Recitation Problems for Week 12, Thursday

8.C8. Two identical objects of mass m are observed in their center-of-mass frame to be moving back-to-back with the same speed v. One is moving up and to the right at an angle of 45° to the x-axis. The other is moving down and to the left, also at an angle of 45° relative to the x axis. The system is also moving with $v_{cm} = 2v$ along the x axis. What angles do the two particles make to the x axis in the lab frame?

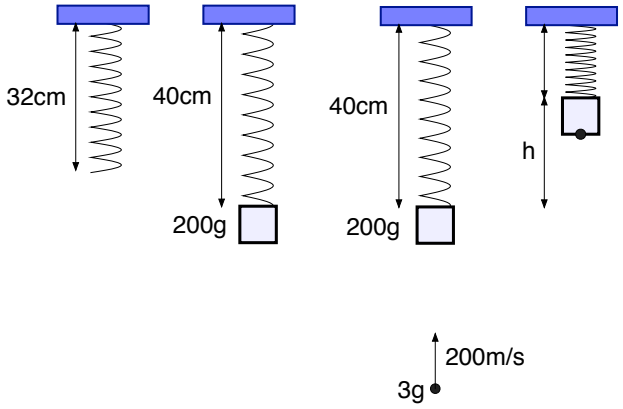

Figure 1: A mass suspended from a spring. A bullet is then shot up into the mass. See problem 8.S40 for details.

8.S40. A spring has an unstretched length of 32 cm. A 200 g block is hung from the spring and its length is measured to be 40 cm. This is depicted in Figure 1. We then stretch the spring an additional 3 cm and release the block from at rest. Ignoring air resistance, answer the following questions about the block-spring system. (a) How long does it take for the block to return to its initial position? (b) The spring is returned to its rest position and a 3 g bullet moving 200 m/s is shot into the block. The bullet sticks inside the mass, and the mass moves upward to some maximum height h above its starting position. What is the speed of the block just after the bullet sticks to it? (c) How high will the block rise after being struck by the bullet?

8.S41. Two balls of identical size and speeds, v_i, have a head-on collision as shown to the left in Figure 2. The ball to the left has a mass m and the ball to the right has a mass $5m$. (a) If the two balls stick together as shown in the figure to the left, what is their final velocity, $\vec{v}_f$? (b) Assume that the collision is elastic as depicted in the right-hand side of Figure 2, and that after the collision both balls are moving along the horizonal axis with velocities $\vec{v}_{1f}$ and $\vec{v}_{2f}$ respetively. What are $\vec{v}_{1f}$ and $\vec{v}_{2f}$ in terms of m and v_i?

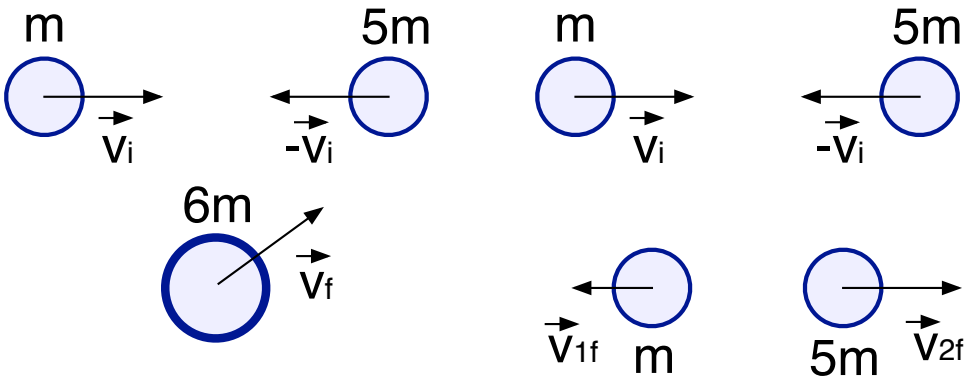

Figure 2: The collisons in problem 8.S41. The left-hand depicts a sticking collision between the two balls. The righ-hand is a one-dimensional elastic collision.

8.S43. Two identical spherical objects of mass m and radius a approach each other nearly head on with equal and opposite velicities, $\vec{v}_i$ and $-\vec{v}_i$. In this case, nearly means that the paths followed by the centers of the two objects are a distance a apart as shown in Figure **??**. The two objects stick together in a spherical shaped mass of $2m$ with a new radius, $2a$. (a) What is the final translational kinetic energy of the resulting mass? (b) What is the final rotational kinetic energy of the resulting mass? (c) How much energy could have gone into heating the resulting mass?

8.S45. One proposal for propelling space craft through the solar system is to have them sail on the light from the Sun. A large sail is attached to the spacecraft and the photons from the Sun striking the sail cause it to start to move. (a) A black sail would absorb the impinging photons, while a silver sail would reflect them back. Which of these would be more effective as a sail? Explain your resoning. (b) Assume that we have N photons striking the sail every second. The photons each have energy E and strike the surface of the sail at a right angle to the sail. What is the force acting on the sail?