and time scale in terms of g and v_0. Does the answer to the problem depend upon $x(t)$ and $y(t)$ really, or just their ratio? Can you explain "why this is so" better now?