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. Uspringmax =

Part B Find the velocity of block A when the energy stored in the spring bumpers is maximum. . vA =

Part C Find the velocity of block B when the energy stored in the spring bumpers is maximum. vB =

Part D Find the velocity of block A after the blocks have moved apart. vA =

Part E Find the velocity of block B after the blocks have moved apart. . vB = need units

Solution

This collision is elastic so momentum and energy are conserved.

A.

$$U_{springmax} = KE_{total} - KE_{CM}$$

$$KE_{total} = \frac{1}{2}\left(m_A v_{Ai}^2 + m_B v_{Bi}^2\right) = \frac{1}{2}(3.00(2.00)^2 + 14.00\ (0.500)^2) = 7.75\,J.$$

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

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

$$U_{springmax} = 7.75 - 0.03 = 7.72\,J.$$

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

$$v_A = v_{CM} = -0.0588\frac{m}{s}$$

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

$$2.00\frac{m}{s} - \left(-0.500\frac{m}{s}\right) = V_B - V_A$$

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,

$$(m_A + m_B)v_{CM} = m_A V_A + m_B(V_A + 2.5)$$

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

E.

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

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