Answer on Question #59435-Physics-Mechanics-Relativity

Blocks A (mass 3.00 kg) and B (mass 14.00 kg, to the right of A) move on a frictionless, horizontal surface. Initially, block B is moving to the left at 0.500 m/s and block A is moving to the right at 2.00 m/s. The blocks are equipped with ideal spring bumpers. The collision is head-on, so all motion before and after it is along a straight line. Let +x be the direction of the initial motion of A. The questions

Part A Find the maximum energy stored in the spring bumpers. \( U_{\text{spring max}} = \)

Part B Find the velocity of block A when the energy stored in the spring bumpers is maximum. \( v_A = \)

Part C Find the velocity of block B when the energy stored in the spring bumpers is maximum. \( v_B = \)

Part D Find the velocity of block A after the blocks have moved apart. \( v_A = \)

Part E Find the velocity of block B after the blocks have moved apart. \( v_B = \) need units

Solution

This collision is elastic so momentum and energy are conserved.

A. \[
U_{\text{spring max}} = KE_{\text{total}} - KE_{\text{CM}}
\]

\[
KE_{\text{total}} = \frac{1}{2}(m_A v_{Ai}^2 + m_B v_{Bi}^2) = \frac{1}{2}(3.00(2.00)^2 + 14.00(0.500)^2) = 7.75 \text{ J.}
\]

\[
v_{CM} = \frac{m_A v_{Ai} + m_B v_{Bi}}{m_A + m_B} = \frac{3.00(2.00) - 14.00(0.500)}{3.00 + 14.00} = -0.0588 \frac{m}{s}
\]

\[
KE_{\text{CM}} = \frac{1}{2}(m_A + m_B)(v_{CM})^2 = \frac{1}{2}(3.00 + 14.00)(-0.0588)^2 = 0.03 \text{ J.}
\]

\[
U_{\text{spring max}} = 7.75 - 0.03 = 7.72 \text{ J.}
\]

B. When the energy stored in the spring bumpers is maximum A and B moves together with velocity of center of mass

\[
v_A = v_B = v_{CM} = -0.0588 \frac{m}{s}
\]

C. \[
v_B = v_{CM} = -0.0588 \frac{m}{s}
\]

D. For an elastic, head-on collision, we know that the relative velocity of approach = relative velocity of separation, or

\[
2.00 \frac{m}{s} - (-0.500 \frac{m}{s}) = V_B - V_A
\]

where \( V_B \) is the post-collision velocity of B, and \( V_A \) is the post-collision velocity of mA.

\[
V_B = V_A + 2.5
\]

Then by conservation of momentum,
\[(m_A + m_B)v_{CM} = m_A V_A + m_B(V_A + 2.5)\]

\[V_A = \frac{(m_A + m_B)v_{CM} - m_B(2.5)}{m_A + m_B} = v_{CM} - \frac{m_B(2.5)}{m_A + m_B} = -0.0588 - \frac{14.00(2.5)}{3.00 + 14.00} = -2.118 \frac{m}{s}\]

\[V_B = V_A + 2.5 = -2.118 + 2.5 = 0.382 \frac{m}{s}.\]