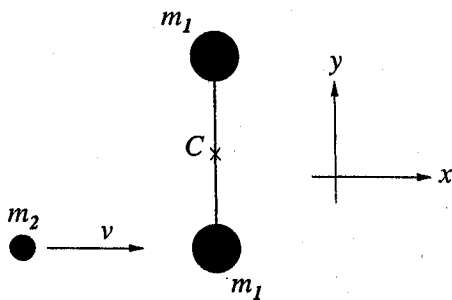


## Problem 3



A massless rod of length  $2R$  has masses  $m_1$  attached to each end. The rod is free to rotate on the surface of a frictionless table about a pin attached to its center  $C$ . A mass  $m_2$  is moving across the table at speed  $v$  perpendicular to the rod and is aimed directly at one of the masses  $m_1$  as shown in the diagram. At time  $t = 0$ ,  $m_2$  collides with  $m_1$  and sticks instantaneously, setting the rod into rotation about  $C$ .

- (a) (2 point) Considering only the rod and masses, which, if any, of the following quantities are conserved in this collision:
1. Linear Momentum?
  2. Angular Momentum about  $C$ ?
  3. Kinetic Energy?
- (b) (3 points) What is the angular velocity  $\omega$  following the collision, and is it constant?
- (c) (3 points) Determine the total linear momentum  $\mathbf{P}$  of the rod and mass system following the collision. Give both the  $x$  and  $y$  components and specify their time dependences, if any.
- (d) (2 points) Determine the force  $\mathbf{F}$  exerted by the pin at  $C$ . Again, give both the  $x$  and  $y$  components and specify their time dependences, if any. Also give the magnitude of the force.