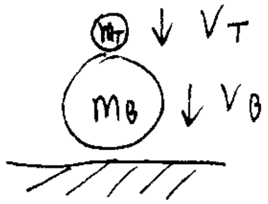
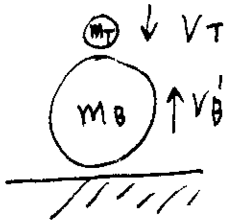


Energy conservation $mgh = \frac{1}{2}mv^2$ $\Rightarrow$ $V_B = -4.85\,m/s$

$V^2 = 2gh$ $\quad V_T = -4.85\,m/s$

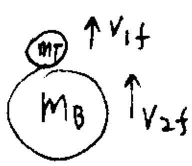


Basketball bounce back with velocity V_B'

$$V_B' = -V_B = +4.85\,m/s$$

Basketball and tennis balls collide

After collision



Momentum conservation $m_1V_{1i} + m_2V_{2i} = m_1V_{1f} + m_2V_{2f}$

$m_1 = m_B \quad V_{1i} = V_B' = 4.85\,m/s$

$m_2 = m_T \quad V_{2i} = V_T = -4.85\,m/s$

V_{BF} = velocity of basketball after collision

V_{TF} = velocity of tennis ball after collision

$$0.59 \times 4.85 + 0.057(-4.85) = 0.59\,V_{BF} + 0.057\,V_{TF}$$

$$0.59\,V_{BF} + 0.057\,V_{TF} = 2.58$$

Elastic collision $KE_f = KE_i$

$$\frac{1}{2}m_BV_B'^2 + \frac{1}{2}m_TV_T^2 = \frac{1}{2}m_BV_{TF}^2 + \frac{1}{2}m_TV_{TF}^2$$

For 1D, elastic collisions

Conservation of momentum $\quad m_1 V_{1i} + m_2 V_{2i} = m_1 V_{1f} + m_2 V_{2f}$

$$m_1 (V_{1i} - V_{1f}) = m_2 (V_{2f} - V_{2i}) \quad (1)$$

Conservation of energy $\quad \frac{1}{2} m_1 V_{1i}^2 + \frac{1}{2} m_2 V_{2i}^2 = \frac{1}{2} m_1 V_{1f}^2 + \frac{1}{2} m_2 V_{2f}^2$

$$m_1 (V_{1i}^2 - V_{1f}^2) = m_2 (V_{2f}^2 - V_{2i}^2)$$

$$m_1 (V_{1i} - V_{1f})(V_{1i} + V_{1f}) = m_2 (V_{2f} - V_{2i})(V_{2f} + V_{2i})$$

(2)

$$\frac{(2)}{(1)} \quad \frac{m_1 (V_{1i} - V_{1f})(V_{1i} + V_{1f})}{m_1 (V_{1i} - V_{1f})} = \frac{m_2 (V_{2f} - V_{2i})(V_{2f} + V_{2i})}{m_2 (V_{2f} - V_{2i})}$$

$$V_{1i} + V_{1f} = V_{2f} + V_{2i}$$

or

$$\underbrace{V_{1i} - V_{2i}}_{\text{Initial velocity of 1 relative to 2}} = - (\underbrace{V_{1f} - V_{2f}}_{\text{Final velocity of 1 relative to 2}})$$

Back to #73.

$$V_{1i} + V_{1f} = V_{2i} + V_{2f}$$

$$V_B' + V_{BF} = V_T + V_{TF}$$

$$4.85 + V_{BF} = -4.85 + V_{TF}$$

$$V_{BF} - V_{TF} = -9.7$$

$$\begin{cases} 0.59\, V_{BF} + 0.057\, V_{TF} = 2.58 \\ V_{BF} - V_{TF} = -9.7 \end{cases} \Rightarrow \begin{array}{l} V_{BF} = 3.11 \text{ m/s} \\ V_{TF} = 12.81 \text{ m/s} \end{array}$$

both go up

AFTER collision, apply conservation of energy for tennis ball

$$\frac{1}{2} m_T V_{TF}^2 = m_T g h_T$$

$$h_T = V_{TF}^2 / 2g = 8.37 \text{ m}$$

compare to $h = 1.2$ m.

Ballistic pendulum

Find V_{1i}, given m_1, m_2 & h

Momentum conservation

$$m_1 V_{1i} + m_2 (0) = (m_1 + m_2)(V_f)$$

$$V_f = \frac{m_1}{m_1 + m_2} V_{1i}$$

Energy conservation after the collision

$$\frac{1}{2}(m_1 + m_2) V_f^2 = (m_1 + m_2) g h$$

$$V_f = \sqrt{2gh}$$

$$\sqrt{2gh} = \frac{m_1}{m_1 + m_2} V_{1i}$$

$$V_{1i} = \left(\frac{m_1 + m_2}{m_1}\right)\sqrt{2gh}$$

$m_1 = 0.057 \text{ kg}$
$m_2 = 0.203 \text{ kg}$ $\Rightarrow V_{1i} = 6.39 \text{ m/s}$
$h = 0.1 \text{ m}$