4. (30 pts.) A $0.007\,$kg bullet is fired with a speed of $200\,$m/s vertically up through a $1.4\,$kg wooden block. The bullet passes through the block and continues up vertically. The wooden block is observed to rise to a maximum height of 0.0287 m. What was the speed of the bullet after it passed through the block?
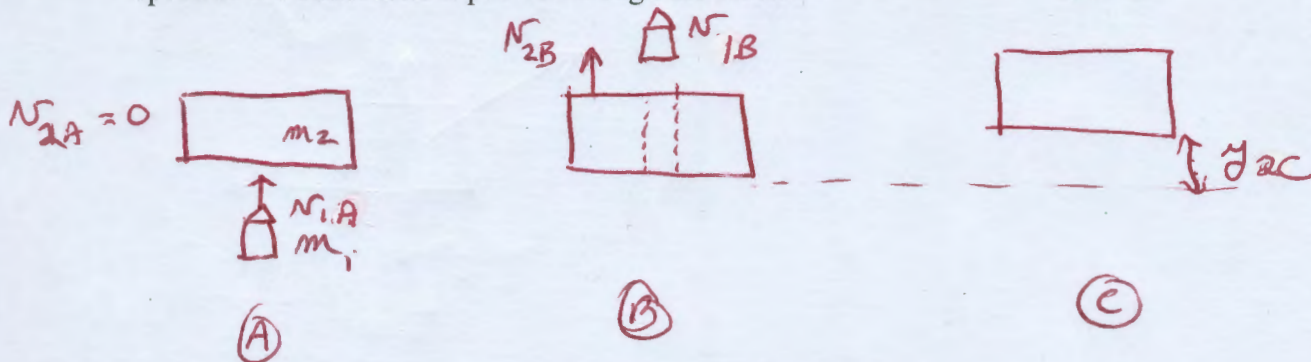
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$N_{2A} = 0$

N_{2B} N_{1B}

m_2

$N_{1,A}$
m_1

Ⓐ   Ⓑ   Ⓒ $\downarrow, v_{2C}$

Ⓐ → Ⓑ : collision $m_1 v_{1A} + m_2 v_{2A} = m_1 v_{1B} + m_2 v_{2B}$

$m_1 v_{1A} + 0 = m_1 v_{1B} + m_2 v_{2B}$

Ⓑ → Ⓒ Conserve energy for the big block

$E_B = E_C$

$m_2 g y_{2B} + \frac{1}{2} m_2 v_{2B}^2 = m_2 g y_{2C} + 0$ stops at max height

$\uparrow$
0

$\frac{1}{2} v_{2B}^2 = g y_{2C}$

$v_{2B} = \sqrt{2 g y_{2C}}$.   (This is 0.750 $\frac{m}{s}$)

Plug this back into the moment um part:

$m_1 v_{1A} = m_1 v_{1B} + m_2 \sqrt{2 g y_{2C}}$

$m_1 v_{1A} - m_2 \sqrt{2 g y_{2C}} = m_1 v_{1B}$

$v_{1A} - \frac{m_2}{m_1} \sqrt{2 g y_{2C}} = v_{1B}$

$200 - \frac{1.4}{0.007} \sqrt{2(9.8)(0.0287)} = v_{1B}$

$\boxed{50 \, m/s = v_{1B}}$