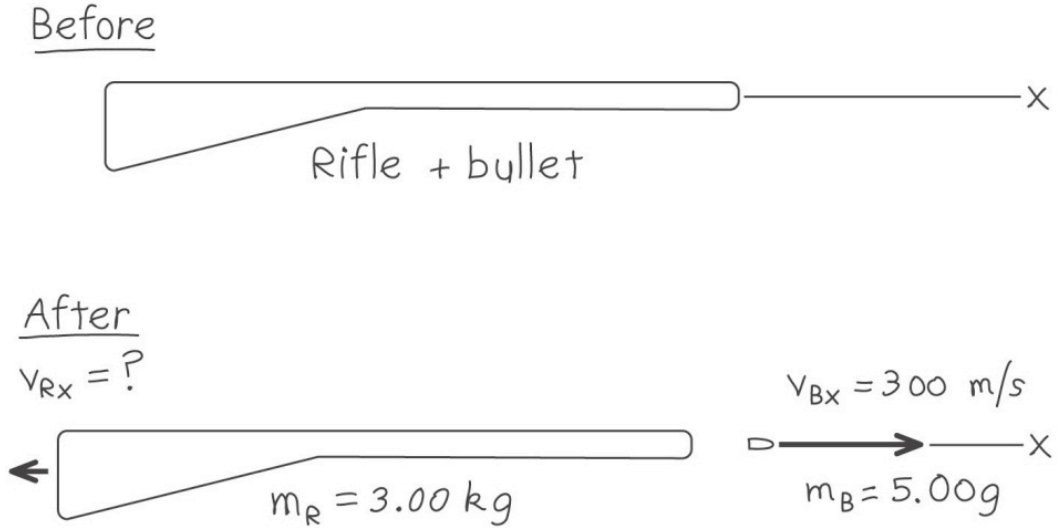
A 5.00-g bullet is fired from a 3.00-kg rifle at a speed of 300 m/s. What is the recoil speed of the rifle?



A. Less than 1 m/s

B. 1m/s ≤ v < 3 m/s

C. 3 m/s ≤ v < 10 m/s

D. 10 m/s ≤ v < 30 m/s

E. Greater than 30 m/s

Ch 8.3-4
Collisions

PHYS 1210 – Prof. Jang-Condell

Goals for Chapter 8

- To learn the meaning of the momentum of a particle and how an impulse causes it to change
- To learn how to use the conservation of momentum
- To learn how to solve problems involving collisions
- To learn the definition of the center of mass of a system and what determines how it moves
- To analyze situations, such as rocket propulsion, in which the mass of a moving body changes

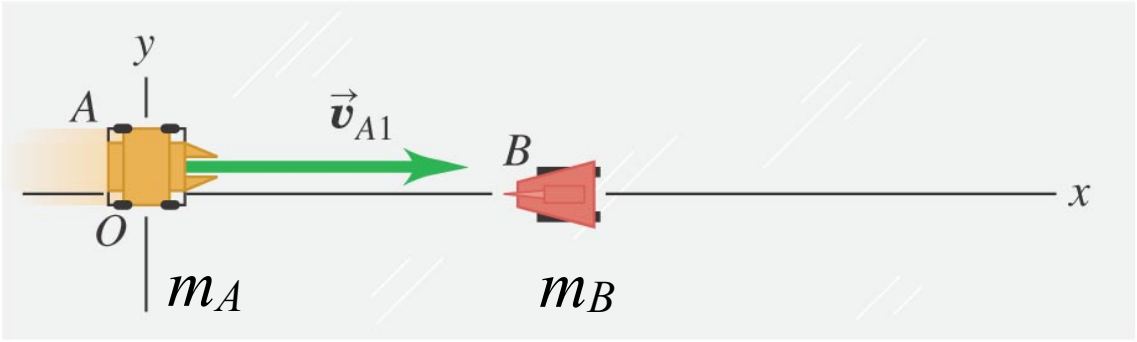
Momentum is **always** conserved during collisions

$$\vec{\boldsymbol{p}}_{A1} + \vec{\boldsymbol{p}}_{B1} = \vec{\boldsymbol{p}}_{A2} + \vec{\boldsymbol{p}}_{B2}$$

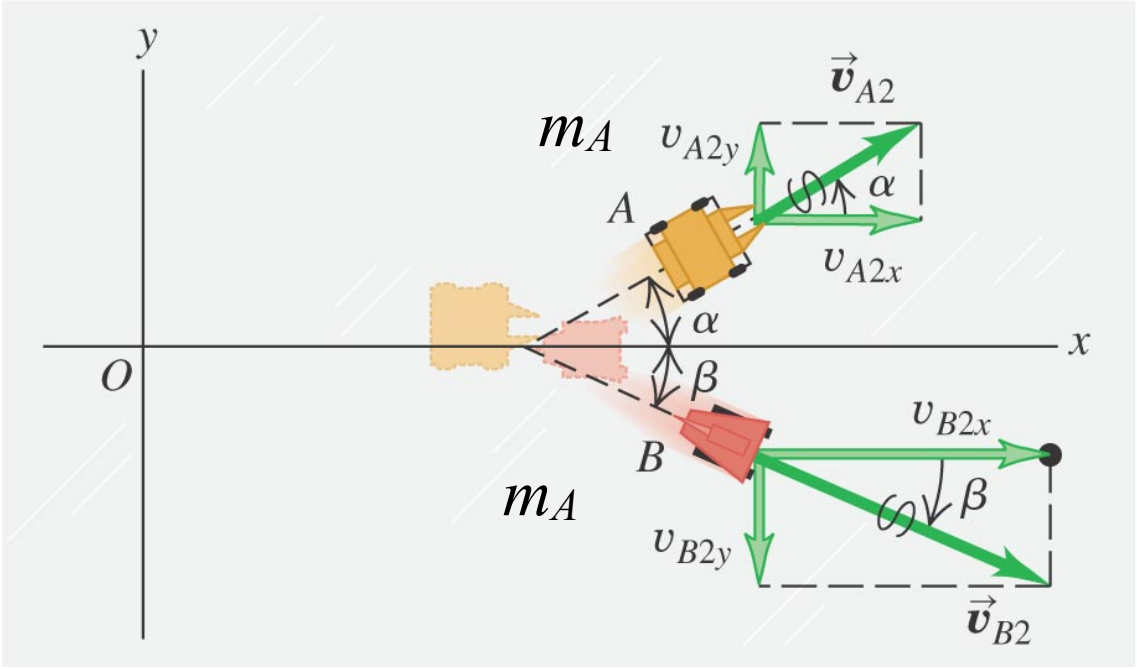
A two-dimensional collision

- Two robots collide and go off at different angles.
- $m_A\vec{v}_{A1} + m_B\vec{v}_{B1} = m_A\vec{v}_{A2} + m_B\vec{v}_{B2}$

(a) Before collision



(b) After collision



Energy is **not** always conserved during collisions

- **Elastic**: energy is conserved
- **Inelastic**: energy not conserved
- **Completely** (or **perfectly**) **inelastic**: objects stick together

Elastic Collisions

- Energy is conserved

$$(1/2)m_A v_{A1}^2 + (1/2)m_B v_{B1}^2 = (1/2)m_A v_{A2}^2 + (1/2)m_B v_{B2}^2$$

- Momentum conservation:

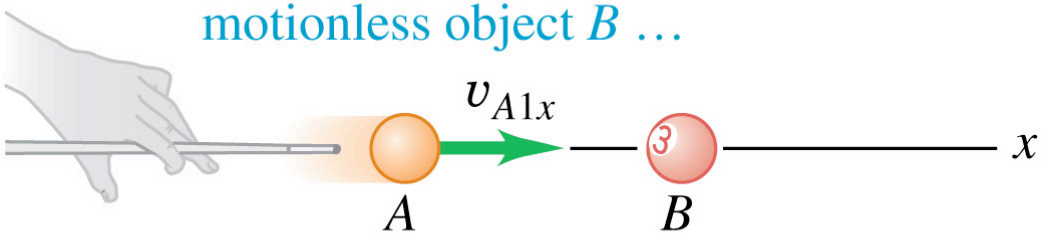
$$m_A\vec{v}_{A1} + m_B\vec{v}_{B1} = m_A\vec{v}_{A2} + m_B\vec{v}_{B2}$$

Solution for 1D elastic collisions

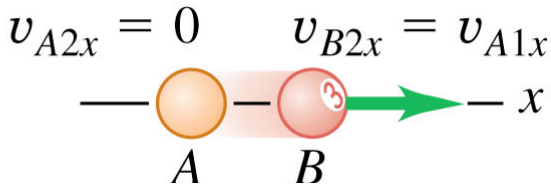
Elastic collisions

- As Figures 8.22 and 8.23 show, the behavior of the colliding objects is greatly affected by their relative masses.

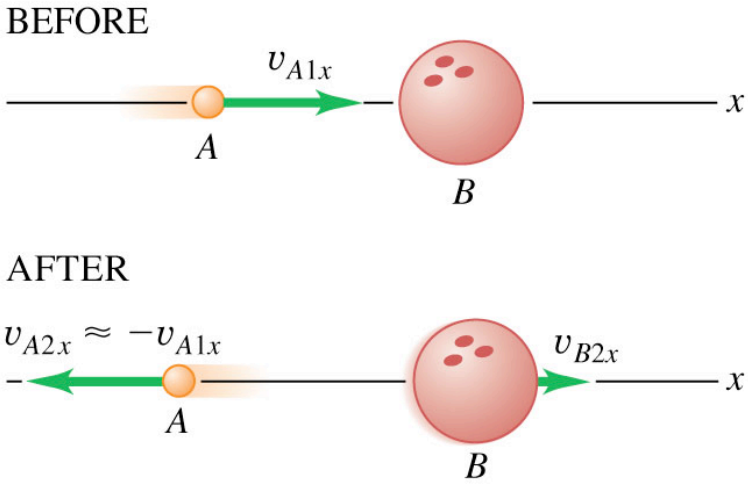
When a moving object *A* has a 1-D elastic collision with an equal-mass, motionless object *B* …



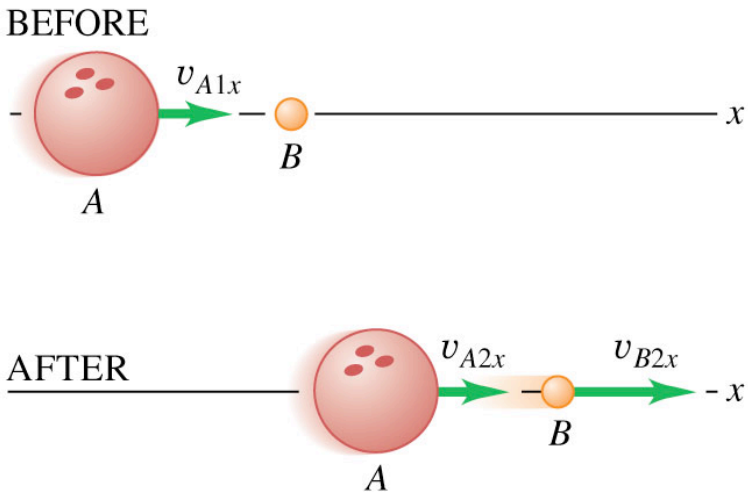
… all of *A*'s momentum and kinetic energy are transferred to *B*.



(a) Ping-Pong ball strikes bowling ball.



(b) Bowling ball strikes Ping-Pong ball.

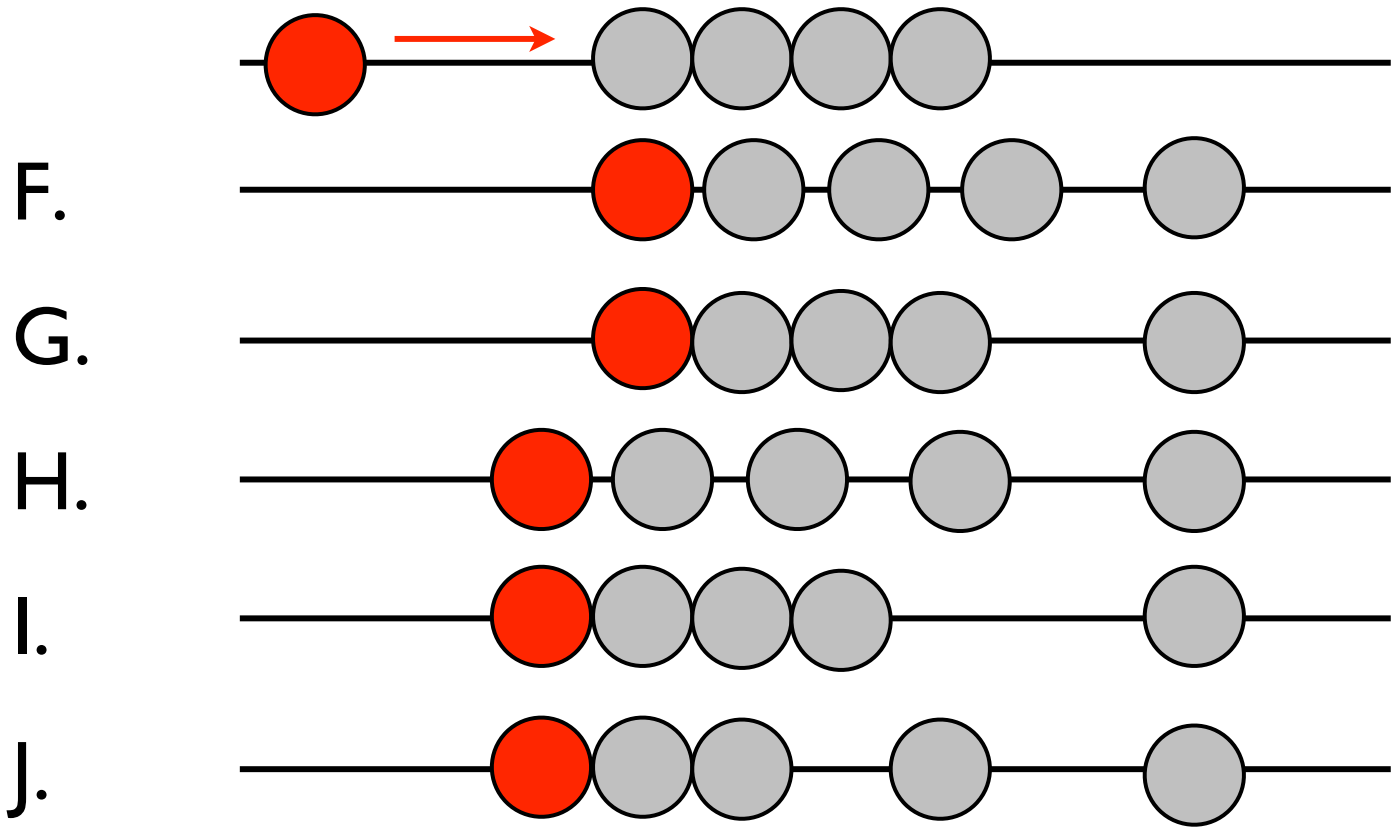


Elastic Collisions

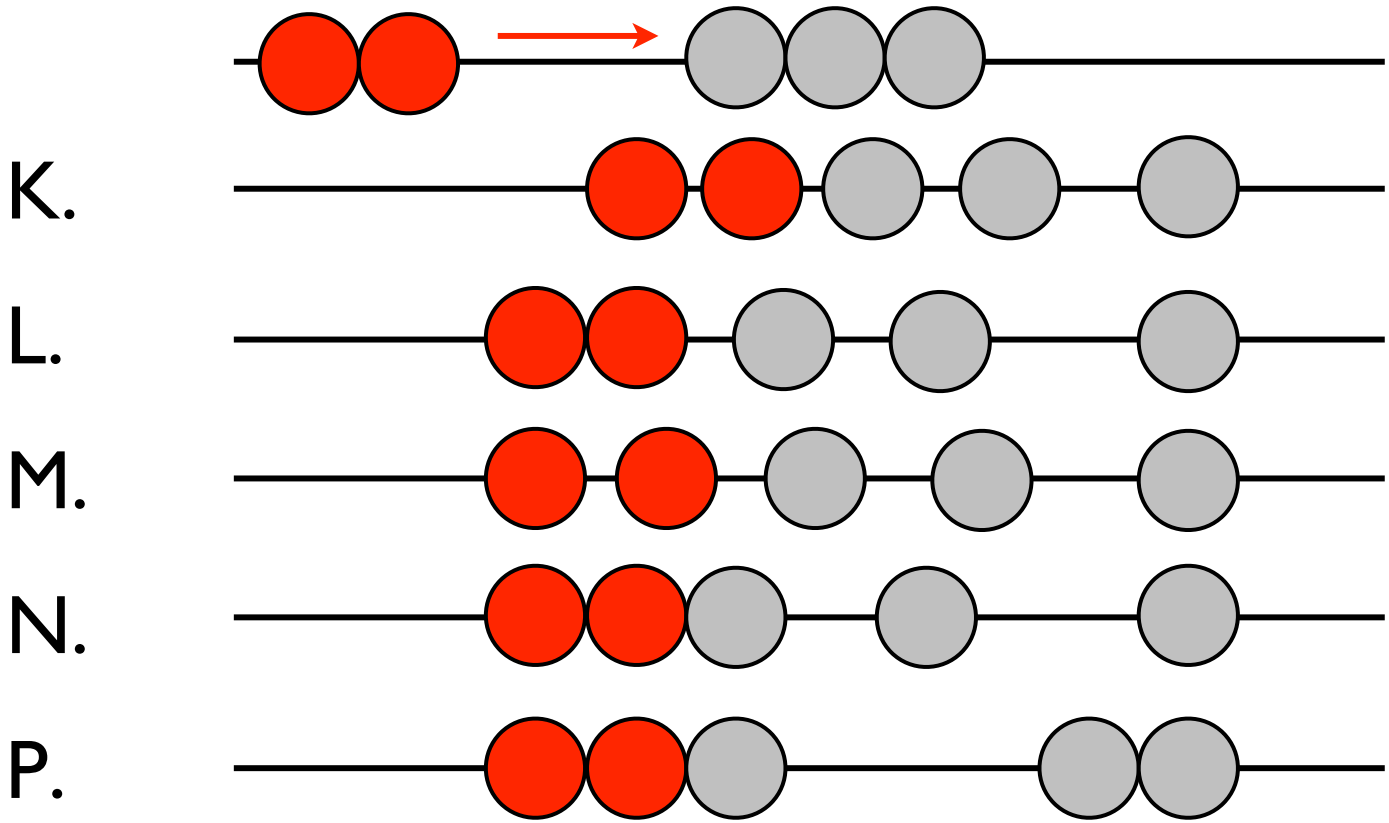
Relative velocities are equal and opposite

$$\vec{v}_{B2} - \vec{v}_{A2} = -(\vec{v}_{B1} - \vec{v}_{A1})$$

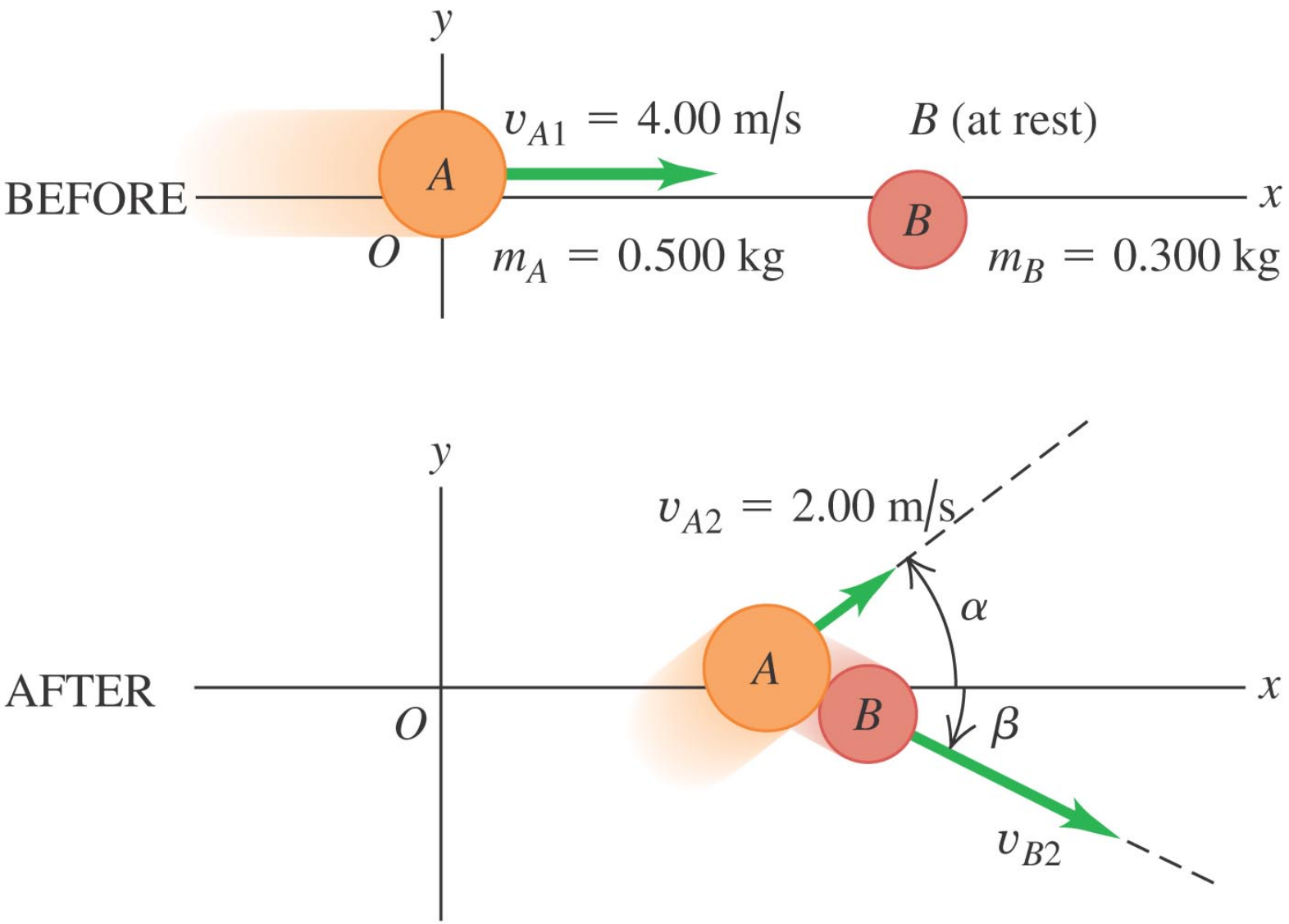
I smack one billiard ball into the rest of the line. What will be the final result?



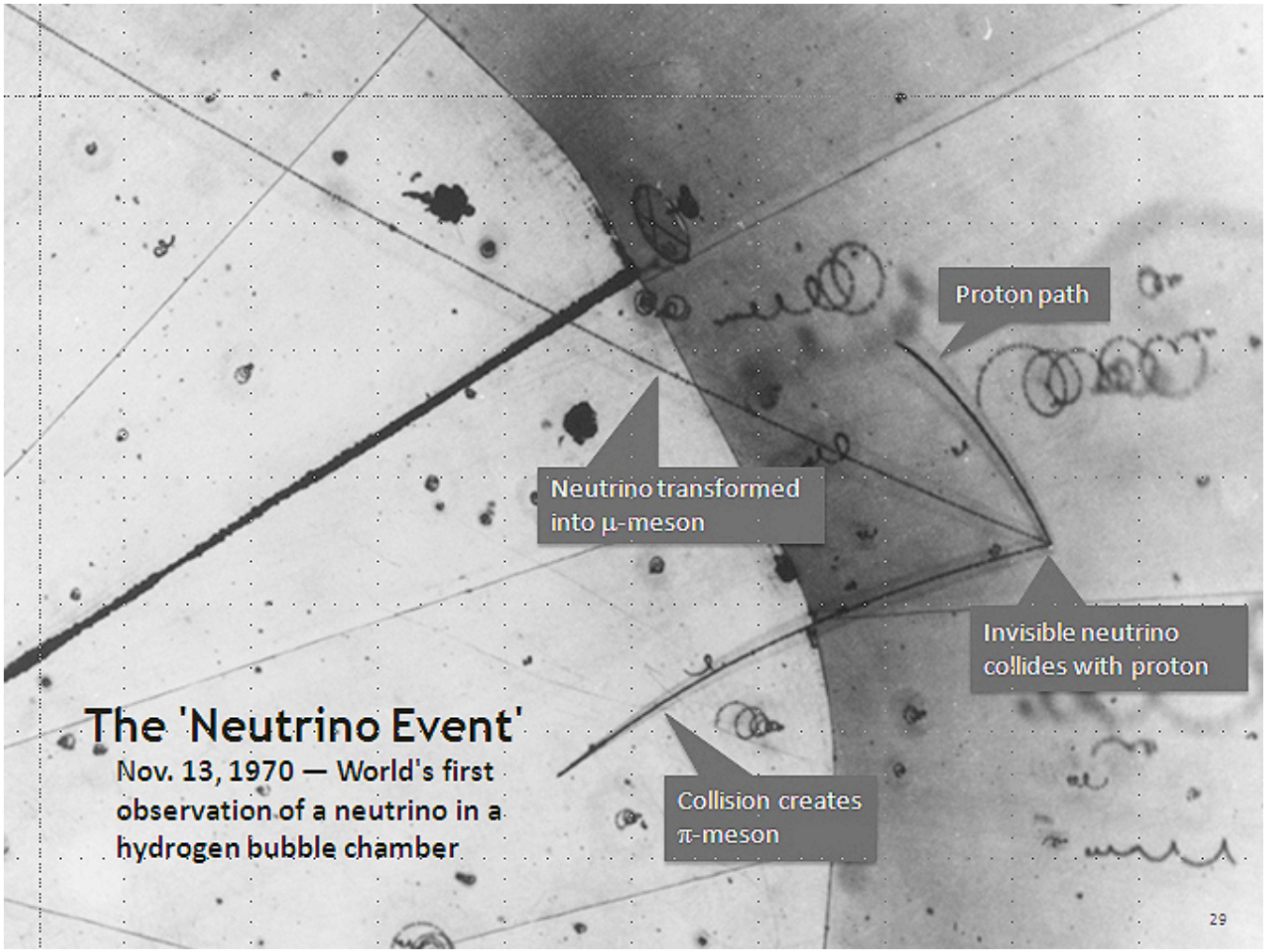
I smack two billiard balls into the rest of the line. What will be the final result?



A two-dimensional elastic collision



Neutrinos first detected using properties of elastic collisions



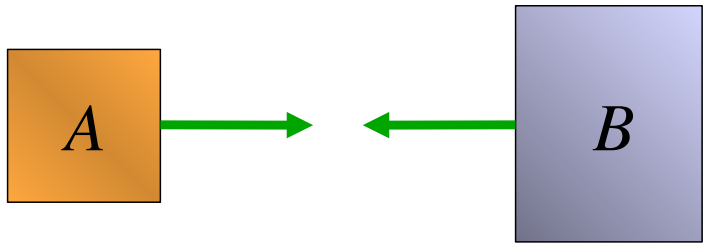
Perfectly Inelastic Collisions

$$\vec{v}_{A2} = \vec{v}_{B2}$$

$$m_A\vec{v}_{A1} + m_B\vec{v}_{B1} = (m_A+m_B)\,\vec{v}_2$$

Q8.4

Two objects with different masses collide and *stick* to each other. Compared to *before* the collision, the system of two objects *after* the collision has



K. the same total momentum and the same total kinetic energy.

L. the same total momentum but less total kinetic energy.

M. less total momentum but the same total kinetic energy.

N. less total momentum and less total kinetic energy.

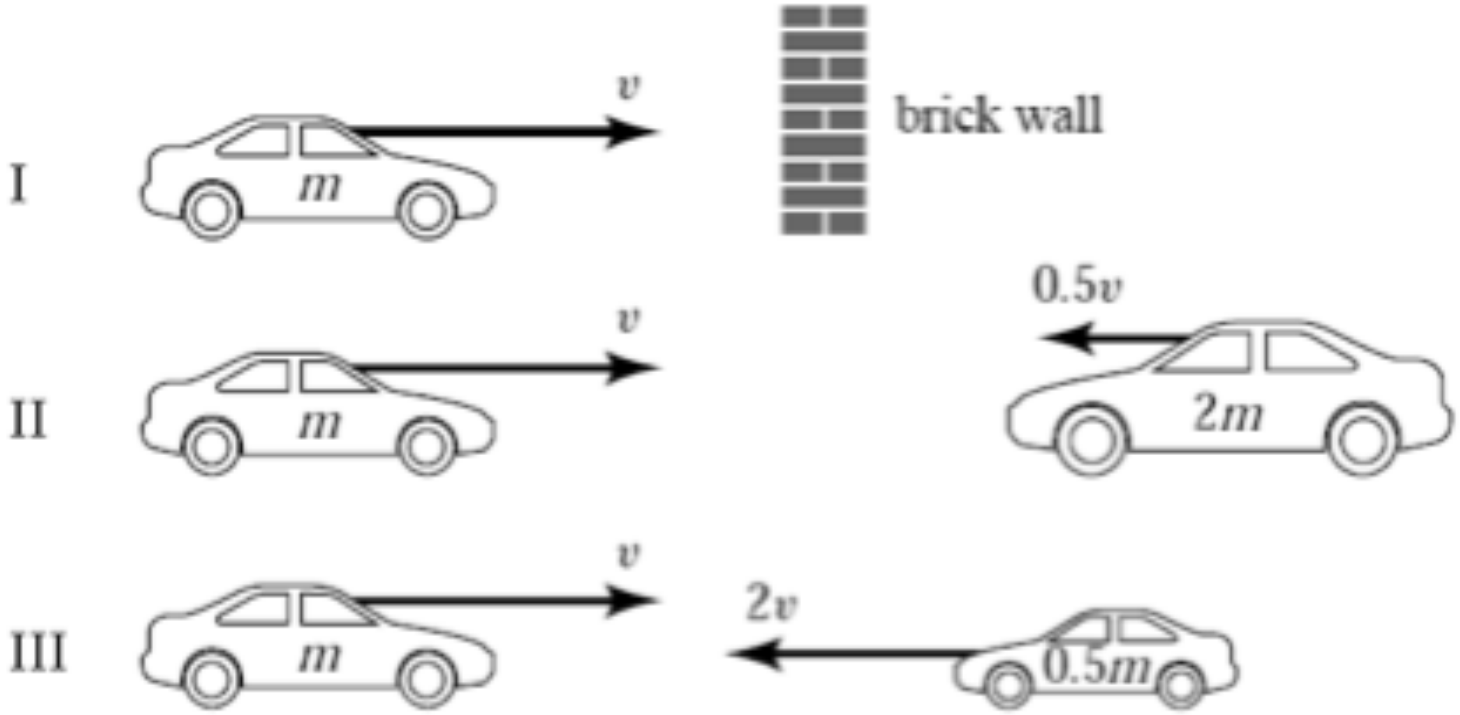
P. not enough information given to decide

Momentum is **always conserved** during collisions

Some inelastic collisions

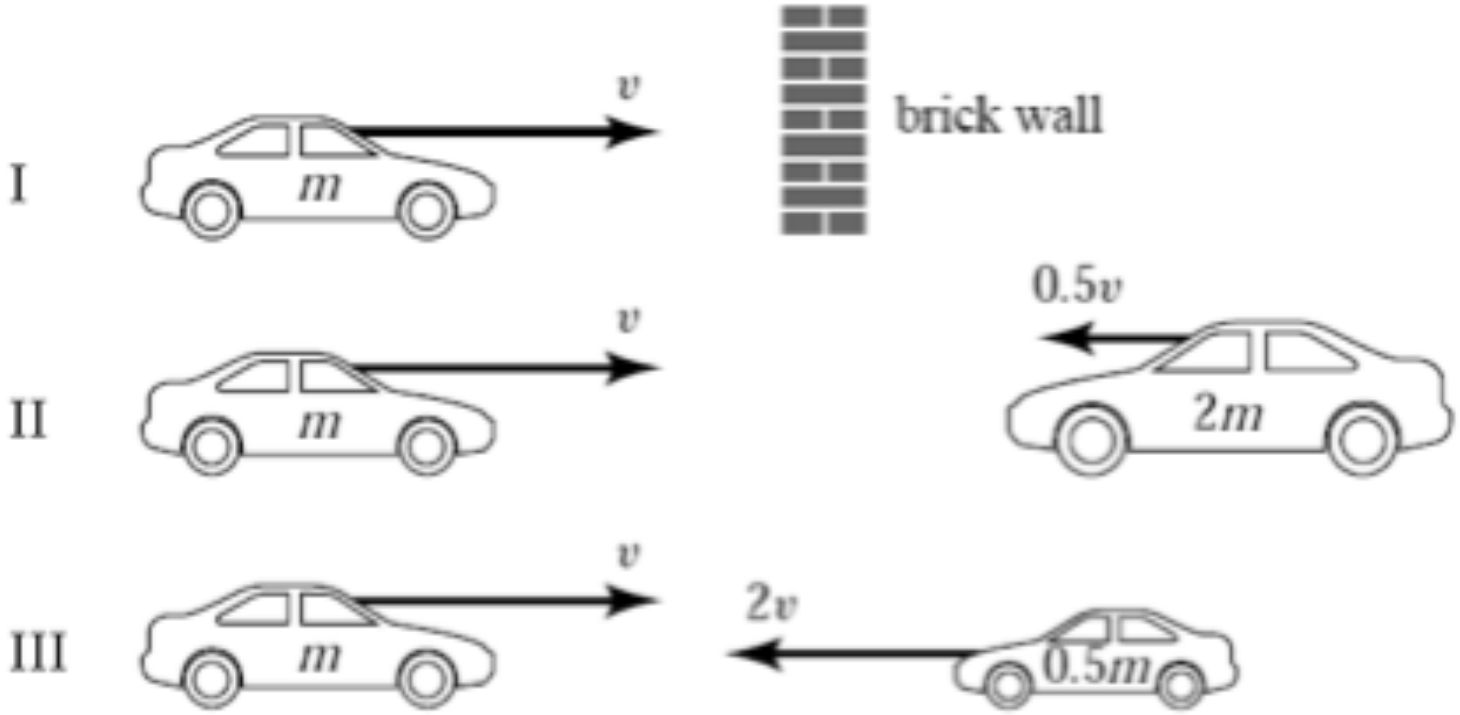
- Cars are intended to have inelastic collisions so the car absorbs as much energy as possible.

If all three collisions in the figure shown here are totally inelastic, which bring(s) the car on the left to a halt?



1. I
2. II
3. III
4. I, II
5. I, III
6. II, III
7. all three

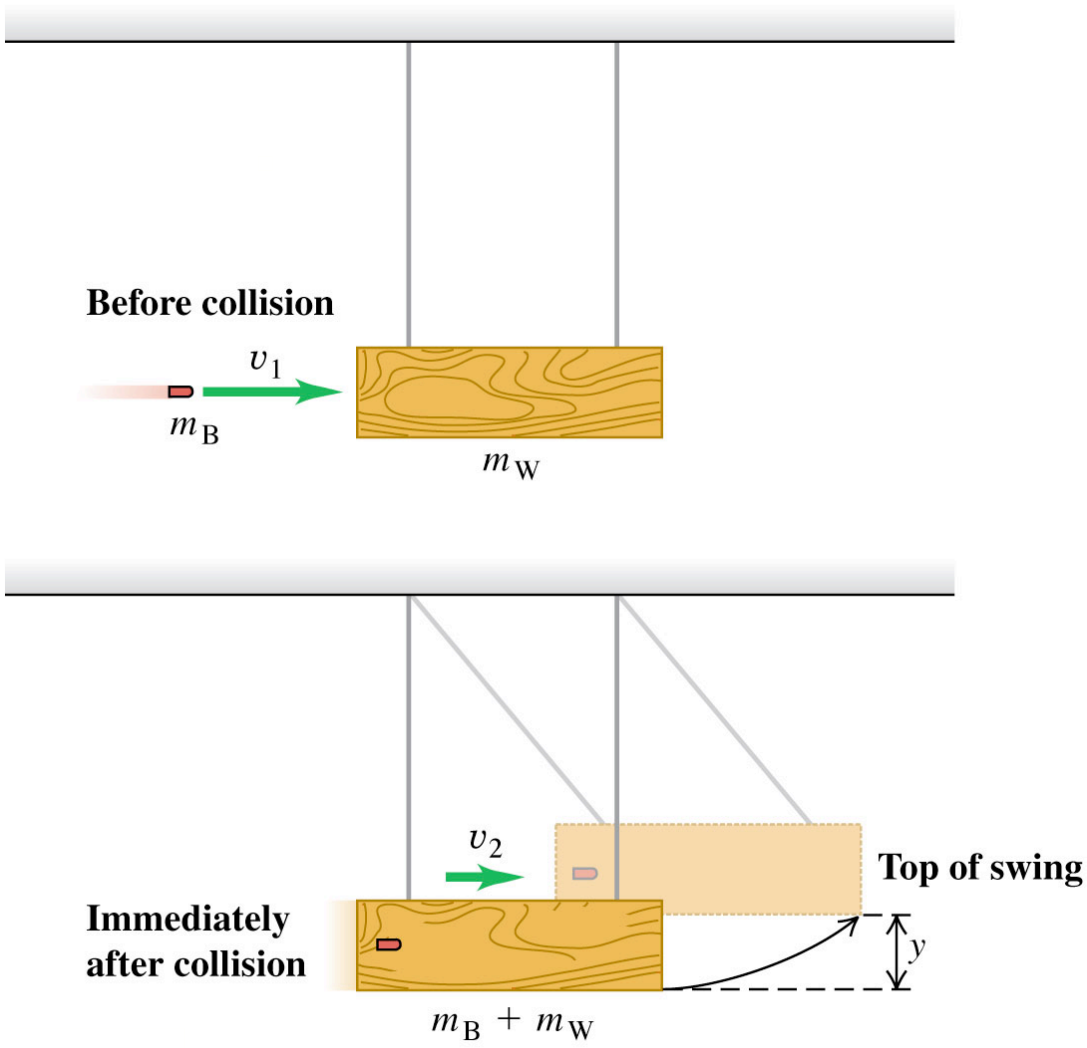
If all three collisions in the figure shown are totally inelastic, which cause(s) the most damage?



1. I
2. II
3. III
4. I, II
5. I, III
6. II, III
7. all three

The ballistic pendulum

- Ballistic pendulums are used to measure bullet speeds.
- Suppose
  - $m_B = 5.00$ grams
  - $m_W = 1.00$ kg
  - $y = 10.0$ cm



An automobile collision

- Example 8.9