1.   As shown in figure, a bullet of mass m and speed v passes completely through a pendulum bob of mass M.   The bullet emerges with a speed of $v/2$. The pendulum bob is suspended by a stiff rod of length ℓ and negligible mass. What is the minimum value of v such that the pendulum bob will barely swing through a complete vertical circle?
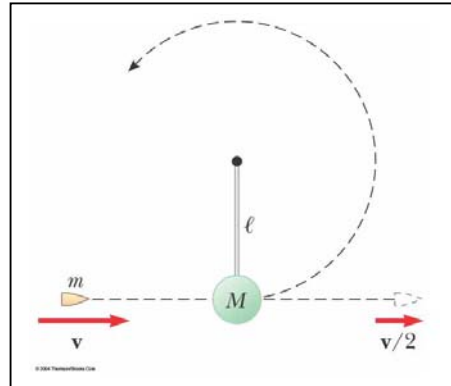
2.   (a) Three carts of masses 4.00 kg, 10.0 kg, and 3.00 kg move on a frictionless horizontal track with speeds of 5.00 m/s, 3.00 m/s, and 4.00 m/s, as shown in figure. Velcro couplers make the carts stick together after colliding. Find the final velocity of the train of three carts. (b) Does your answer require that all the carts collide and stick together at the same time?   What if they collide in a different order?
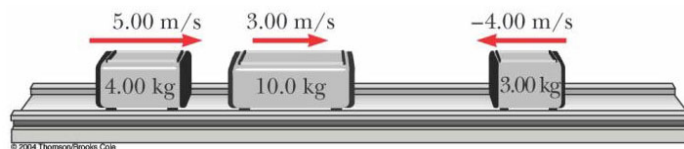
3.   Two gliders are set in motion on a flat horizontal air track. A spring of force constant k is attached to the rear side of one glider. The first glider of mass m_1 has velocity $\mathbf{v_1}$ and the second glider of mass m_2 moves more slowly, with velocity $\mathbf{v_2}$, as shown in the figure. When m_1 collides with the spring attached to m_2 and compresses the spring to its maximum compression x_{max}, the velocity of the gliders is $\mathbf{v}$.   In terms of $\mathbf{v_1}$, $\mathbf{v_2}$, m_1, m_2, and k, find (a) the velocity $\mathbf{v}$ at maximum compression, (b) the maximum compression x_{max}, and (c) the velocity of each glider after m_1 has lost contact with the spring.
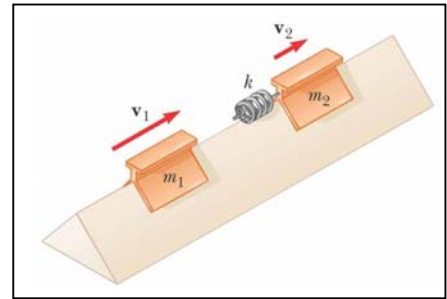
4.   A tennis ball of mass 57.0 g is held just above a basketball of mass 590 g. With their centers vertically aligned, both balls are released from rest at the same time to fall through a distance of 1.20 m as shown in the figure. Assume that an elastic collision with the ground instantaneously reverses the velocity of the basketball while the tennis ball is still moving down, and the two balls meet immediately in an elastic collision. Both balls can be treated as two separate point masses.

(a)   Find the magnitude of the downward velocity with which the basketball reaches the ground.

(b)   To what height does the tennis ball rebound?