

35. **ORGANIZE AND PLAN** We are asked to find the magnitude of the momentum from mass and speed. We'll use the definition of momentum

$$p = mv.$$

Known: $m = 64 \text{ kg}; v = 7.3 \text{ m/s}.$

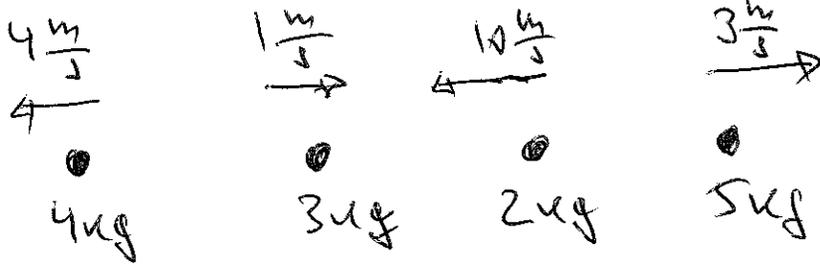
SOLVE Using the definition of momentum,

$$p = mv = (64 \text{ kg})(7.3 \text{ m/s}) = 470 \text{ kg}\cdot\text{m/s}$$

REFLECT A person with a mass of 64 kg "weighs" about 140 lb on a spring scale. This is a reasonable weight. A person in good physical condition can run 100. m in 10-11 seconds (9.1-10 m/s). So a speed of 7.3 m/s is also reasonable.



Four objects are moving along a straight line as shown in the figure. Taking the positive direction to be to the right, what is the total momentum of this system?



$$\Delta \vec{p} = \sum p_i \quad ; \quad \vec{p} = m \cdot \vec{v}$$

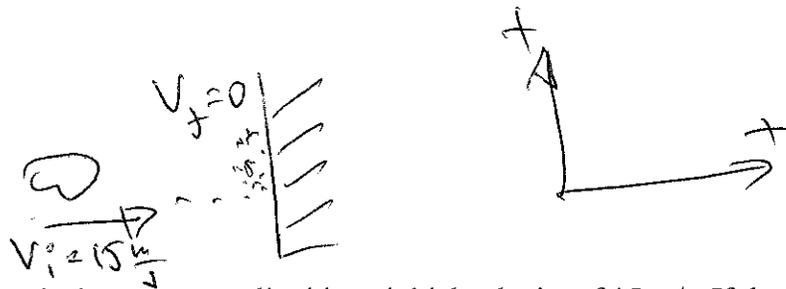
$$= -\left(4 \frac{\text{m}}{\text{s}}\right) \cdot 4 \text{ kg} = -16$$

$$+ \left(1 \frac{\text{m}}{\text{s}}\right) \cdot 3 \text{ kg} \quad + 3$$

$$- \left(10 \frac{\text{m}}{\text{s}}\right) \cdot 2 \text{ kg} \quad - 20$$

$$+ \left(3 \frac{\text{m}}{\text{s}}\right) \cdot 5 \text{ kg} \quad + 15$$

$$= -\left(8 \text{ kg} \cdot \frac{\text{m}}{\text{s}}\right)$$



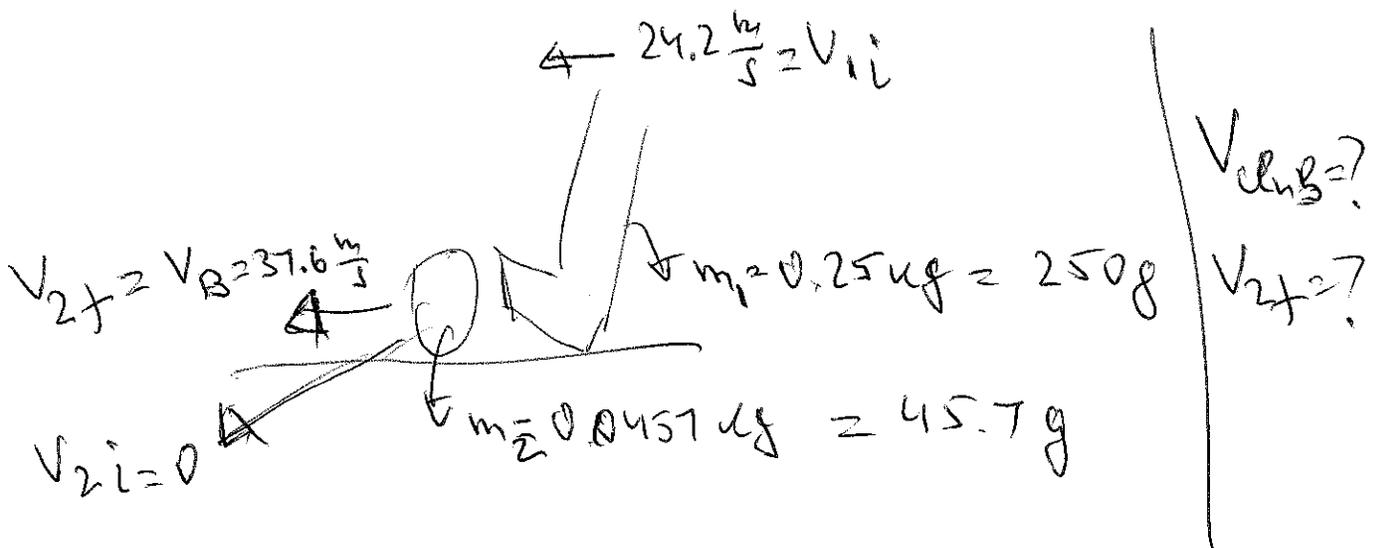
A 0.50 kg blob of putty is thrown at a wall with an initial velocity of 15 m/s. If the putty comes to a stop in 600 μ s, what is the average force experienced by the putty?

$$\vec{F} \Delta t = J = \Delta p = p_f - p_i$$

$$\vec{F} = (p_f - p_i) / \Delta t = \left(0 - \left(0.5 \text{ kg} \cdot 15 \frac{\text{m}}{\text{s}} \right) \right) / \Delta t$$

$$\vec{F} = -(0.50 \text{ kg}) \cdot (15 \text{ m/s}) / (600 \cdot 10^{-6})$$

$$= -1.25 \cdot 10^4 \text{ N}$$



57. **ORGANIZE AND PLAN** Here momentum is conserved and both objects are moving after the collision. We'll assume that the club and the ball are moving in the same straight line just before and after the collision. We're to find the speed of the head of the golf club. We'll use $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$ where subscript 1 refers to the club and subscript 2 refers to the ball. The club initially moves in the positive x -direction.

Known: $m_1 = 250 \text{ g}$; $m_2 = 45.7 \text{ g}$; $v_{1i} = 24.2 \text{ m/s}$; $v_{2i} = 0 \text{ m/s}$; $v_{2f} = 37.6 \text{ m/s}$.

SOLVE First we convert mass to kilograms:

$$m_1 = 250 \text{ g} \left(\frac{1 \text{ kg}}{1000 \text{ g}} \right) = 0.250 \text{ kg}$$

Likewise,

$$m_2 = 0.0457 \text{ kg}$$

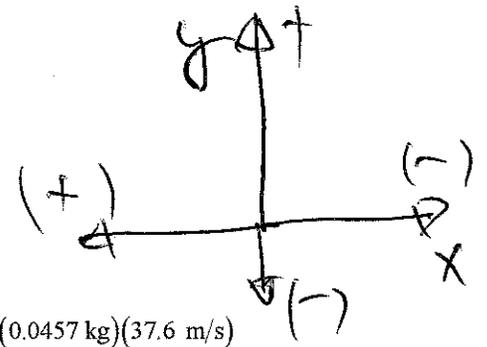
For conservation of momentum,

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

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$v_{1f} = \frac{m_1 v_{1i} + m_2 v_{2i} - m_2 v_{2f}}{m_1} = \frac{(0.250 \text{ kg})(24.2 \text{ m/s}) + 0 \text{ kg} \cdot \text{m/s} - (0.0457 \text{ kg})(37.6 \text{ m/s})}{0.250 \text{ kg}}$$

$$v_{1f} = 17.3 \text{ m/s}$$



The club head is moving at 17.3 m/s in its original direction.

REFLECT When a golfer swings the club, the club head "follows through" after colliding with the ball and ends up over the golfer's shoulder, so the positive final direction of the club head is reasonable. Only part of the head's momentum is imparted to the ball.