8.8: a) The magnitude of the velocity has changed by

\[(45.0 \text{ m/s}) - (-55.0 \text{ m/s}) = 100.0 \text{ m/s},\]

and so the magnitude of the change of momentum is \((0.145 \text{ kg})(100.0 \text{ m/s}) = 14.500 \text{ kg m/s},\) to three figures. This is also the magnitude of the impulse. b) From Eq. (8.8), the magnitude of the average applied force is

\[\frac{14.500 \text{ kg m/s}}{2.00 \times 10^{-3} \text{ s}} = 7.25 \times 10^3 \text{ N}.\]

8.12: The change in the ball’s momentum in the \(x\)-direction (taken to be positive to the right) is

\[(0.145 \text{ kg})(-65.0 \text{ m/s} \cos 30^\circ - 50.0 \text{ m/s}) = -15.41 \text{ kg} \cdot \text{m/s},\] so the \(x\)-component of the average force is

\[\frac{-15.41 \text{ kg} \cdot \text{m/s}}{1.75 \times 10^{-3} \text{ s}} = -8.81 \times 10^3 \text{ N},\]

and the \(y\)-component of the force is

\[\frac{(0.145 \text{ kg})(65.0 \text{ m/s} \sin 30^\circ)}{(1.75 \times 10^{-3} \text{ s})} = 2.7 \times 10^3 \text{ N}.\]

8.17: The change in velocity is the negative of the change in Gretzky’s momentum, divided by the defender’s mass, or

\[v_{B2} = v_{B1} - \frac{m_A}{m_B} (v_{A2} - v_{A1})\]

\[= -5.00 \text{ m/s} - \frac{756 \text{ N}}{900 \text{ N}}(1.50 \text{ m/s} - 13.0 \text{ m/s})\]

\[= 4.66 \text{ m/s}.\]

Positive velocities are in Gretzky’s original direction of motion, so the defender has changed direction.

b) \(K_2 - K_1 = \frac{1}{2} m_A (v_{A2}^2 - v_{A1}^2) + \frac{1}{2} m_B (v_{B2}^2 - v_{B1}^2)\)

\[= \frac{1}{2(9.80 \text{ m/s}^2)} \left[ (756 \text{ N})(1.50 \text{ m/s})^2 - (13.0 \text{ m/s})^2 \right.\]

\[+ (900 \text{ N})(4.66 \text{ m/s})^2 - (-5.00 \text{ m/s})^2 \left.\right]\]

\[= -6.58 \text{ kJ}.\]
8.22: 

$^{214}$Po decay: $^{214}$Po $\rightarrow ^4\alpha ^{210}X$

Set $v_\alpha : KE_\alpha = \frac{1}{2} m_\alpha v_\alpha^2$

$v_\alpha = \sqrt{\frac{2KE_\alpha}{m_\alpha}}$

$= \sqrt{\frac{2(1.23 \times 10^{-12} \text{ J})}{6.65 \times 10^{-27} \text{ kg}}} = 1.92 \times 10^7 \text{ m/s}$

Momentum conservation:

$0 = m_\alpha v_\alpha - m_x v_x$

$v_x = \frac{m_\alpha v_\alpha}{m_x} = \frac{m_\alpha v_\alpha}{210 m_p}$

$= \frac{(6.65 \times 10^{-27} \text{ kg})(1.92 \times 10^7 \text{ m/s})}{(210)(1.67 \times 10^{-25} \text{ kg})}$

$= 3.65 \times 10^5 \text{ m/s}$

8.30: Take north to be the $x$-direction and east to be the $y$-direction (these choices are arbitrary). Then, the final momentum is the same as the initial momentum (for a sufficiently muddy field), and the velocity components are

$v_x = \frac{(110 \text{ kg})(8.8 \text{ m/s})}{(195 \text{ kg})} = 5.0 \text{ m/s}$

$v_y = \frac{(85 \text{ kg})(7.2 \text{ m/s})}{(195 \text{ kg})} = 3.1 \text{ m/s}$.

The magnitude of the velocity is then $\sqrt{(5.0 \text{ m/s})^2 + (3.1 \text{ m/s})^2} = 5.9 \text{ m/s}$, at an angle or $\arctan \left( \frac{3.1}{5.0} \right) = 32^\circ$ east of north.

8.36: a) The final speed of the bullet-block combination is

$V = \frac{12.0 \times 10^{-3} \text{ kg}}{6.012 \text{ kg}} (380 \text{ m/s}) = 0.758 \text{ m/s}$.

Energy is conserved after the collision, so $(m + M)gy = \frac{1}{2}(m + M)V^2$, and
\[ y = \frac{1}{2} \frac{V^2}{g} = \frac{1}{2} \frac{(0.758 \text{ m/s})^2}{(9.80 \text{ m/s}^2)} = 0.0293 \text{ m} = 2.93 \text{ cm.} \]

b) \[ K_1 = \frac{1}{2} m v^2 = \frac{1}{2} (12.0 \times 10^{-3} \text{ kg})(380 \text{ m/s})^2 = 866 \text{ J.} \]

c) From part a), \[ K_2 = \frac{1}{2} (6.012 \text{ kg})(0.758 \text{ m/s})^2 = 1.73 \text{ J.} \]

8.34: The initial momentum of the car must be the \( x \)-component of the final momentum as the truck had no initial \( x \)-component of momentum, so

\[ v_{\text{car}} = \frac{p_x}{m_{\text{car}}} = \frac{(m_{\text{car}} + m_{\text{truck}}) v \cos \theta}{m_{\text{car}}} \]

\[ = \frac{2850 \text{ kg}}{950 \text{ kg}} (16.0 \text{ m/s} \cos (90^\circ - 24^\circ)) \]

\[ = 19.5 \text{ m/s.} \]

Similarly, \[ v_{\text{truck}} = \frac{2850}{1900} (16.0 \text{ m/s} \sin 66^\circ) = 21.9 \text{ m/s.} \]

8.64: a) \[ m_A v_{Ax} + m_B v_{Bx} + m_C v_{Cx} = m_{tot} v_x \]

\[ v_{Cx} = \frac{(0.100 \text{ kg})(0.50 \text{ m/s}) - (0.020 \text{ kg})(-1.50 \text{ m/s}) - (0.030 \text{ kg})(-0.50 \text{ m/s}) \cos 60^\circ}{0.050 \text{ kg}} \]

\[ v_{Cx} = 1.75 \text{ m/s} \]

Similarly,

\[ v_{Cy} = \frac{(0.100 \text{ kg})(0 \text{ m/s}) - (0.020 \text{ kg})(0 \text{ m/s}) - (0.030 \text{ kg})(-0.50 \text{ m/s}) \sin 60^\circ}{0.050 \text{ kg}} \]

\[ v_{Cy} = 0.26 \text{ m/s} \]

b) \[ \Delta K = \frac{1}{2} (0.100 \text{ kg})(0.5 \text{ m/s})^2 - \frac{1}{2} (0.020 \text{ kg})(1.50 \text{ m/s})^2 - \frac{1}{2} (0.030 \text{ kg})(-0.50 \text{ m/s})^2 \]

\[ - \frac{1}{2} (0.050 \text{ kg}) \times [(1.75 \text{ m/s})^2 + (0.26 \text{ m/s})^2] = -0.092 \text{ J} \]

8.72: a) The stuntman’s speed before the collision is \( v_{os} = \sqrt{2 g y} = 9.9 \text{ m/s.} \) The speed after the collision is
\[ v = \frac{m_s}{m_s + m_v} v_{0x} = \frac{80.0 \text{ kg}}{0.100 \text{ kg}} (9.9 \text{ m/s}) = 5.3 \text{ m/s}. \]

b) Momentum is not conserved during the slide. From the work-energy theorem, the distance \( x \) is found from \( \frac{1}{2} m_{\text{total}} v^2 = \mu_k m_{\text{total}} g x \), or

\[ x = \frac{v^2}{2 \mu_k g} = \frac{(5.28 \text{ m/s})^2}{2(0.25)(9.80 \text{ m/s}^2)} = 5.7 \text{ m}. \]

Note that an extra figure was needed for \( V \) in part (b) to avoid roundoff error.