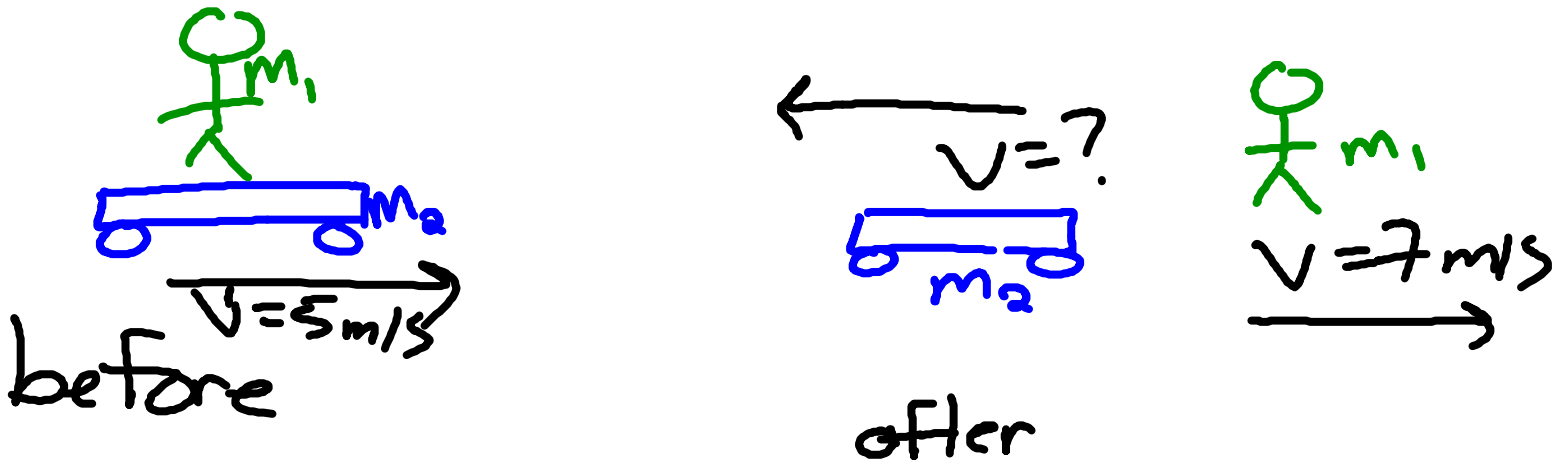


### Example Conservation of Momentum Problem

A 50 kg woman is riding on a 10 kg cart moving east at 5.0 m/s. The woman jumps off the front of the cart and hits the ground at 7.0 m/s eastward, relative to the ground. Calculate the cart's velocity after the woman jumps off.



$$P_b = P_a$$

$$(m_1 + m_2)v_b = m_1 v_{1a} + m_2 v_{2a}$$

$$\frac{(m_1 + m_2)v_b - m_1 v_{1a}}{m_2} = \frac{m_2 v_{2a}}{m_2}$$

$$\frac{(50\text{ kg} + 10\text{ kg})5\text{ m/s} - (50\text{ kg})(7\text{ m/s})}{(10\text{ kg})} =$$

$$\boxed{-5\text{ m/s} = v_{2a}}$$

$$p = mv$$

Video of marble colliding with soda can.

What is the velocity of the marble before the collision?

$$\frac{960 \text{ frames}}{s}$$

$$\begin{aligned} \text{marble} \\ \rightarrow 18 \text{ cm} = .18 \text{ m} \\ \rightarrow 3 \text{ frames} \end{aligned}$$

$$\begin{aligned} \text{can} \\ \rightarrow 15 \text{ cm} = .15 \text{ m} \\ \rightarrow 20 \text{ frames} \end{aligned}$$

$$t_{\text{marble}} = 3 \text{ frames} \times \frac{1 \text{ s}}{960 \text{ frames}} = .003125 \text{ s}$$

$$t_{\text{can}} = 20 \text{ frames} \times \frac{1 \text{ s}}{960 \text{ frames}} = .02083 \text{ s}$$

$$v = \frac{d}{t}$$

$$v_{\text{marble}} = \frac{.18 \text{ m}}{.003125 \text{ s}} = 57.6 \text{ m/s}$$

$$v_{\text{can}} = \frac{.15 \text{ m}}{.02083 \text{ s}} = 7.20 \text{ m/s}$$

$$\begin{aligned} m_c &= .013 \text{ kg} \\ m_m &= .0023 \text{ kg} \end{aligned}$$

$$P_b = P_a$$
$$\frac{m_m v_m + m_c v_c}{m_m} = \frac{m_m v_{ma} + m_c v_{ca}}{m_m}$$

$$v_m = \frac{[(.0023 \text{ kg})(57.6 \text{ m/s}) + (.013 \text{ kg})(7.20 \text{ m/s})]}{(.0023 \text{ kg})}$$

$$v_m = 98.3 \text{ m/s}$$