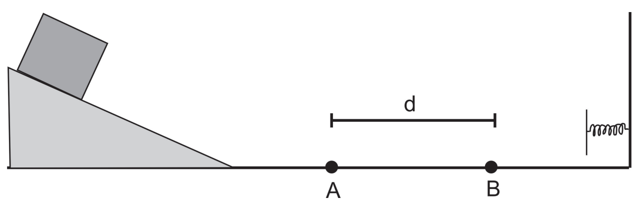
Assignment VII, PHYS 111 (General Physics I)
Fall 2016
Due 10/21/16 at start of class

As always, please put your clearly written answers on separate paper.

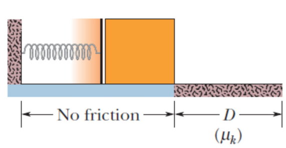
1. A block with mass M is released from height h above the level portion of the track shown below. The track is rough between points A and B, but elsewhere all surfaces are frictionless. As the block traverses the distance d between points A and B it loses mechanical energy E_1 ($E_1 < Mgh$). The spring constant of the spring affixed to the wall is k. Leave all of your answers to this problem symbolically in terms of M, h, g, E_1, and k.

   a) Find the speed of the block at point A the first instant it passes through point A.
   b) Find the speed of the block at point B the first instant it passes through point B.
   c) What is the maximum compression of the spring during the motion of the block?
   d) What is the coefficient of kinetic friction between the block and the rough portion of the track?
   e) Assuming $E_1 < \frac{Mgh}{2}$, how high would the block reach on the first "return trip" up the triangular wedge?



2. A 4.2 kg block is accelerated from rest by a compressed spring of spring constant 732 N/m. The block leaves the spring at the spring's relaxed length and then travels over a horizontal floor with a coefficient of kinetic friction $\mu_k = 0.17$. The frictional force stops the block in distance $D = 11.2$ m. Leave all your answers to this problem numerical (with appropriate units!)

   a) What is the increase in the thermal energy of the block-floor system?
   b) What is the maximum kinetic energy of the block?
   c) What is the original compression distance of the spring?
   d) What was the initial velocity of the block right after breaking contact with the spring?
   e) What is the velocity of the block when it has traveled $D/2 = 5.6$ m from the spring?



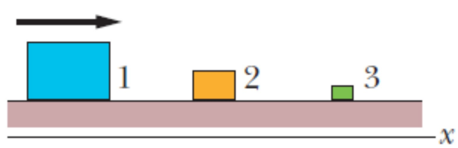
3. A toy consists of a piece of plastic attached to a spring. The spring is compressed 3.00 cm and the toy is released. If the mass of the toy is 180 g and it rises to a maximum height of 85 cm, find the force constant of the spring.

4. The figure below shows block 1 (with mass m_1) sliding along the x axis of a frictionless floor with speed $v_{1i} = 4.00$ m/s. Then block 1 undergoes an elastic collision with a stationary block of mass $m_2 = \frac{m_1}{2}$. Next, block 2 undergoes a one-dimensional elastic collision with stationary block 3 having mass $m_3 = \frac{m_2}{2}$.

   a) What then is the final speed of block 3?

   b) What fraction of the initial kinetic energy is transferred to block 3? (In other words, if the initial kinetic energy is K_i, you can write that the final kinetic energy of block 3 as $(K_f)_3 = \gamma K_i$ with γ some constant between 0 and 1. Find γ).

   c) What fraction of the initial momentum is transferred to block 3? (In other words, if the initial momentum is p_i, you can write the final momentum of block 3 as $(p_f)_3 = \beta p_i$ with β some constant. Find β).



5. A neutron in a reactor makes a collision with the nucleus of a carbon atom initially at rest. (Assume that the nucleus of a carbon atom is initially equal to 12 times the mass of a neutron). (You may need to look up the mass of a neutron; it is in the front cover of your textbook). You may assume that this problem is 1-dimensional (e.g. everything occurs in a line).

   a) If the collision was inelastic (e.g. the neutron combines with the carbon nucleus), what fraction of the initial kinetic energy of the neutron is lost?

   b) If the collision was actually perfectly elastic (e.g. the neutron just "hits" the carbon nucleus; all motion stays in a line), then what fraction of the neutron's initial kinetic energy is transferred to the carbon nucleus?

   c) Again, if the collision was actually perfectly elastic and if the initial kinetic energy of the neutron was 1.93×10^{-13} J, what are the final kinetic energies of both the neutron and the Carbon nucleus after the collision?

6. During the battle of Gettysburg, the gunfire was so intense that several bullets collided in midair and fused together. Assume a 5.00 g Union musket ball moving to the right at 280 m/s and 23.0° above the horizontal collides with a 3.75 g Confederate ball moving to the left at 294 m/s and 14° above the horizontal.

    a) Immediately after they collide, what was the velocity of the fused-together bullet?

    b) How much kinetic energy was lost in the fusing-together process?