

# Momentum Problems ("ASSIGN 5")

Note Title

$$(1) \vec{p} = m\vec{v} = 950 \text{ kg} \times 40 \frac{\text{km}}{\text{h}} [\text{West}] \times \frac{1}{3.6} = \boxed{1.06 \times 10^4 \text{ kg}\cdot\frac{\text{m}}{\text{s}} [\text{W}]}$$

$$(2) \vec{p} = m\vec{v} \therefore \vec{v} = \frac{\vec{p}}{m} \quad \vec{v} = \frac{16 \text{ kg}\cdot\text{m}/\text{s}}{0.825 \text{ kg}} = 19.4 \text{ m/s} = \boxed{69.8 \frac{\text{km}}{\text{h}} [\text{E}]}$$

$$(3) \Delta\vec{p} = \Delta(m\vec{v}) = \Delta m \cdot \vec{v} = -40 \text{ kg} \times \left(\frac{50}{3.6}\right) \text{ m/s} = -556 \text{ kg}\cdot\frac{\text{m}}{\text{s}} [\text{E}]$$

$$= \boxed{556 \text{ kg}\cdot\frac{\text{m}}{\text{s}} [\text{W}]}$$

$$(4) \Delta\vec{p} = m\Delta\vec{v} \quad \left. \begin{array}{l} \uparrow 4.0 \text{ m/s} \\ 0 \end{array} \right\} \left. \begin{array}{l} 0 \\ \downarrow 3.0 \text{ m/s} \end{array} \right\} \begin{array}{l} \Delta v = v' - v \\ \Delta v = -3 - 4 = -7.0 \text{ m/s} [\text{N}] \\ \text{or } +7.0 \text{ m/s} [\text{S}] \end{array}$$

$$\therefore \Delta\vec{p} = 5.0 (7.0) = \boxed{35.0 \text{ kg}\cdot\frac{\text{m}}{\text{s}} [\text{S}]}$$

$$(7) \begin{array}{c} \text{[E]} \rightarrow \\ 140 \text{ kg} \\ \text{⊙} \rightarrow \text{⊙} \\ 30 \text{ km/h} \end{array} \quad \left\{ \quad \begin{array}{c} \text{⊙⊙} \rightarrow \\ ? \end{array} \right. \quad \begin{array}{l} m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2' \\ 140 \text{ kg} \times 30 \frac{\text{km}}{\text{h}} + 0 = (m_1 + m_2) v' \\ 4200 \text{ kg}\cdot\frac{\text{km}}{\text{h}} = 225 \text{ kg} \cdot v' \\ \boxed{18.7 \frac{\text{km}}{\text{h}} [\text{E}] = v'} \\ = 5.19 \text{ m/s} [\text{E}] \end{array}$$

$$(8) m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

$$85(40) + 140(-30) = 85 v_1' + 0$$

$$-941 = v_1' \quad \therefore v_1' = \boxed{9.41 \frac{\text{km}}{\text{h}} [\text{N}]}$$

$$= \boxed{2.61 \text{ m/s} [\text{N}]}$$

$$\textcircled{7} \text{ c) } \Delta \vec{p} = m \Delta \vec{v} = 150(7 \text{ m/s}) = \boxed{1050 \text{ kg} \cdot \text{m/s}}$$

$$\text{b) } \text{Impulse} = \Delta \vec{p} = \boxed{1050 \text{ kg} \cdot \text{m/s}}$$

$$\text{c) } \text{impulse on couch} = 1050 \text{ N} \cdot \text{s} \quad \text{imp} = F \Delta t \quad \bar{F} = \frac{1050 \text{ N} \cdot \text{s}}{0.05 \text{ s}} = \boxed{21,000 \text{ N}}$$

$$\textcircled{8} \text{ c) } \text{impulse} = \Delta p = m \Delta v$$

$$\text{speed @ impact: } v^2 = v_0^2 + 2ad$$

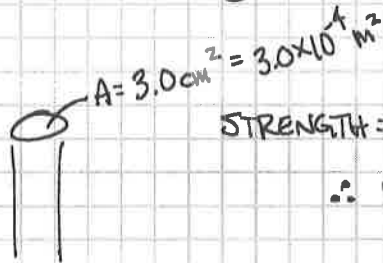
$$v^2 = 0 + 2(9.8)(5.0)$$

$$v = 9.90 \text{ m/s}$$

$$\therefore \Delta v = 9.90 \text{ m/s}$$

$$\Delta p = 70 \text{ kg}(9.90 \text{ m/s}) = \boxed{693 \text{ kg} \cdot \text{m/s}}$$

b)



$$A = 3.0 \text{ cm}^2 = 3.0 \times 10^{-4} \text{ m}^2$$

$$\text{STRENGTH} = 1.7 \times 10^8 \text{ N/m}^2$$

$$\therefore \text{max force} = 1.7 \times 10^8 \frac{\text{N}}{\text{m}^2} \times 3.0 \times 10^{-4} \text{ m}^2$$

$$= 51,000 \text{ N}$$

$$\text{Now, } \Delta t = 0.0020 \text{ s} \quad \therefore F = \frac{\Delta p}{\Delta t} = \frac{693 \text{ N} \cdot \text{s}}{0.0020 \text{ s}} = 347,000 \text{ N}$$

$\therefore$  he shatters his legs ( $347,000 > 2 \times 51,000$ )

$$\text{c) } F = \frac{\Delta p}{\Delta t} = \frac{693 \text{ N} \cdot \text{s}}{0.050 \text{ s}} = 13,900 \text{ N} \quad \therefore 6930 \text{ N each leg}$$

$\therefore$  no fractures