HW Assignment #8: Collisions

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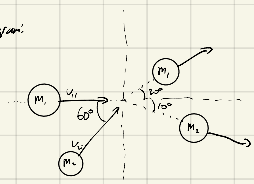
Question 1

Given: $m_1 = 4\ kg$ $\quad V_{1i} = 2.55\ m/s$
$m_2 = 2.61\ kg$ $\quad V_{2i} = 1.55\ m/s$

Find: Velocities of m_1 and m_2

Diagram:



Theory: $mv_i = mv_f$

Assumptions: momentum is conserved and collision is elastic

Solution: $m_1 v_{1i} + m_2 v_{2i} \cos 60 = m_1 v_{1f} \cos 20 + m_2 v_{2f} \cos 10$

$m_2 v_{2i} \sin 60 = m_1 v_{1f} \sin 20 - m_2 v_{2f} \sin 10$

$4(2.55) + 2.61(1.55)\cos 60 = 4 v_{1f} \cos 20 + 2.61 v_{2f} \cos 10$

$2.61(1.55)\sin 60 = 4 v_{1f} \sin 20 - 2.61 v_{2f} \sin 10$

System solved with calculator

$v_{1f} = 2.79\ m/s$

$v_{2f} = 0.681\ m/s$

Question 2

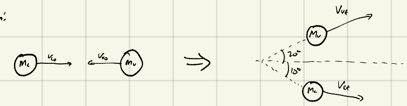
Part A)

Given: $m_v = 84.0\ kg$ $\quad V_{co} = 0.150\ m/s$ $\quad V_{cf} = 0.0745\ m/s$ $\quad \theta_c = 10°$

$V_{vo} = 9.26\ m/s$ $\quad V_{vf} = 8.52\ m/s$ $\quad \theta_v = 20°$

Find: Mass of Chuck Norris's fist in kg

Diagram:



Theory: $mv_o = mv_f$

Assumptions: momentum is not lost in collision

Solution:
$m_c v_{co} - m_v v_{vo} = m_c v_{cf} \cos 10 + m_v v_{vf} \cos 20$
$m_c v_{co} - m_c v_{cf} \cos 10 = m_v v_{vo} + m_v v_{vf} \cos 20$
$m_c (v_{co} - v_{cf} \cos 10) = m_v v_{vo} + m_v v_{vf} \cos 20$
$$m_c = \frac{m_v v_{vo} + m_v v_{vf} \cos 20}{v_{co} - v_{cf} \cos 10} = \frac{(84)(9.26) + (84)(8.52)\cos 20}{(0.15) - (0.0745)\cos 10}$$
$= 18900\ kg$

Part B)

Given: Same as part A

Find: Kinetic energy lost in the collision

Diagram: Same as part A

Theory: $KE_{lost} = KE_i - KE_f$

Assumptions: the masses remain the same shape

Solution: $KE_{lost} = \frac{1}{2} m_c v_{co}^2 + \frac{1}{2} m_v v_{vo}^2 - \frac{1}{2} m_c v_{cf}^2 - \frac{1}{2} m_v v_{vf}^2$

$= \frac{1}{2}(18900)(0.15)^2 + \frac{1}{2}(84)(9.26)^2 - \frac{1}{2}(18900)(0.0745)^2 - \frac{1}{2}(84)(8.52)^2$

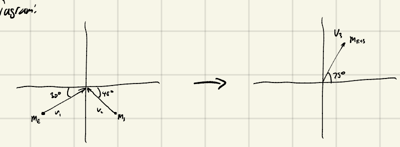
$= 713\ J$

Question 3

Given: $V_1 = 9.660\ m/s$ $\quad V_2 = 7.26\ m/s$ $\quad m_s = 53.8\ kg$ $\quad V_3 = 5.164\ m/s$

Find: mass of Ender

Diagram:



Theory: $mv_i = mv_f$

Assumptions: the collision is perfectly inelastic

Solution: $m_E V_1 \cos 30 - m_S V_2 \cos 45 = (m_E + m_s) V_3 \cos 75$
$m_E v_1 \cos 30 - m_s v_2 \cos 45 = m_E v_3 \cos 75 + m_s v_3 \cos 75$
$m_E v_1 \cos 30 - m_E v_3 \cos 75 = m_s v_2 \cos 45 + m_s v_3 \cos 75$
$m_E (v_1 \cos 30 - v_3 \cos 75) = m_s v_2 \cos 45 + m_s v_3 \cos 75$
$$m_E = \frac{m_s v_2 \cos 45 + m_s v_3 \cos 75}{v_1 \cos 30 - v_3 \cos 75} = \frac{(53.8)(7.26)\cos 45 + (53.8)(5.164)\cos 75}{(9.66)\cos 30 - (5.164)\cos 75}$$
$= 49.5\ kg$