1. A bullet is fired horizontally into a wooden block that is initially at rest. The bullet becomes embedded in the piece of wood and the two begin to slide across a rough horizontal surface. We know that the mass of the bullet is $m_b = 10 \text{ g}$, its initial velocity is $v_{bi} = 400 \text{ m/s}$ the mass of the wooden block is $m_w = 300 \text{ g}$, and the coefficient of kinetic friction between the block and floor is $\mu_k = 0.50$. We are going to find how far the block slides.

(a) We can split this problem into two sub-processes. The first is when the bullet hits the wooden block. Since this is a collision, we will want to use momentum to analyze it. For this process:
   i. Identify a system.
   ii. Identify the initial and final states.
   iii. Is the momentum of the system conserved?
   iv. What is the magnitude of the impulse on the system?
   v. What is the final momentum of the block and bullet after they have stuck together?
   vi. What is the final velocity of the block and bullet after they have stuck together?

(b) The second sub-process is when the block/bullet conglomeration slides across the floor. The final velocity from the first sub-process will be the initial velocity for the second sub-process. Since there is a frictional force, we will want to use energy to analyze it. For this process:
   i. Identify a system.
   ii. Identify the initial and final states.
   iii. Is the energy of the system conserved?
   iv. How much work is done on the system?
   v. What is the magnitude of the frictional force that acts on the block/bullet conglomeration?

(c) How far does the wooden block slide?

2. Hockey puck 1 is tied to a string that is nailed to a frictionless floor, while hockey puck 2 travels toward it, as shown on the left side of the figure. Eventually, the pucks collide and hockey puck 1 begins to move in uniform circular motion, while hockey puck 2 continues on its path with a smaller velocity, as shown on the right side of the figure. Both hockey pucks have masses of $m_p = 0.5 \text{ kg}$, the initial velocity of puck 2 is $v_{2i} = 3 \text{ m/s}$, the final velocity of puck 2 is $v_{2f} = 1 \text{ m/s}$, and the length of the string is $\ell = 20 \text{ cm}$. We are going to find the tension in the string after the collision.

(a) Use momentum to find the velocity of puck 1 just after the collision.

(b) Use your knowledge of centripetal motion to find the tension in the string.
3. To measure the speed of a bullet, the following situation is set up: a wooden block \((m_w = 0.5\, \text{kg})\) is put on top of a fencepost with a height of 1.5 m. The bullet \((m_b = 0.1\, \text{kg})\) strikes the block from a perfectly horizontal direction and remains embedded in it. The block is measured to fall 1.6 m from the base of the post. How fast was the bullet going?

This problem is from the University of Oregon’s Physics Problems page, located at http://zebu.uoregon.edu/. (Click on Physics Courses, then Physics Problems.) This is a good site with problems you can use to review.