Physics 151: Accelerated Physics I—Mechanics and Thermodynamics
Multi-step Collision

Problem 1: (20 pts.) A speeding car ($m_1 = 2200\,\text{kg}$) strikes the rear of a parked car ($m_2 = 1400\,\text{kg}$). After the impact the two automobiles remain locked together and skid along the pavement a distance of 18 m. The frictional force acting on the cars during the skid is $f_k = 33\,500\,\text{N}$. The goal is to find the speed of the moving automobile prior to the collision.

Hints: You should break the process up into two steps: Assume that the collision is sufficiently rapid that friction may be ignored during the collision. Then, assume that after the collision, the only external force acting on the system is friction. Part (a) below concerns motion after the collision, while part (b) deals with the collision itself. If you are at all confused, please ask.

a. (10 pts.) Find the speed of the two cars immediately after impact. *Hint*: Use the length of the skid marks.

b. (10 pts.) Using your result from part (a), find the speed of the moving car before the impact. (If you were unable to obtain a numerical answer for part a, you may use 15 m/s, even though that is not the correct answer.)

Physics 111: General Physics I—Mechanics and Thermodynamics
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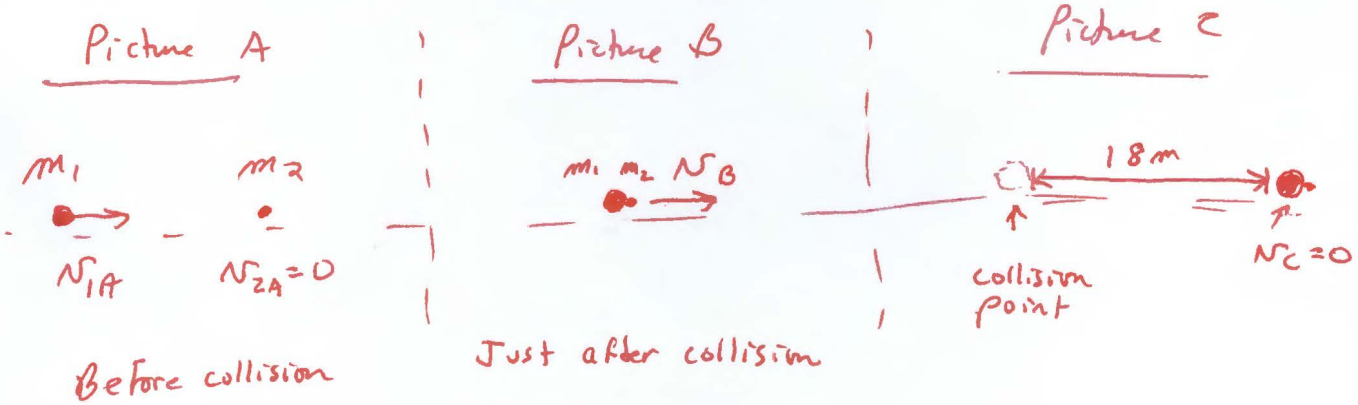

(a) Compare picture B and C.

$\Sigma F = ma$, where $m = m_1 + m_2 = 3600\,\text{kg}$

$-f_k = ma \Rightarrow a = \frac{-f_k}{m} = -9.306\,\text{m/s}^2$

$v_C^2 = v_B^2 + 2a(\Delta x)$

$0 = v_B^2 + 2(-9.306\,\text{m/s}^2)(18\,\text{m}) \Rightarrow \boxed{v_B = 18.30\,\text{m/s}}$

(b) Compare pictures A and B

$P_A = P_B$

$m_1 v_{1A} + m_2 v_{2A} = (m_1 + m_2) v_B$

$(2200)\, v_{1A} + 0 = (3600)(18.30\,\text{m/s})$

$\boxed{v_{1A} = 30.0\,\text{m/s}}$