PHY6938 Mechanics Fall 97 January 28, 2000

Note: hand in questions 1, 2 and 4 as homework; we will work 3 in class on Tuesday.

1. A block of mass m rests on an inclined plane which forms an angle of θ with the horizontal. The block is prevented from sliding down by being attached to a spring with spring constant k. The block is displaced upwards (along the plane) by a distance d, and then released at time $t = 0$.

a) Calculate the displacement of the block at time $t > 0$, ignoring friction.

b) How much work is required to perform the initial displacement if the coefficients of static and kinetic friction are μ_s and μ_k, respectively?

c) What is the minimum angle θ, such that the block will start to move after the displacement?

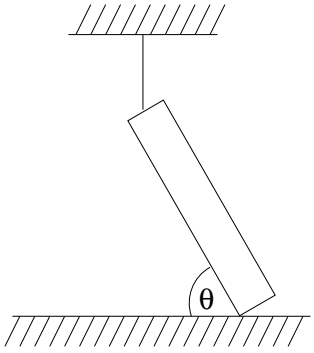
d) What is the minimum displacement d, such that the block will start to move, independent of the angle θ?

2. A projectile of mass m is fired at an angle θ above the horizontal, with an initial velocity v_0. At the highest point of the trajectory, the projectile explodes into two fragments of equal mass. One of the fragments falls vertically with zero initial speed, following the explosion.

a) How far from the point of firing does the other fragment strike the level terrain?

b) How much energy was released during the explosion? (Assume that the energy loss in the form of heat and soiund may be ignored.)

3.A uniform rod of mass m and length L is suspended on one end by a string, while the other end rests on the ground, such that it forms an angle θ with the horizontal.



a) What is the tension in the string?

b) Now imagine the string is cut, and the rod starts to fall. Calculate the vertical component of the acceleration of the center of mass of the rod, at the moment $t = 0$ immediately following

the cut. Ignore friction with the ground.

c) What is the force F_N that the rod exerts on the ground at time $t = 0$, immediately after the cut? (*Hint*: It is different than before the string was cut.)

4) A fountain designed to spray a column of water 12 m into the air has a 1 cm diameter nozzle at ground level. The water pump is 3 m below the ground. The pipe to the nozzle has a diameter of 2 cm. What pump pressure is required? $P_{\text{atm}} = 101$ kPa. (Neglect the viscosity of the water).