Quiz 4

Solutions

Choose the best answer.

1. Two athletes are at opposite ends of a long cart that can roll freely on a floor. The combined mass of the cart and its contents is M. The athlete at the left end throws a heavy medicine ball of mass m at speed v to the other one at the the right end, who catches it without moving relative to the cart. After this:

   A. The cart is moving to the right with speed mv / M.

   B. The cart remains fixed at its original location..

   C. The CM has shifted to the right.

   ☛D. The CM remains fixed at its original location. [No external horizontal force.]

Choose T or F depending on whether the statement is true or false.

2. The static friction force on a ball rolling from rest down an incline is directed up the incline. **T**

3. A fireworks rocket is shot vertically into the air. At the top of its flight it explodes into two pieces of mass m and $2m$. Immediately after the explosion the heavier piece moves horizontally toward the north with speed v_0.

   a. How much energy did the internal forces of the explosion provide? [Answer in terms of m and v_0.]

   b. Describe the motion of the CM of the system while the pieces are in the air. [What external forces are acting?]

   c. If the heavier piece lands at distance R north of the original launch point, where does the lighter one land? [Answer in terms of R.]

a. The rocket is at rest when it explodes, so the explosion adds all the initial kinetic energy of the two pieces. The light piece has equal and opposite momentum to the heavier one, or $2mv_0$, so it has speed v_0. The total kinetic energy is $K = \frac{1}{2}(2m){v_0}^2 + \frac{1}{2}m(2v_0)^2 = 3m{v_0}^2$. This is the energy provided by the explosion.

b. The only external force is gravity, so the CM falls straight down to the original launch site.

c. The two pieces and the CM land simultaneously, so the lighter piece lands at distance $2R$ south of the launch point.