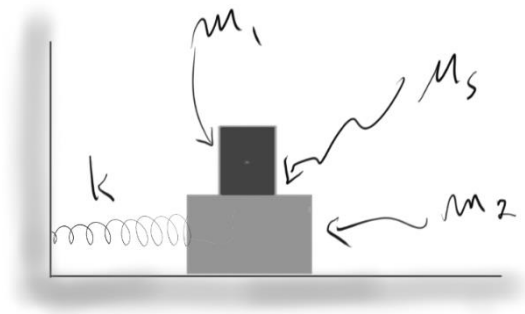


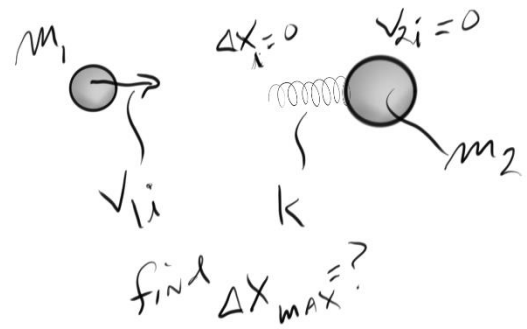
1. (10 points) A block of mass  $m_2$  rests on a frictionless surface and is connected to a horizontal spring of stiffness constant  $k$ . The other end of the spring is attached to a wall. A second block with a mass  $m_1$  rests on top of the first block. The coefficient of static friction between the blocks is given as  $\mu_s$ . **Find the maximum amplitude of the oscillation such that the top block will not slip over the bottom block.**

If you need it, recall that  $T = 2\pi(m/k)^{0.5}$

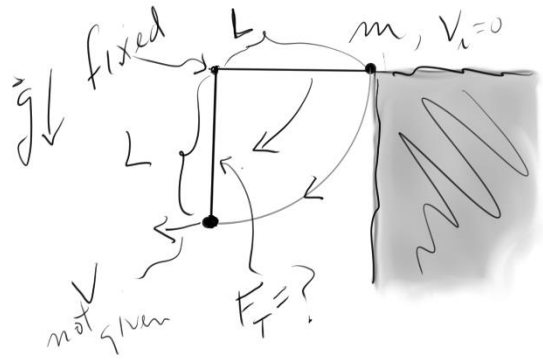


2. (10 points) Given that we know the mass of the moon,  $M_m$ , and the earth,  $M_E$ , and the initial distance between their centers as the moon orbits the earth,  $R_{EM}$ , if the earth's angular velocity about its own axis is slowing down from say some initial given angular velocity,  $\omega_i$  to a final angular velocity (due to tidal friction),  $\omega_f$ , then **find the final orbital distance between the earth and moon as a consequence**. Ignore the rotation of the moon about its own axis and treat it as a point object in circular orbit about the center of a fixed (but spinning) earth.

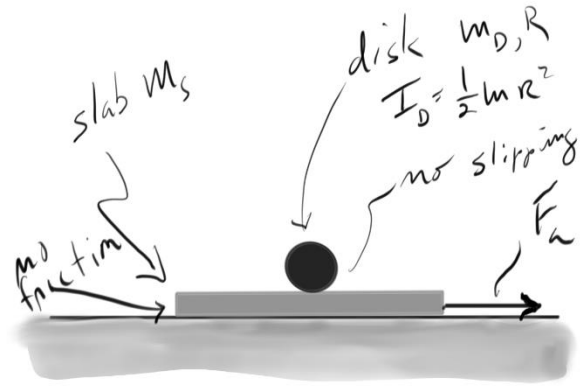
3. (10 points) Gravity is irrelevant in this problem. This is a one dimensional problem. Mass  $m_1$  has an initial given velocity of  $v_{1i}$ . The initial velocity of mass  $m_2$  is zero; it is not held fixed. The spring is initially in a relaxed state and attached to  $m_2$ . The two masses undergo a collision and the spring compresses. **Find the maximum compression of the spring.**



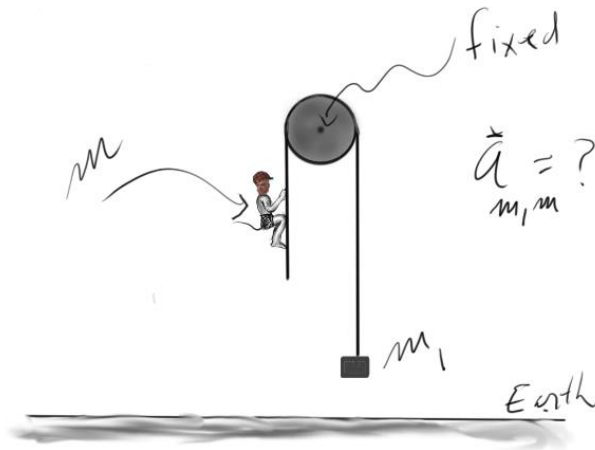
4. (10 points) A mass,  $m$ , starts from rest at the position as shown. It then swings down, attached to the string of given length  $L$ , through a circular arc. **Find the tension in the string when the mass is at the bottom of the swing** (its velocity would not be zero there). There is gravity in this problem.



5. (10 points) Refer to the diagram. The slab is pulled to the right by a given applied force  $F_A$ . There is no friction between the slab and the table it is on. The coefficient of static friction between the slab and the disk is not given. The cylinder rolls without slipping. **Find the acceleration of the center of mass of the cylinder relative to the ground. Specify the direction.**



6. (10 points) Refer to the diagram. The pulley has no mass (you're welcome) and it is free to rotate about its fixed center. The string has no mass and does not stretch. The monkey (mass,  $m$ ) in the problem is sliding down along the rope (sliding friction, coefficient not given) such that it starts from rest (relative to the earth) and slides downward (relative to the earth) a distance (relative to the earth) of  $H$  in a given time of  $t$  such that its acceleration is a constant. While this is occurring,  $m_1$  is also accelerating. You may assume the friction between the monkey and the rope has the same magnitude as the tension in the rope. **Find the acceleration of  $m_1$  relative to the monkey.**



7. (10 points) The mass,  $m$ , slides off a fixed sphere from rest with no friction and no rolling. The sphere is held fixed. Where does the mass land on the ground? There is gravity in the problem.

