## Answer on Question #56597, Physics Mechanics Relativity

5.14 A stick of length l lies on horizontal table. It has a mass M and is free to move in any way on the table. A ball of mass m, moving perpendicularly to the stick at a distance d from its center with speed v collides elastically with it as shown in figure -5.117. What quantities are conserved in the collision? What must be the mass of the ball so that it remains at rest immediately after collision.

## Figure 5.117

Solution

## In the collision, linear momentum of the system (stick+ball), angularmomentum and kinetic energy are conserved. Using the law of conservation of angular momentum

$$mv = MV \tag{1}$$

By the law of conservation of angular momentum

$$mvd = J\omega$$
 (2)

where  $J = \frac{1}{12}Ml^2$ 

From the principle of conservation of kinetic energy

$$\frac{1}{2}mv^2 = \frac{1}{2}J\omega^2 + \frac{1}{2}MV^2$$
(3)

Then

$$mv^{2} = J \cdot \frac{m^{2}v^{2}d^{2}}{J^{2}} + M \frac{m^{2}v^{2}}{M^{2}} \Longrightarrow m = \frac{m^{2}d^{2}}{\frac{1}{12}Ml^{2}} + \frac{m^{2}}{M} \Longrightarrow$$
$$1 = \frac{12d^{2}m}{Ml^{2}} + \frac{m}{M} \Longrightarrow m = M \left(\frac{l^{2}}{l^{2} + 12d^{2}}\right)$$

**Answer:** 
$$m = M\left(\frac{l^2}{l^2 + 12d^2}\right).$$

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