We are given that the object m_1 collides with the rod with velocity v_0, and the rod is floating in free space. Given m_1, v_0, m_2, I_0, and r, we are to figure to the final velocity of m_1 after collision v_f, the velocity of m_2 after collision v_{CM}, and of course the rotation of the rod after collision ω.

We are assuming that this collision elastic.

We have, then, for conservation of linear momentum:

$$m_1 v_0 = m_1 v_f + m_2 v_{CM} \tag{1}$$

Furthermore, we understand that kinetic energy is also conserved here; therefore:

$$\frac{1}{2} m_1 {v_0}^2 = \left(\frac{1}{2} m_1 {v_f}^2\right) + \left(\frac{1}{2} m_2 {v_{CM}}^2\right) + \left(\frac{1}{2} I_0 \omega^2\right) \tag{2}$$

$$\Rightarrow m_1 {v_0}^2 = \left(m_1 {v_f}^2\right) + \left(m_2 {v_{CM}}^2\right) + \left(I_0 \omega^2\right) \tag{3}$$

as the point mass does not have any rotational inertia, and the rod is not rotating at the start.

Lastly, we understand that the angular momentum is also conserved; setting the origin at the centre of mass:

$$v_0(m_1 r^2) = v_f(m_1 r^2) + v_{CM} I_0 \tag{4}$$

Actually setting up to solve the expressions, then:

```
var("I m1 v0 m2 r")
var("vf vcm w")

solve([m1*v0 == m1*vf+m2*vcm, m1*v0^2==m1*vf^2+m2*vcm^2+I*w^2, v0*m1*r^2 == vf*m1*r^2+vcm*I], vf, vcm,
```