20-P-MOM-JK-422

Similar to Fundamental F15-9 Conservation of energy and momentum

The 5.00 kg block A has an initial speed of v_A = 5.00 m/s as it slides down the smooth ramp. Smooth means it is frictionless. At the bottom it collides with the stationary block B of mass 8.00 kg. The height "h" shown in the diagram is 1.50 m. This is a perfectly inelastic collision so the two blocks couple together after the collision. What is the common speed of the two blocks immediately after the collision? The direction is clearly left, so just tell me the speed here.

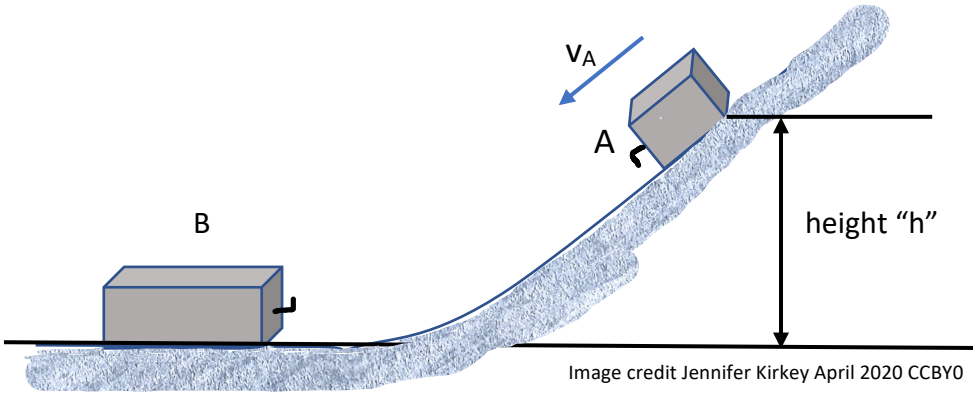

Image credit Jennifer Kirkey April 2020 CCBY0

Answers First find the height of A at the bottom of the ramp just before the collision. Then use conservation of momentum to find the velocities after the collision.

Conservation of energy

$(m_A g h_{A \text{ top of ramp}}) + (½ m_A v_{A \text{ top of ramp}}^2) = (m_A g h_{A \text{ bottom of ramp}}) + (½ m_A v_{A \text{ bottom of ramp}}^2)$

$(5 \text{ kg})(9.81 \text{ m/s}^2)(1.50 \text{ m}) + (^1/_2)(5 \text{ kg})(5.00 \text{ m/s})^2 = 0 + (^1/_2)(5 \text{ kg})(v_{A \text{ bottom of ramp}})^2$

$v_{A \text{ bottom of ramp}} = 7.3777 \text{ m/s}$

or if you want to keep it all in symbols and plug in at the end.

$v_A \text{ at bottom of ramp} = ((m_A g h_{A \text{ top of ramp}}) + (½ m v_{A \text{ top of ramp}}^2) / (½ m_A))^{0.5}$

$v_A \text{ at bottom of ramp} = (2 g h_{A \text{ top of ramp}} + v_{A \text{ top of ramp}}^2)^{0.5}$

I am using the ^0.5 as it is not easy to draw a square root sign in MSWord and the equation editor is a royal pain

Conservation of momentum

$(m_A v_{A \text{ before}}) + (m_B v_{B \text{ before}}) = (m_A v_{AB \text{ after}}) + (m_B v_{AB \text{ after}}) = (m_A + m_B)(v_{AB \text{ after}})$

(5 kg)(7.3777 m/s) + (8 kg)(0 m/s) = (5 + 8 kg) ($v_{AB\ after}$)

$v_{AB\ after}$ = 2.84 m/s

Or if you want to keep it all in symbols

$v_{AB\ after} = ((m_A v_{A\ before}) + (m_B v_{B\ before})) / (m_A + m_B)$

$v_{AB\ after}$ = 2.84 m/s Textbook asked for velocity so you should say “left” but that is obvious.

Brina’s image