

Name:

Key

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A cart with mass of 340 g moving on a frictionless linear air track at an initial speed of 1.2 m/s undergoes an **elastic** collision with an initially stationary cart of unknown mass. After collision, the first cart continues in its original direction at 0.66 m/s.

a) What is the mass of the second cart, and b) what is its speed after collision.

$$\vec{P}_i = \vec{P}_f$$

$$(0.34)(1.2)\hat{i} = m_2 \vec{v}_{2f} + 0.34(0.66)\hat{i}$$

$$m_2 v_2 = 0.34(1.2)\hat{i} - 0.34(0.66)\hat{i}$$

$$m_2 \vec{v}_2 = 0.1836 \hat{i} \quad (1)$$

$$K_i = K_f$$

$$\frac{1}{2}(0.34)(1.2)^2 = \frac{1}{2}m_2 v_2^2 + \frac{1}{2}0.34(0.66)^2$$

$$\Rightarrow m_2 v_2^2 = 0.3415 \quad (2)$$

Solving (1) \rightarrow (2) we get:

$$m_2 = 0.099 \text{ kg}$$

$$\vec{v}_{2f} = (1.86 \frac{\text{m}}{\text{s}})\hat{i}$$

c) What is the speed of the center of mass **before** and **after** collision?

it is the same

$$\begin{aligned}
 (v_{\text{com}})_i &= \frac{(P_{\text{tot}})_i}{M_{\text{tot}}} = \frac{m_1 v_{1i} + m_2 v_{2i}}{m_1 + m_2} = \frac{(0.34)(1.2) + 0}{0.34 + 0.099} \\
 &= \frac{0.408}{0.439} = \boxed{0.929 \frac{\text{m}}{\text{s}}} = (v_{\text{com}})_f
 \end{aligned}$$