March 29, Week 10

Today: Chapter 8, Conservation of Momentum

Homework Assignment #7 - Due Today

Mastering Physics: 6 problems from chapter 7

Written Questions: 7.60

Homework Assignment #8 - Due Monday, April 8. (Special Office hours to be held that Monday.)

Homework Assignment #9 - Due Friday, April 12.

Exam #3, Next Wednesday, April 3. Practice Exam available on webpage. Review session: Tuesday, April 2, 5:15-7:00 PM. Room 114 of Regener Hall.

Conservation of Momentum

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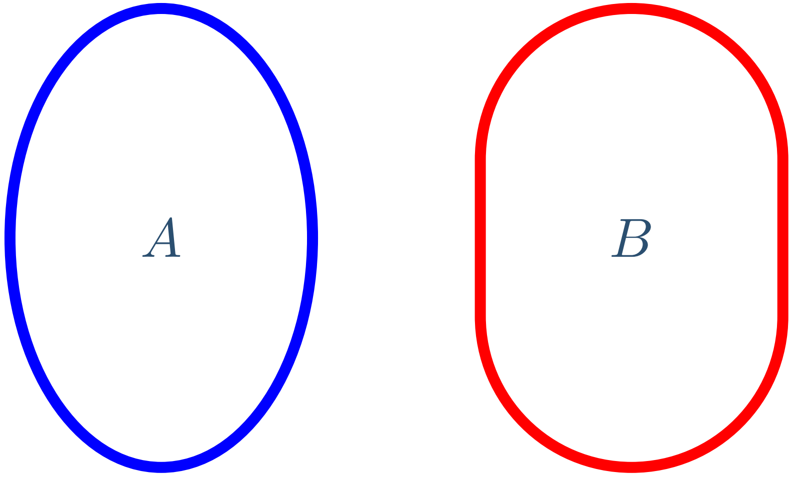

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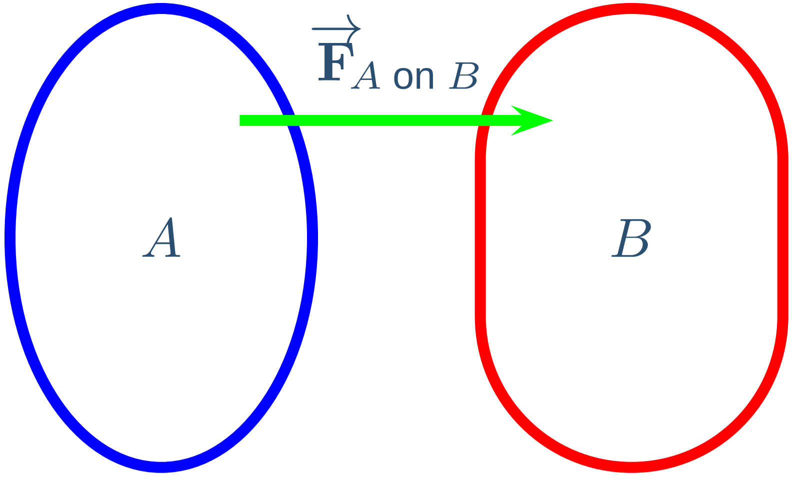

$\vec{\mathbf{F}}_{A \text{ on } B} =$ Force on B due to A

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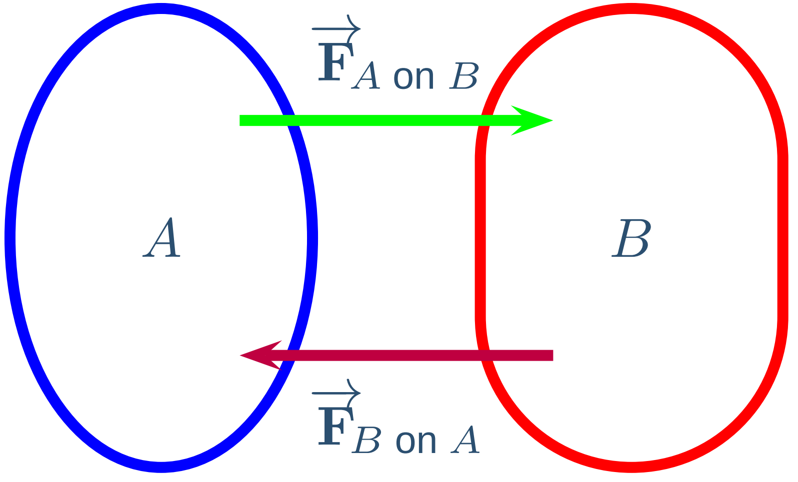

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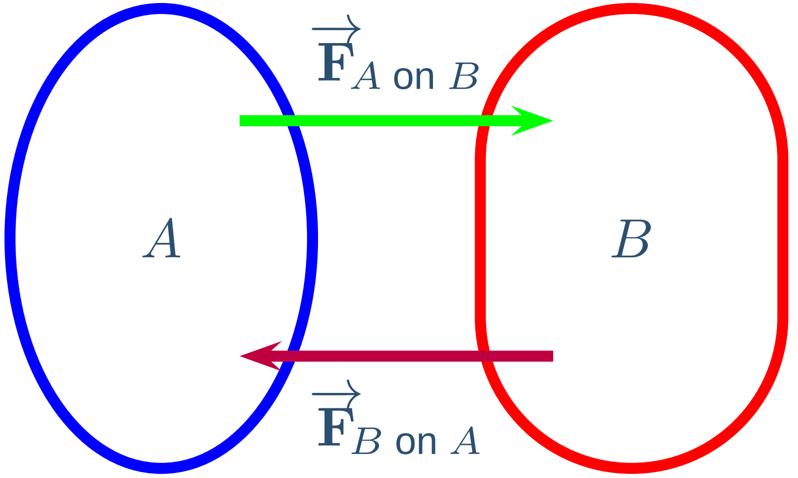

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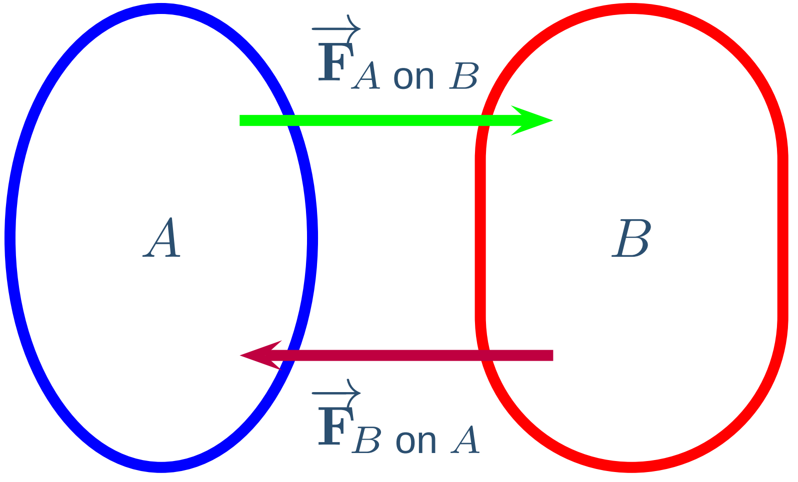

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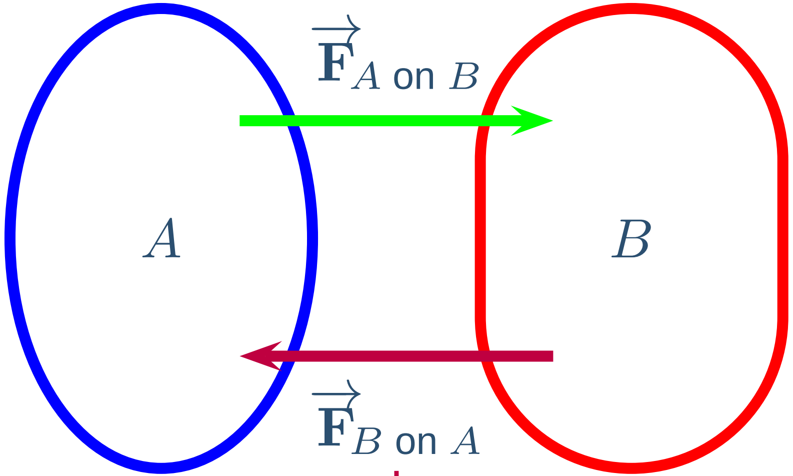

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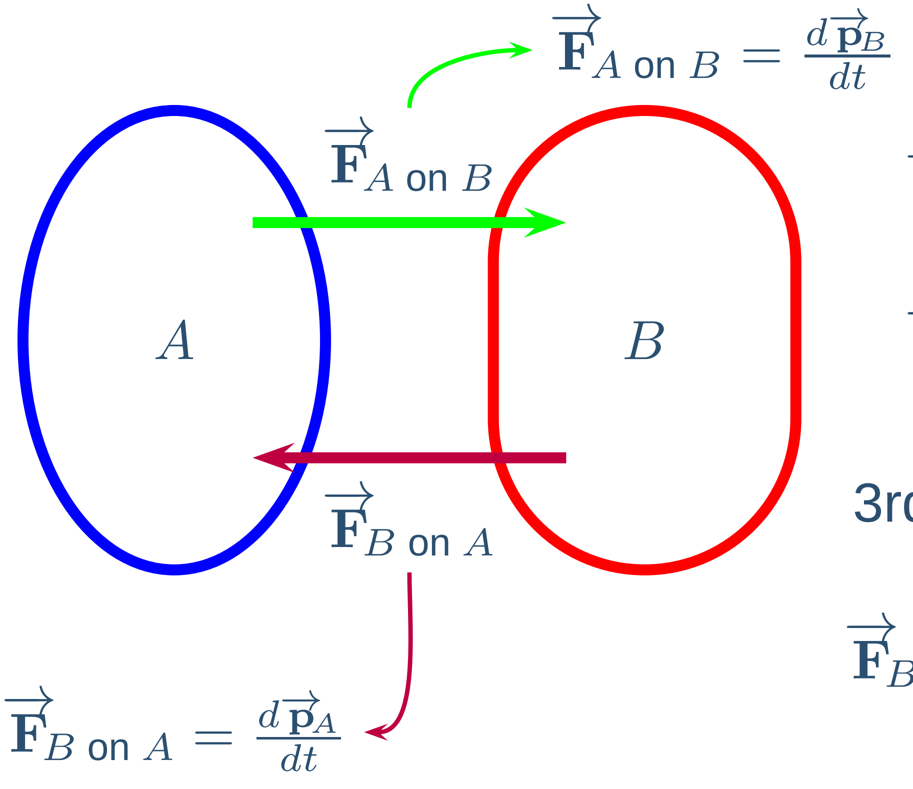

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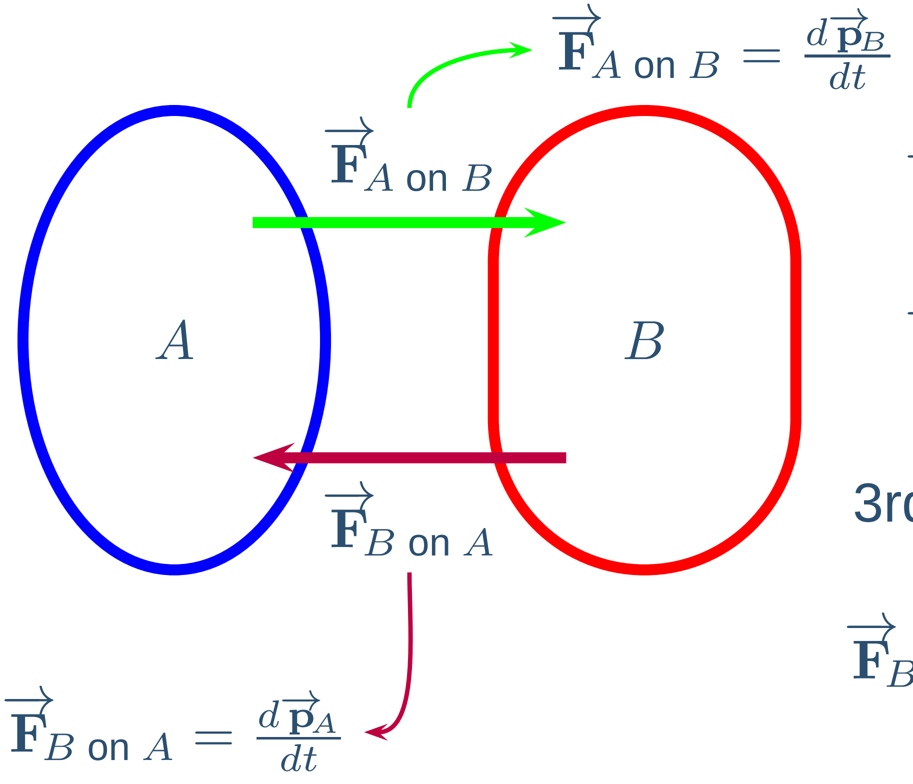

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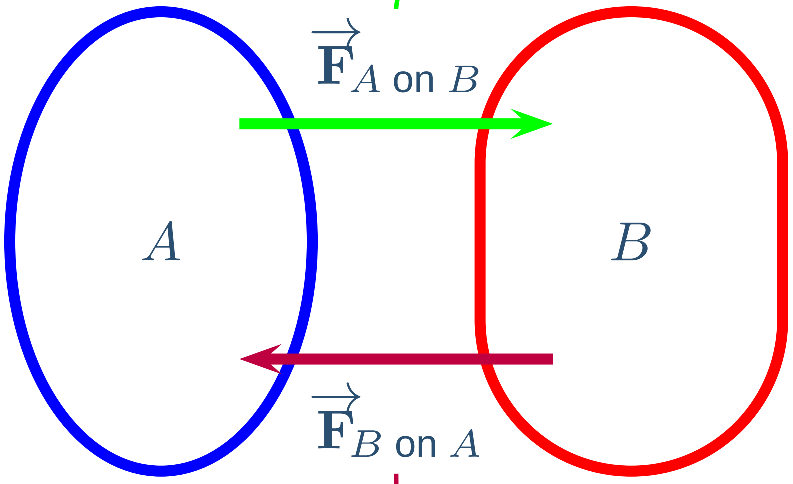

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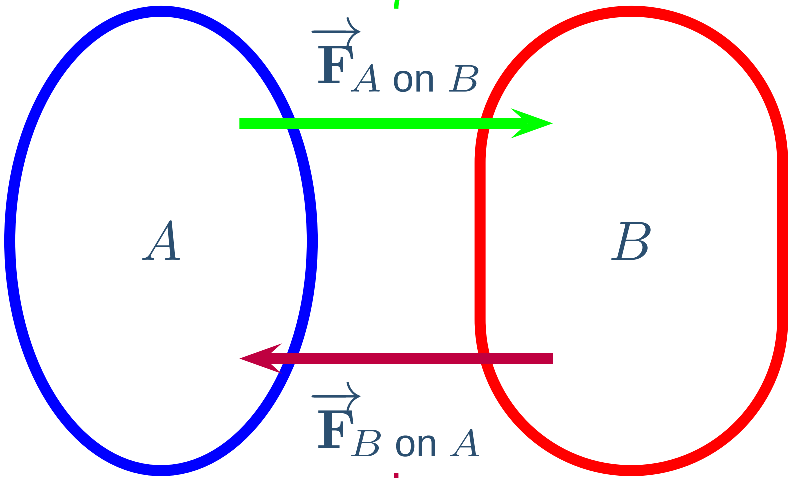

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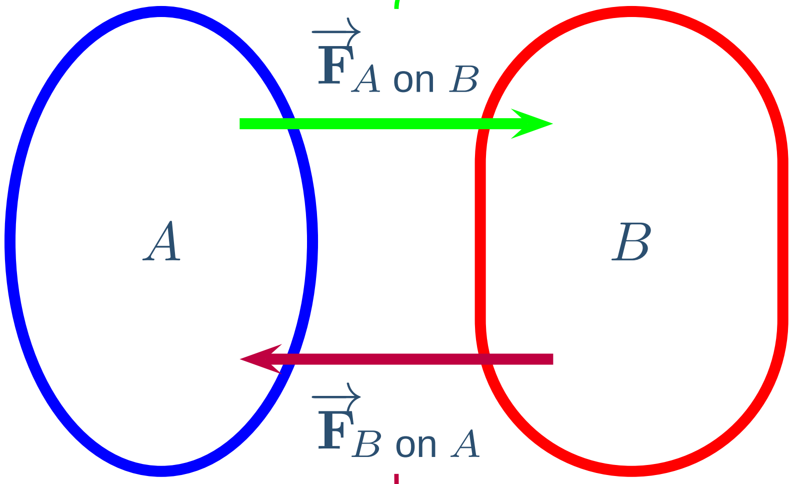

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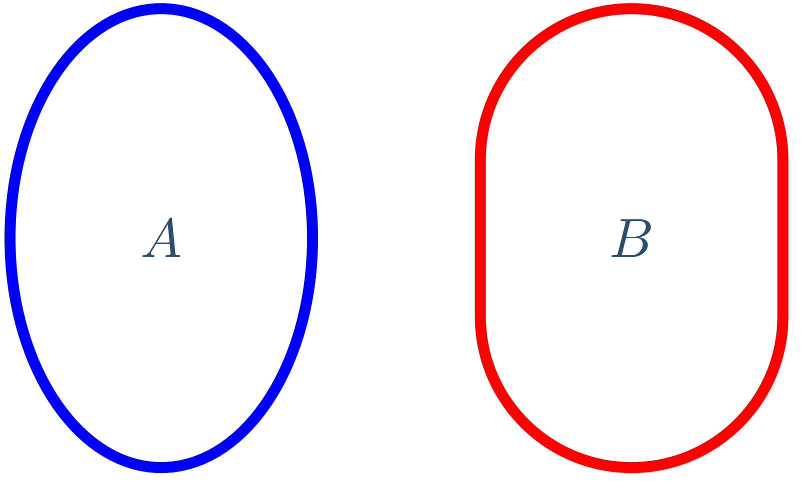
The *total* momentum can't change

Conservation of Momentum II

Conservation of Momentum - In the absence of external forces, the total momentum of the system cannot change.



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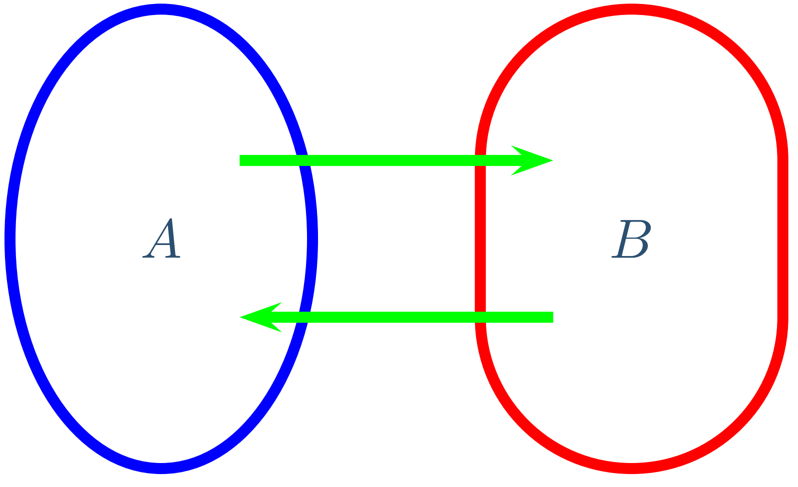

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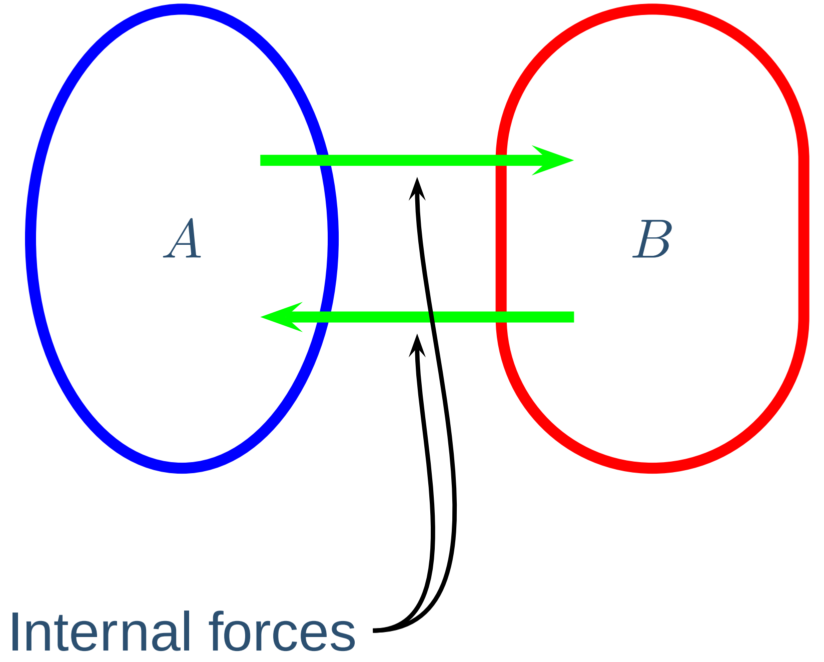

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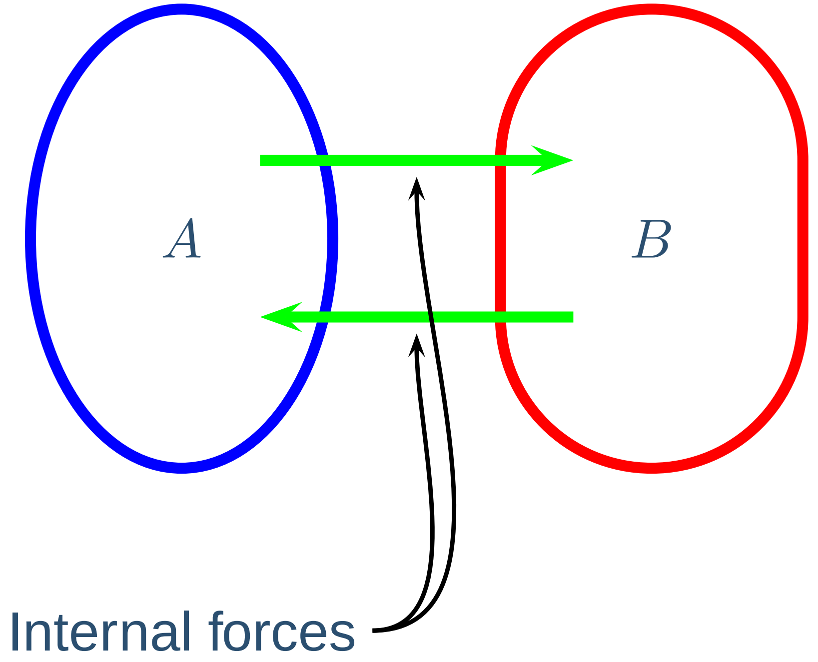

Internal Forces - Forces inside the system. Always come in action/reaction pairs

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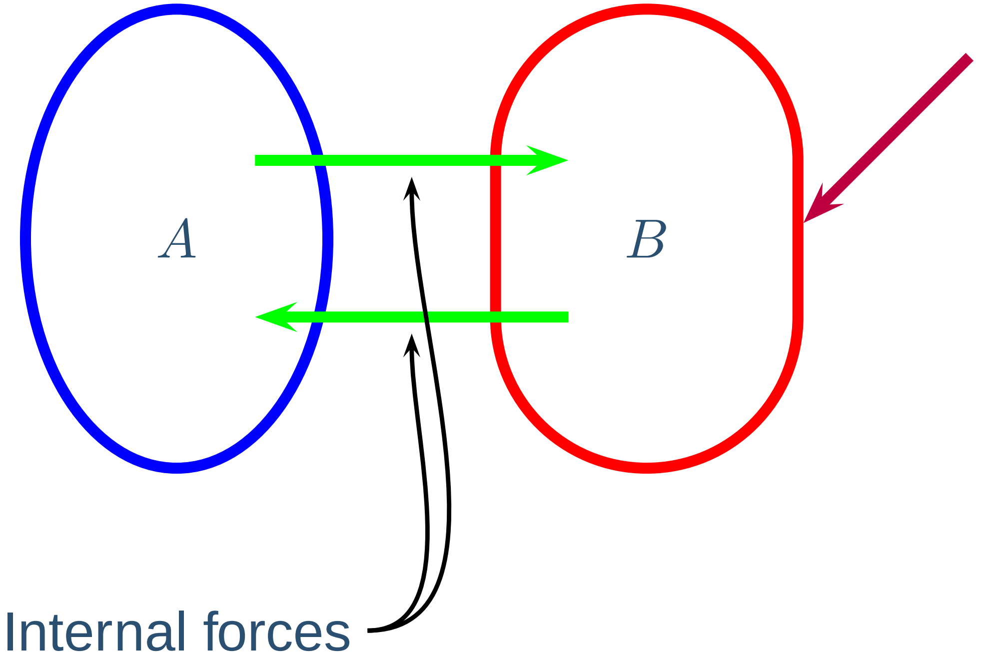

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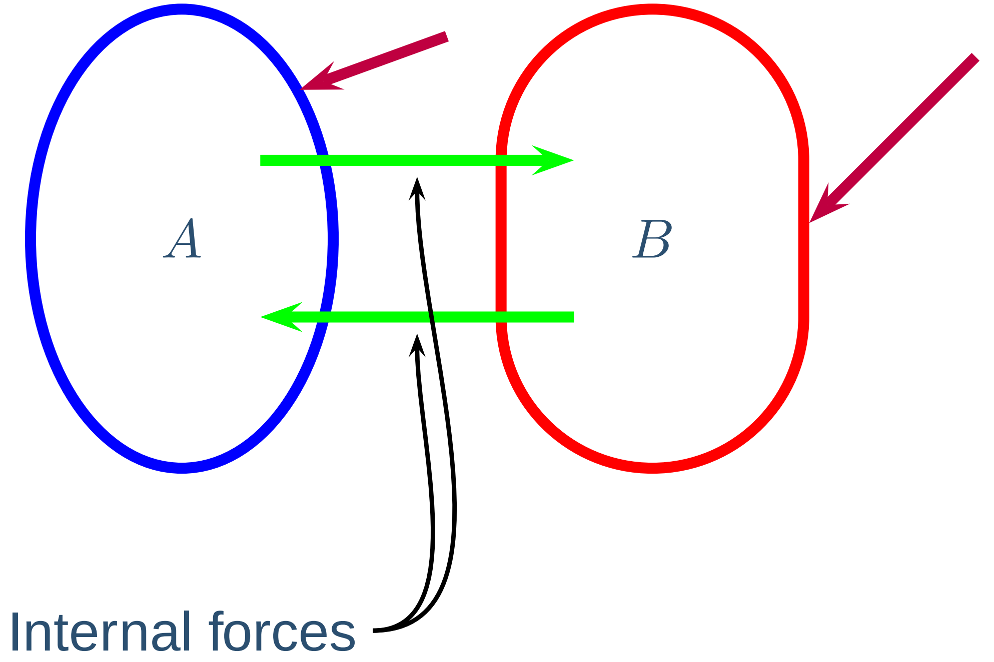

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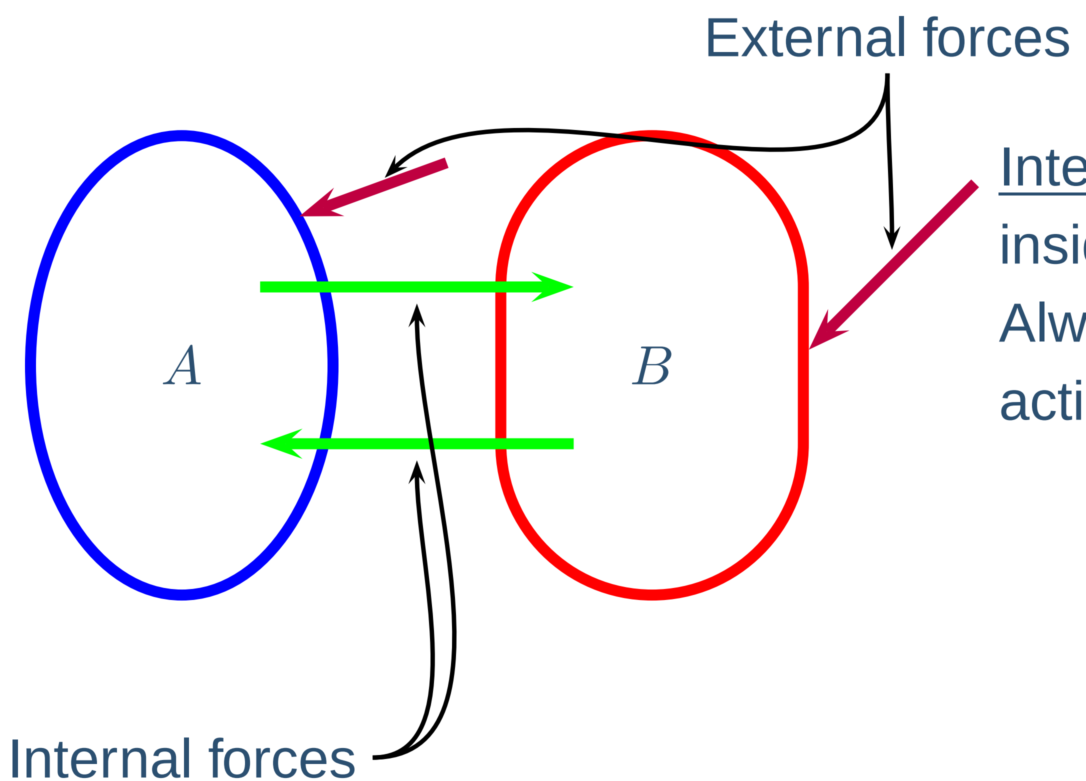

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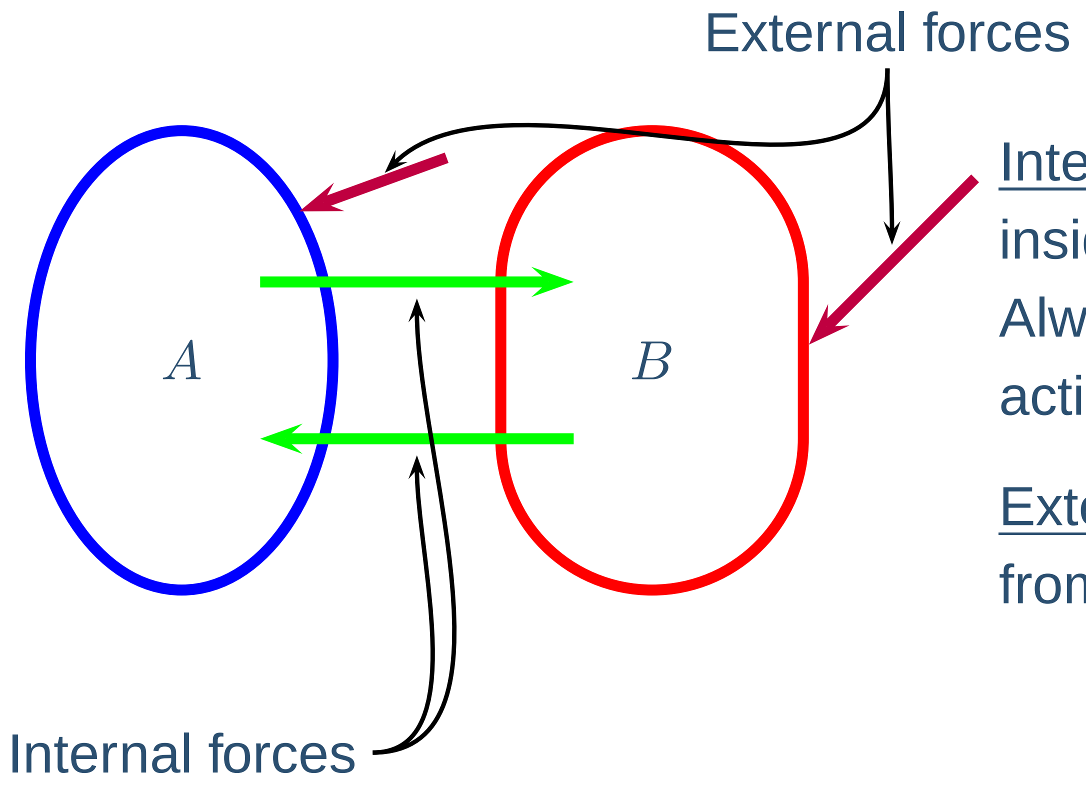

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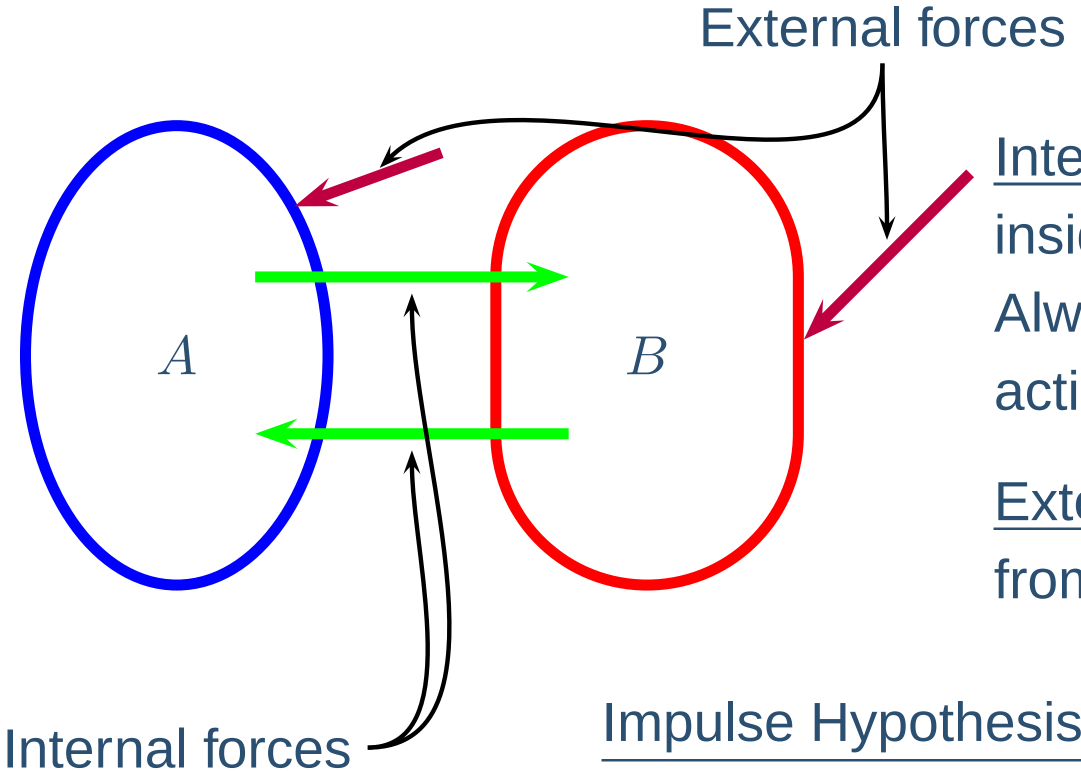

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Impulse Hypothesis - During the small times that a collision lasts, the external forces are small compared to the internal forces so we can ignore them

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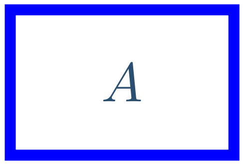

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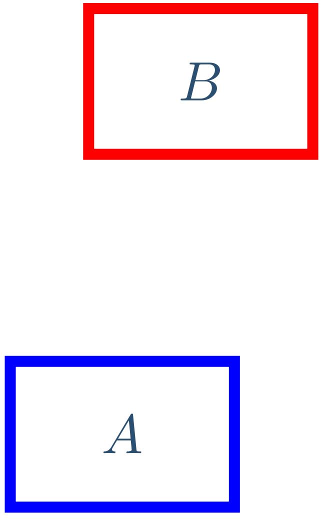

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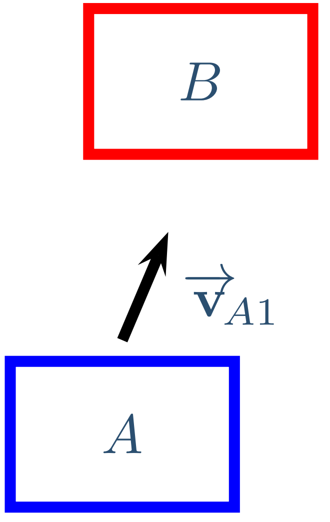

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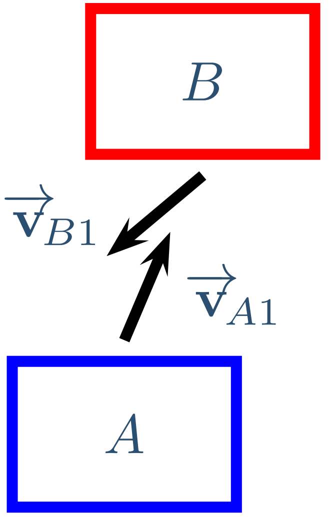

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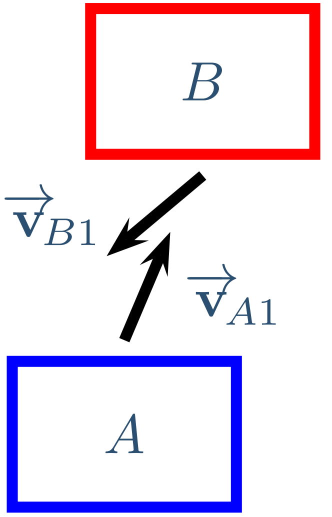

Before

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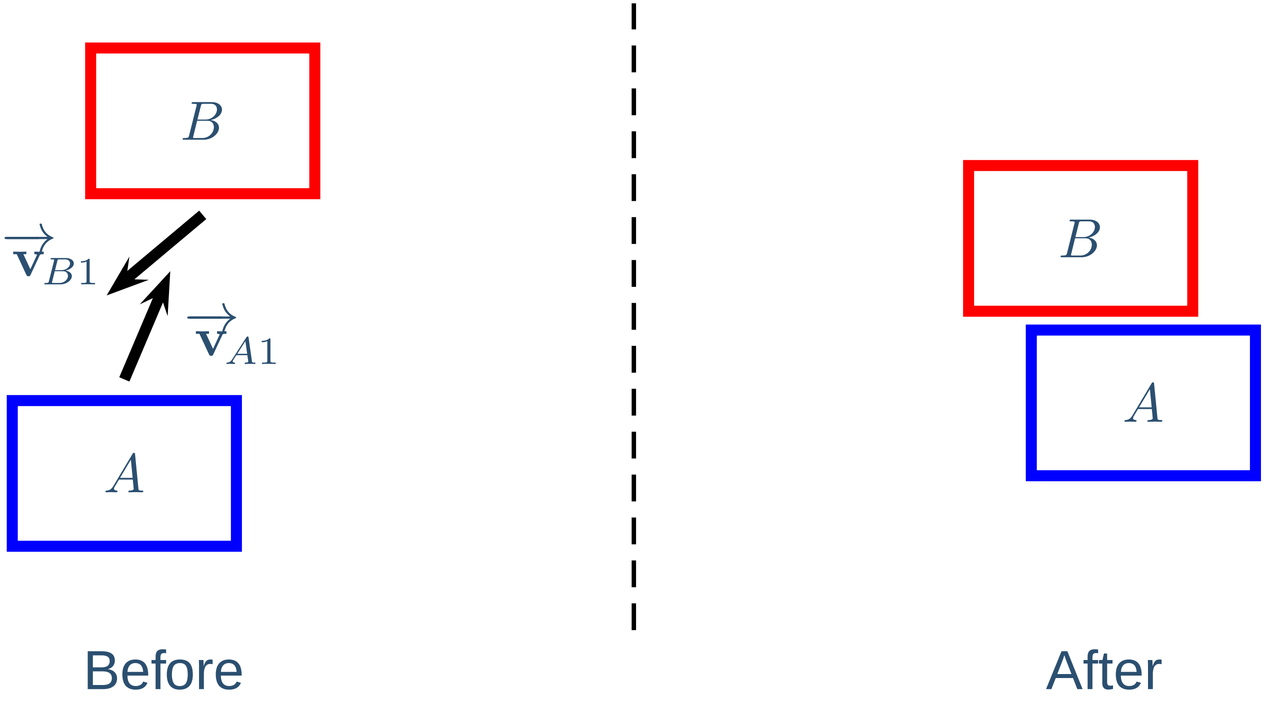

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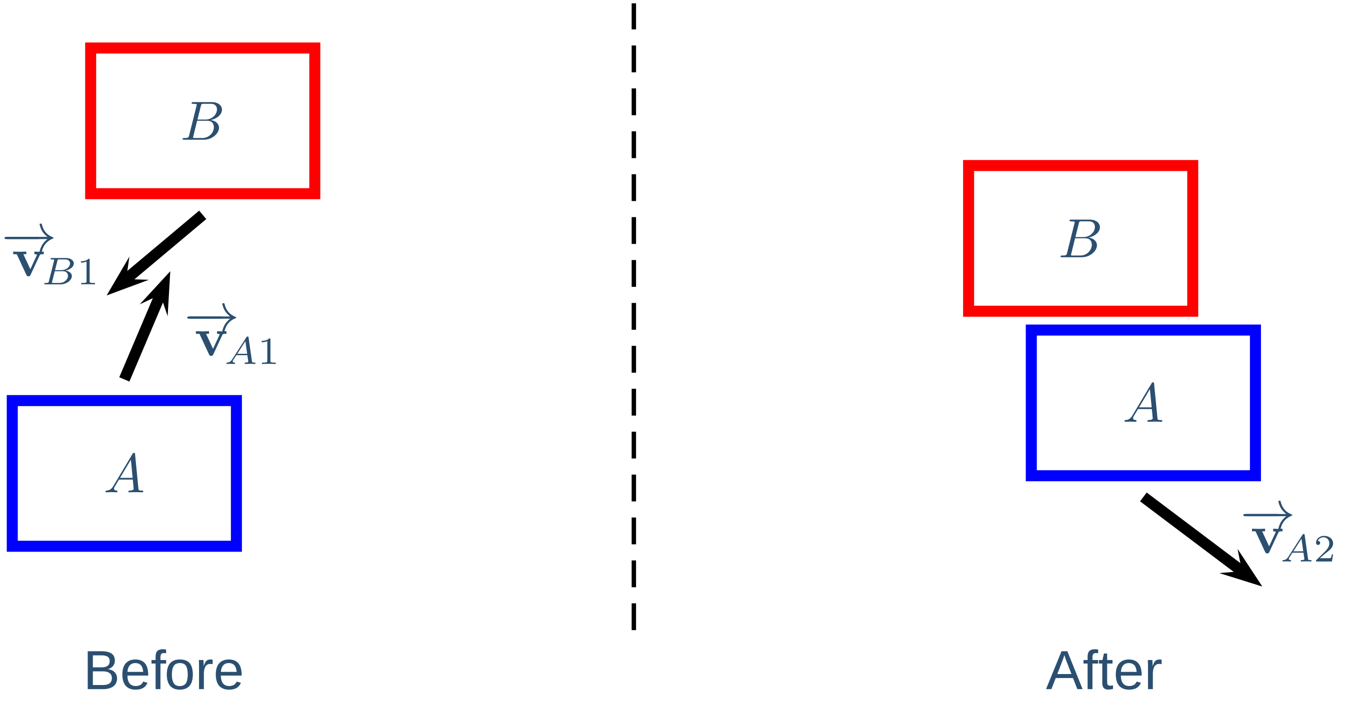

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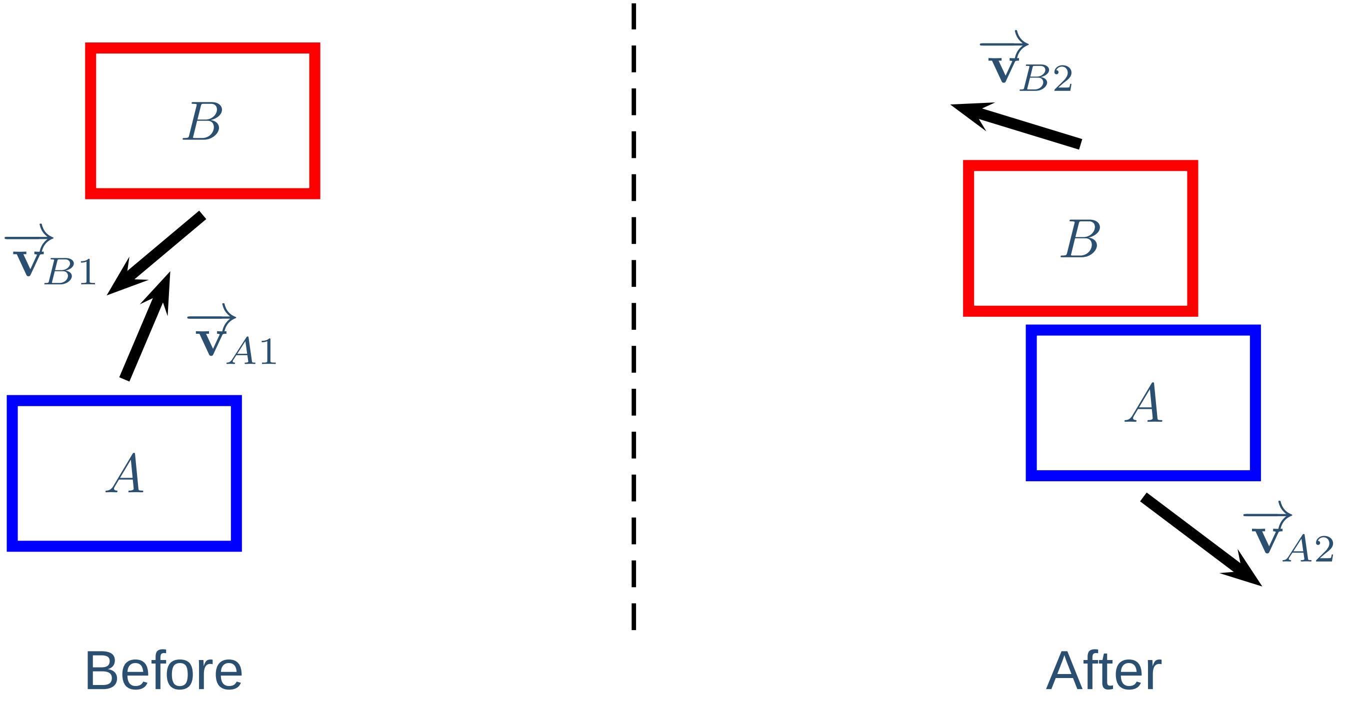

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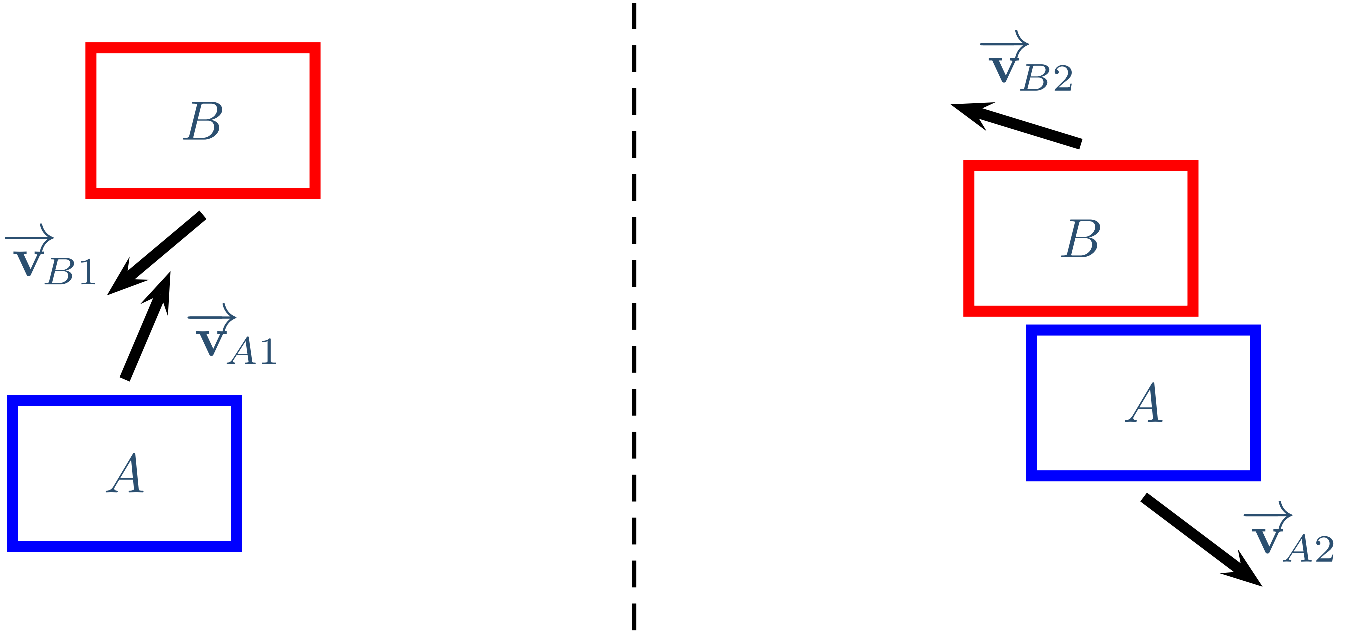

Before | After

$M_A \vec{\mathbf{v}}_{A1} + M_B \vec{\mathbf{v}}_{B1}$ $\qquad$ $M_A \vec{\mathbf{v}}_{A2} + M_B \vec{\mathbf{v}}_{B2}$

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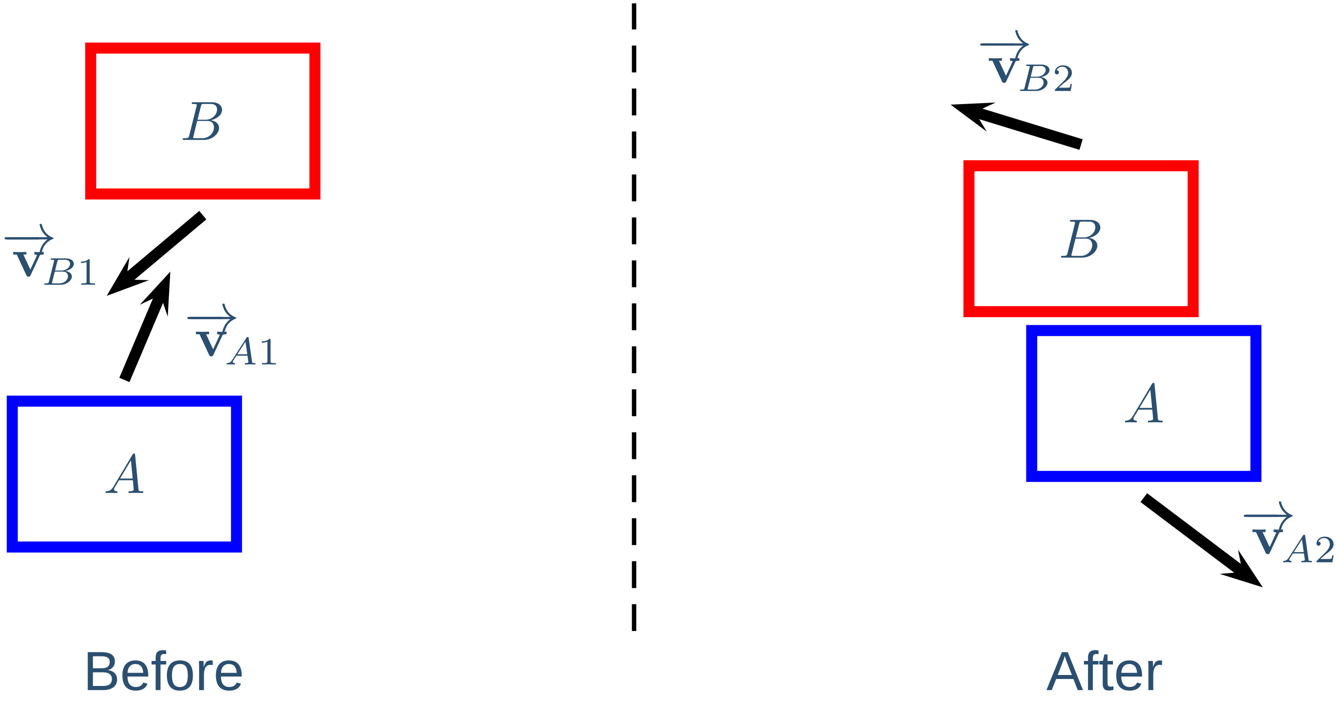
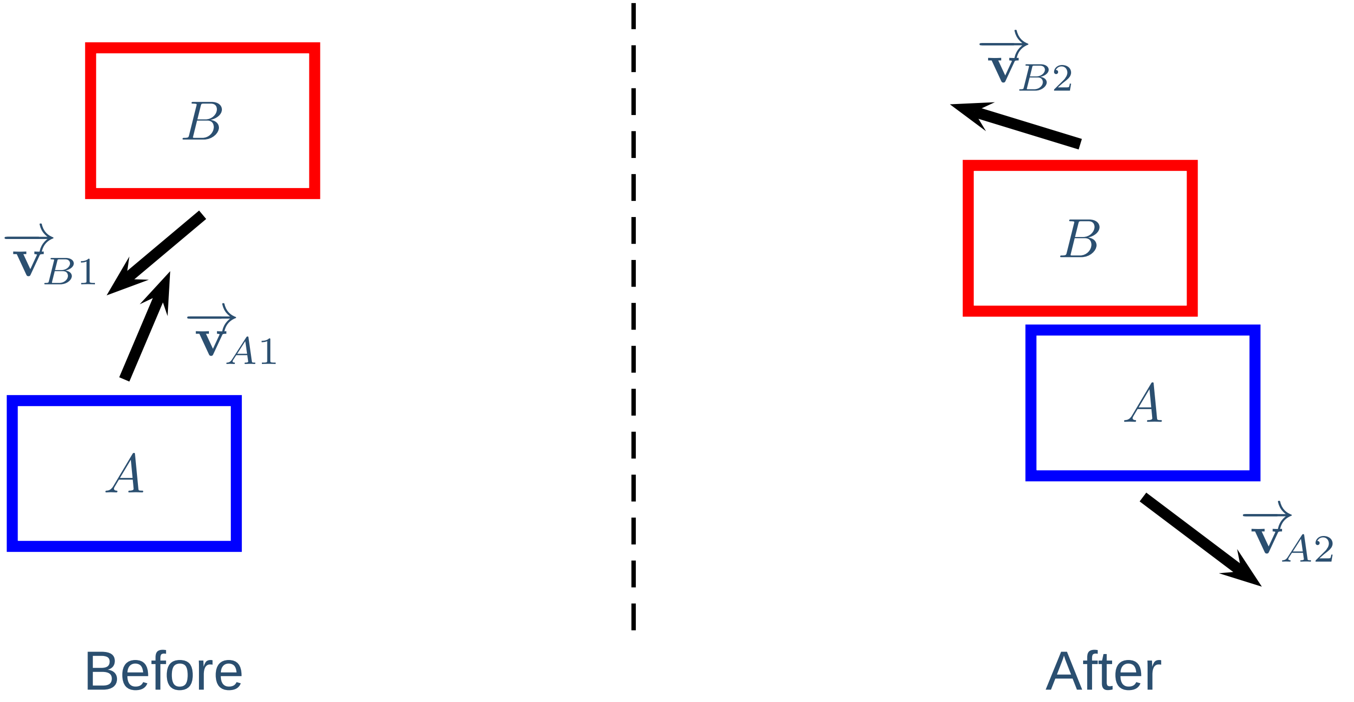


$$M_A \vec{\mathbf{v}}_{A1} + M_B \vec{\mathbf{v}}_{B1} = M_A \vec{\mathbf{v}}_{A2} + M_B \vec{\mathbf{v}}_{B2}$$

Using Conservation of Momentum II



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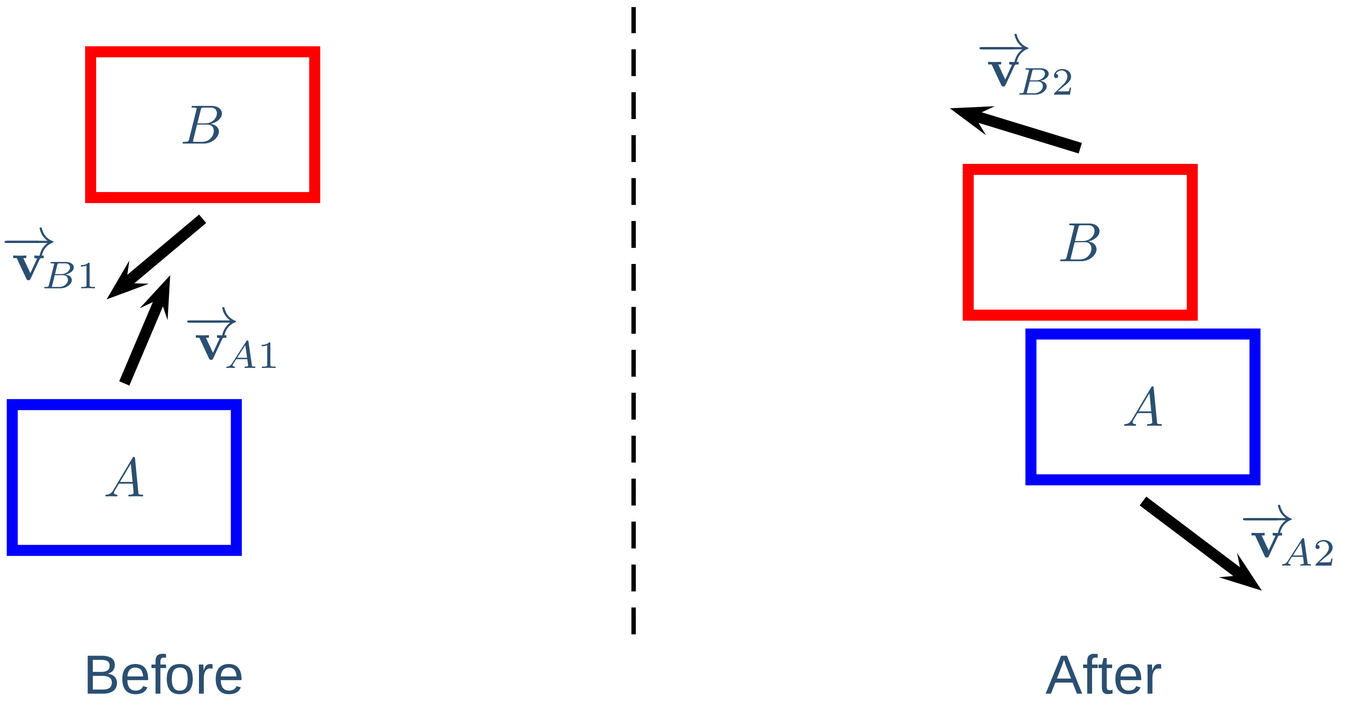

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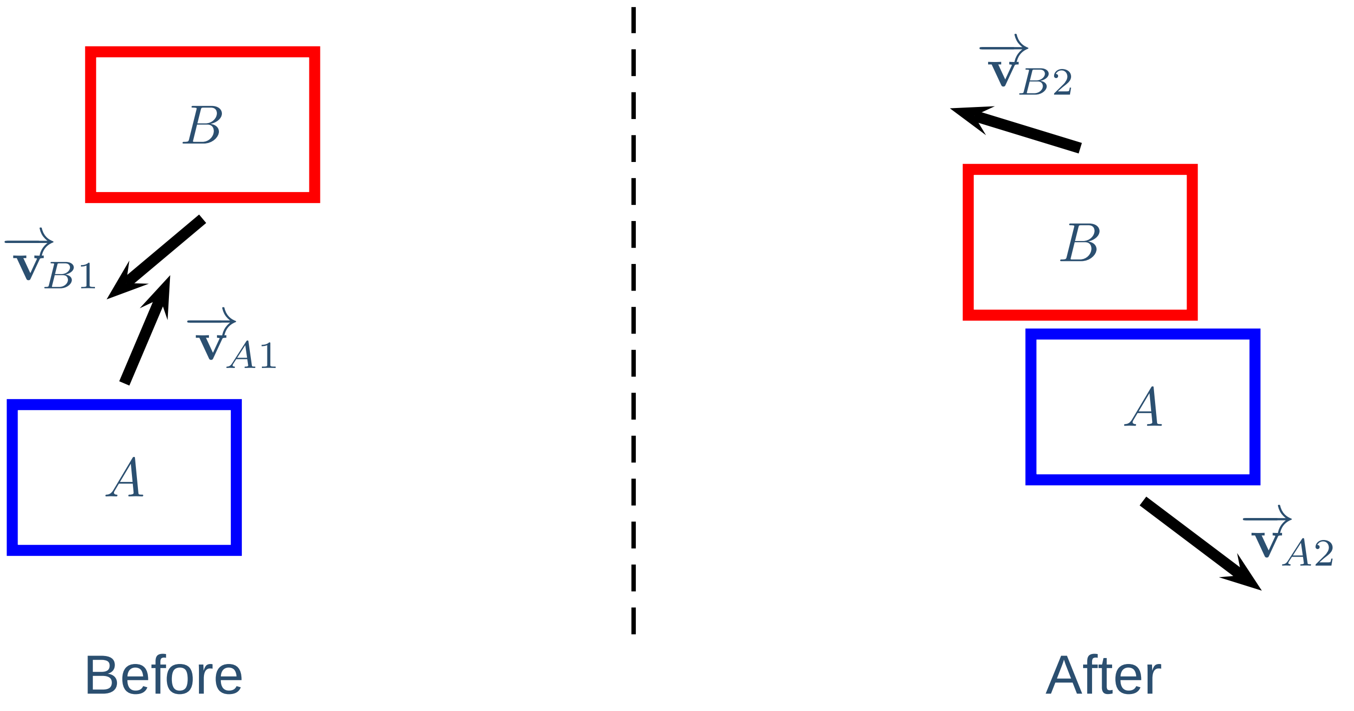
Component Form:

Using Conservation of Momentum II



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Component Form:

$$M_A \left(v_{A1}\right)_x + M_B \left(v_{B1}\right)_x = M_A \left(v_{A2}\right)_x + M_B \left(v_{B2}\right)_x$$

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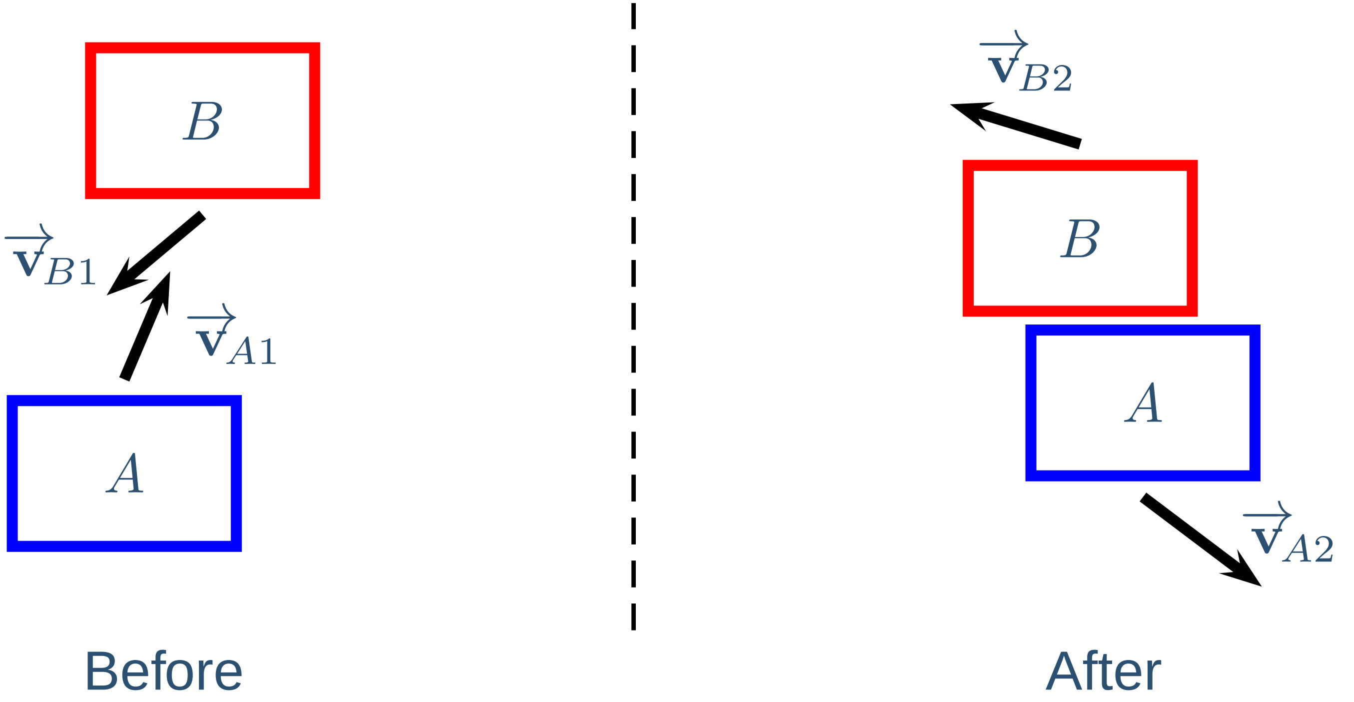

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$$M_A \left(v_{A2}\right)_y + M_B \left(v_{B2}\right)_y = M_A \left(v_{A2}\right)_y + M_B \left(v_{B2}\right)_y$$

Conservation Exercise I

A $1\,kg$ mass sliding to the right with speed $2\,m/s$ on a frictionless floor collides with another $1\,kg$ mass at rest. If the first mass stops after the collision, how fast must the second mass be going?

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(b) $1\,m/s$

(c) $2\,m/s$

(d) $3\,m/s$

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(d) $3\,m/s$ (e) $4\,m/s$

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(a) $0\,m/s$

(b) $1\,m/s$

(c) $2\,m/s$

(d) $3\,m/s$

(e) $4\,m/s$

Conservation: $(1\,kg)(2\,m/s) + 0 = 0 + (1\,kg)(v_{B2})_x \Rightarrow (v_{B2})_x = 2\,m/s$

Conservation Exercise II

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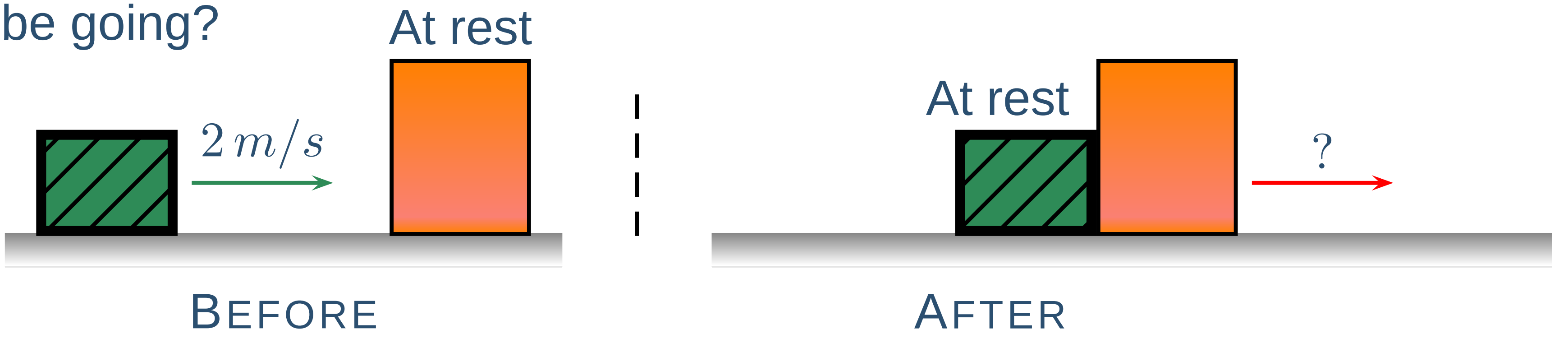

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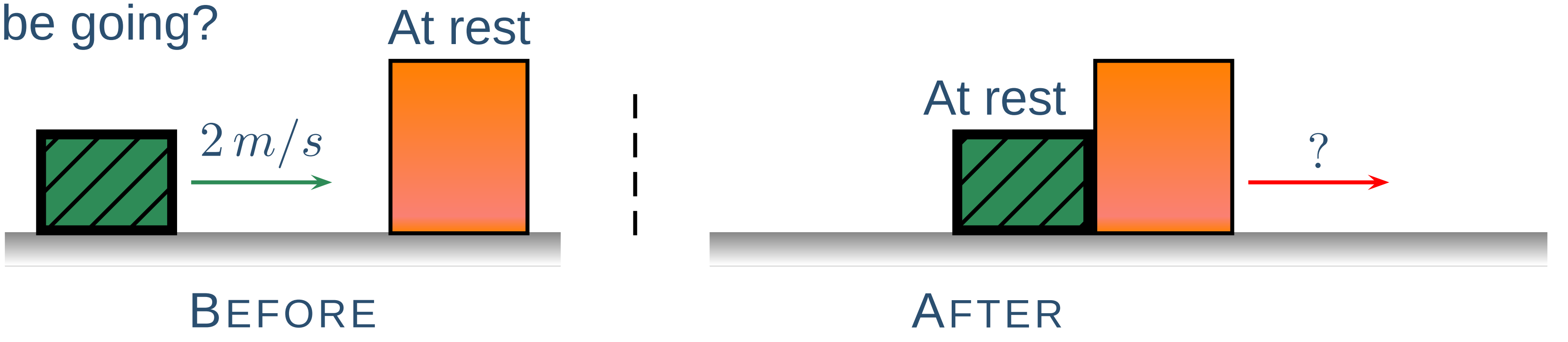

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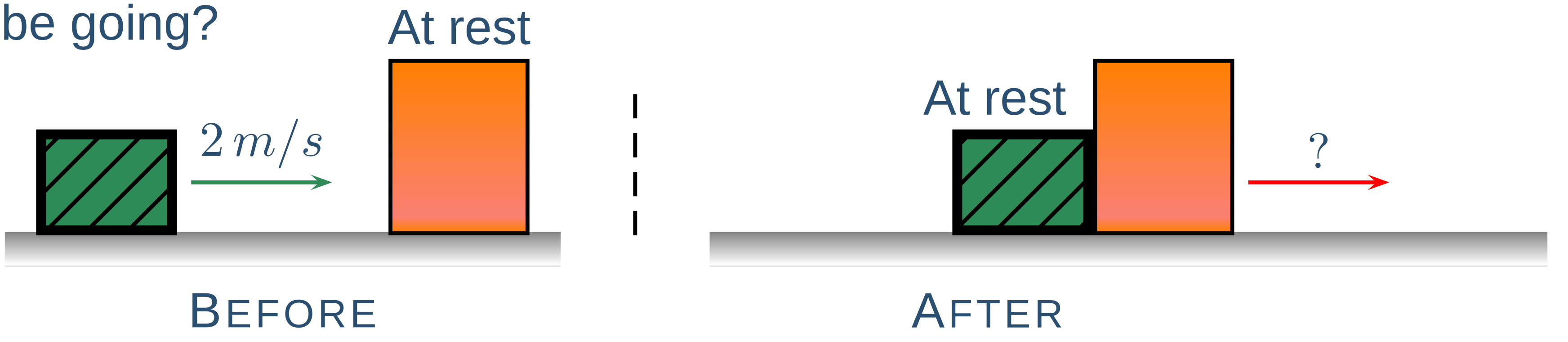

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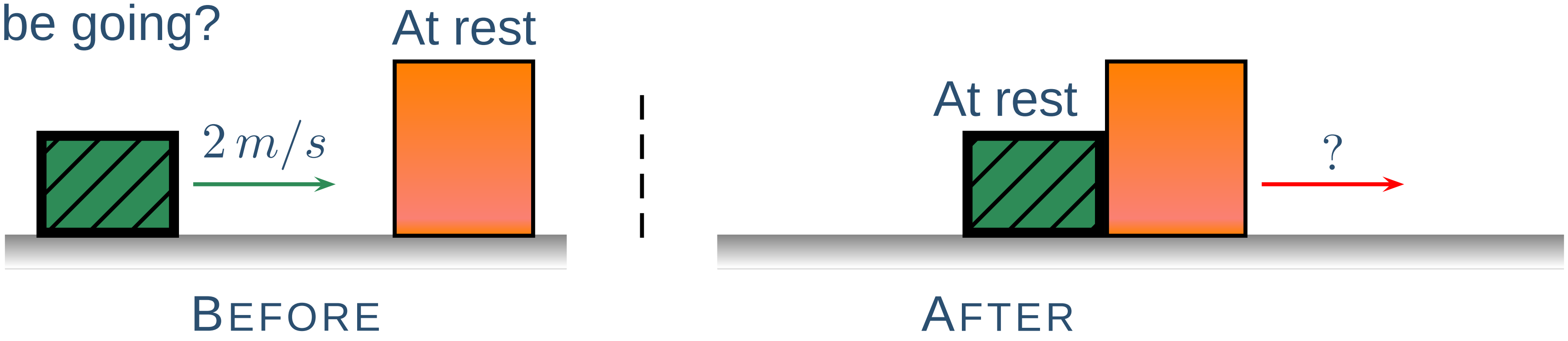

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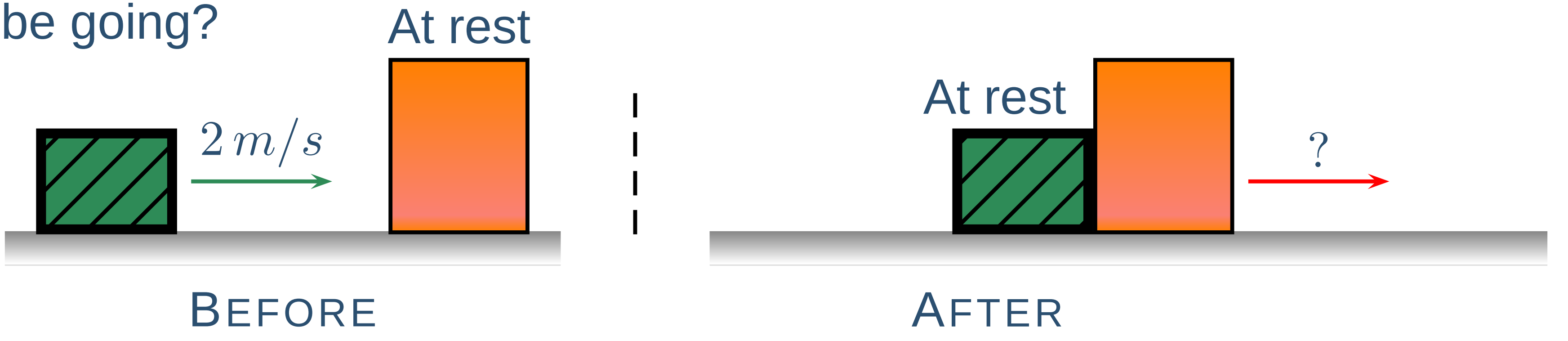

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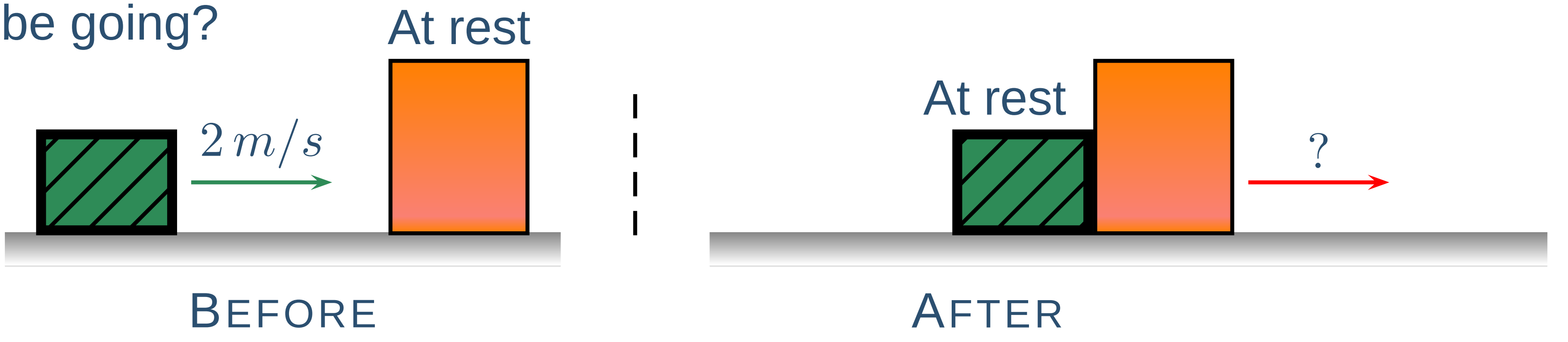

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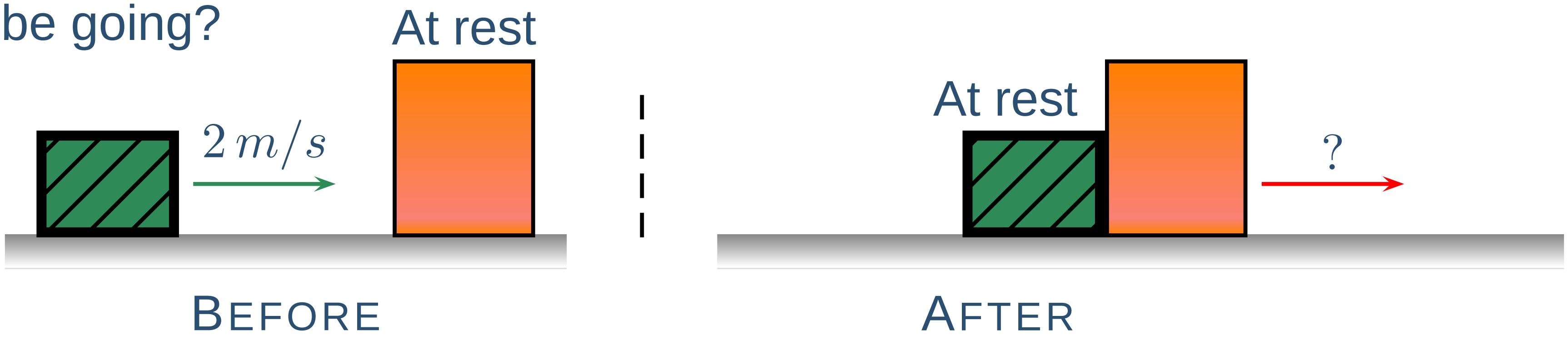

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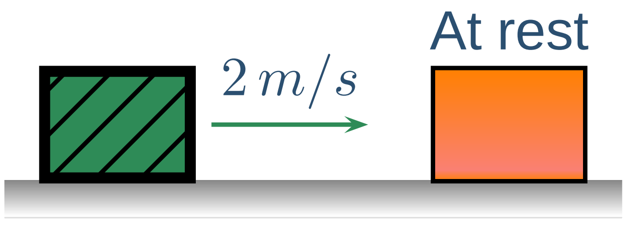
Conservation: $(1\,kg)(2\,m/s) + 0 = 0 + (2\,kg)(v_{B2})_x \Rightarrow (v_{B2})_x = 1\,m/s$

Conservation Exercise III

A $1\,kg$ mass sliding to the right with speed $2\,m/s$ on a frictionless floor collides with another $1\,kg$ mass at rest. If the first mass bounces back with a speed of $1\,m/s$, how fast must the second mass be going?



BEFORE

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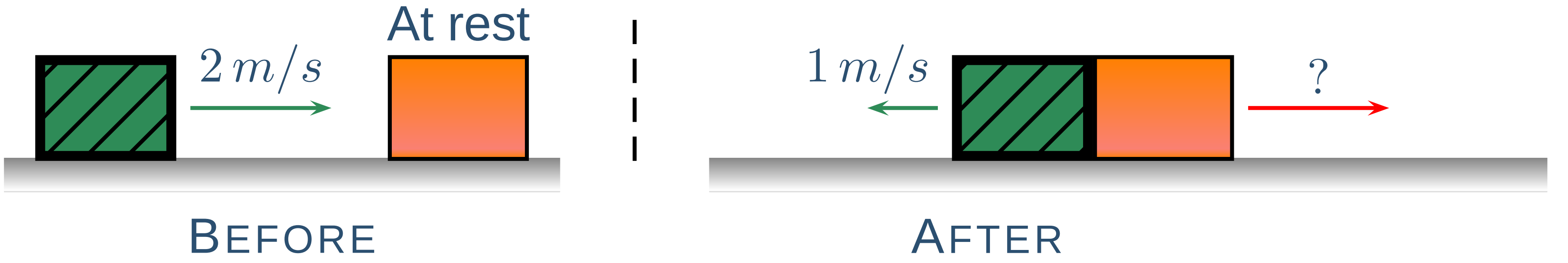

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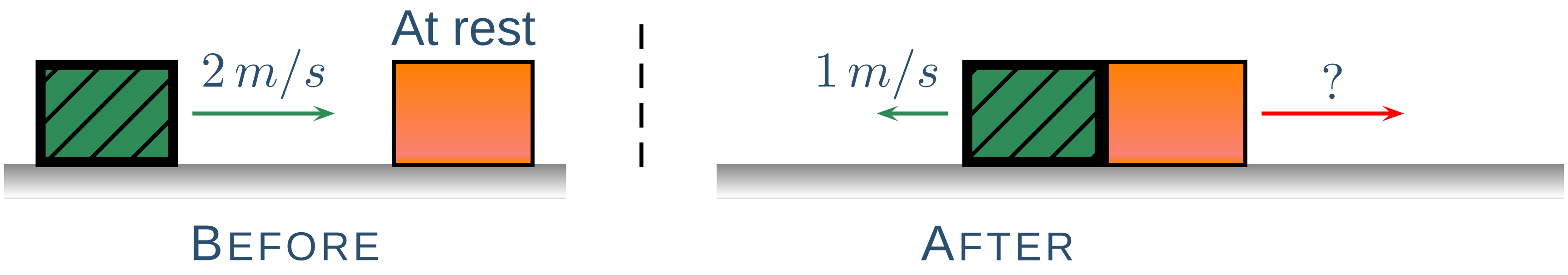

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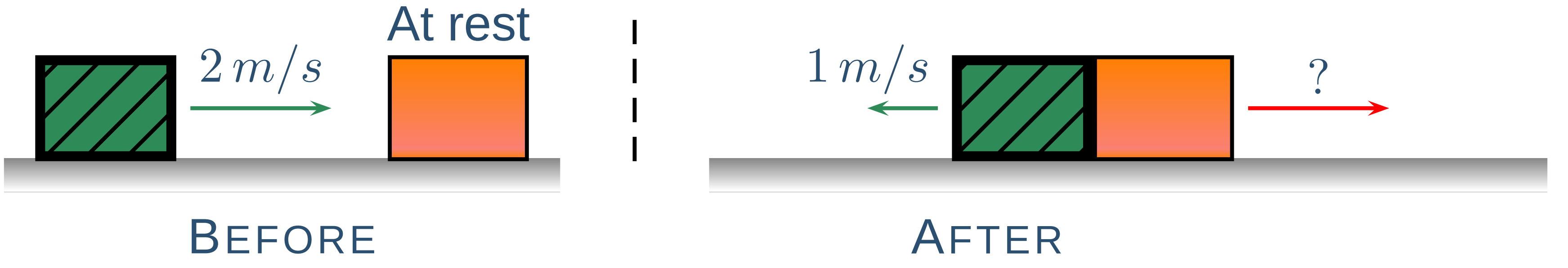

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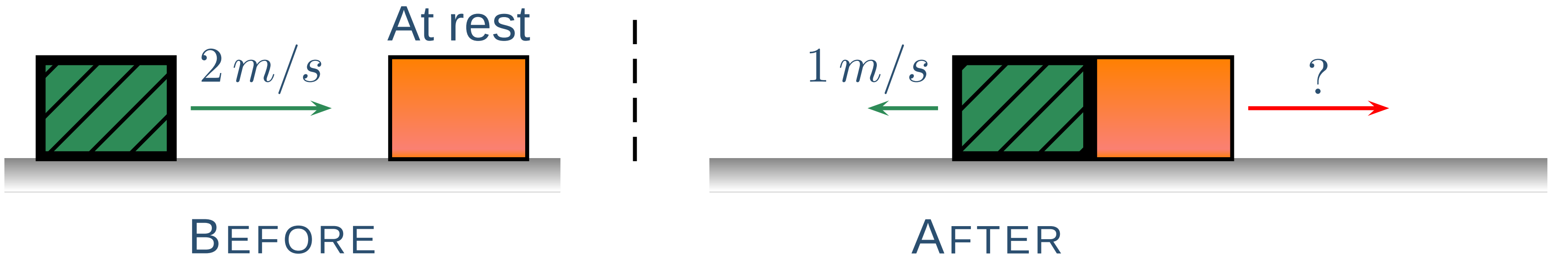

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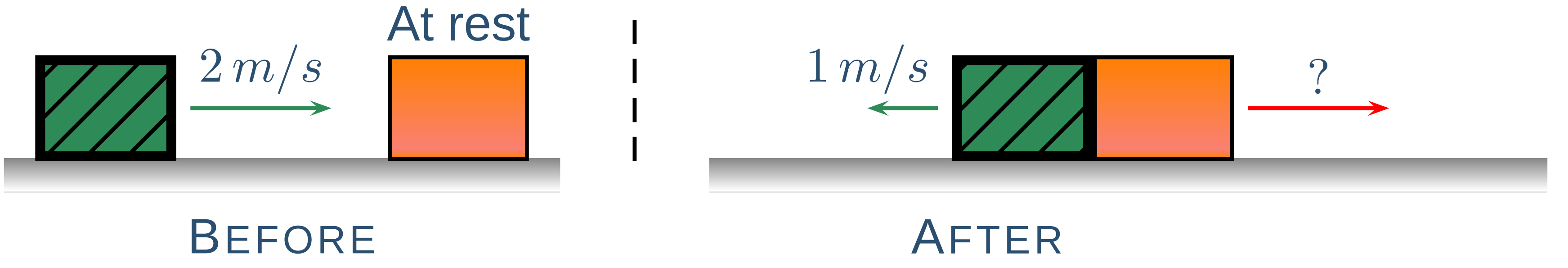

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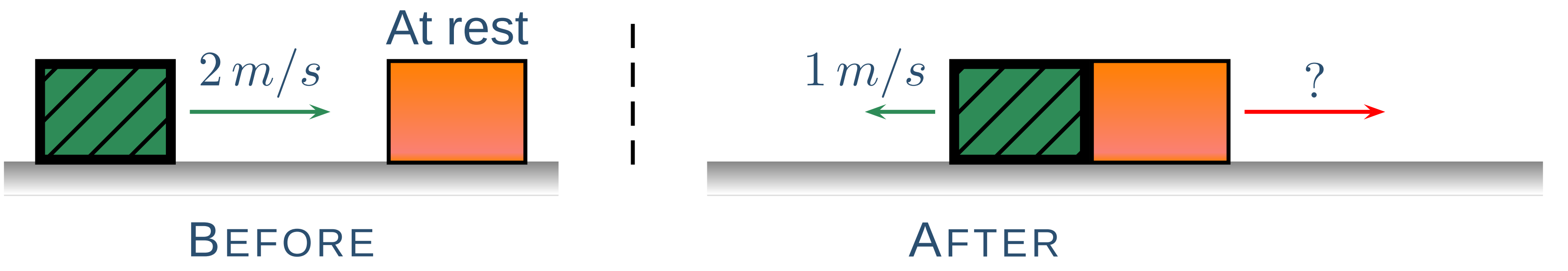

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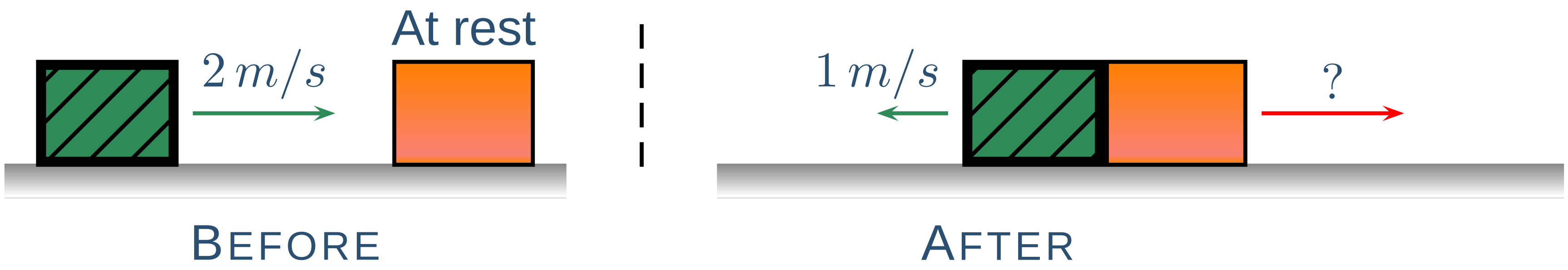

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(d) $3\,m/s$ (e) $4\,m/s$

Conservation: $(1\,kg)(2\,m/s) + 0 = (1\,kg)(-1\,m/s) + (1\,kg)(v_{B2})_x$

$$(2\,kg \cdot m/s) = -(1\,kg \cdot m/s) + (1\,kg)(v_{B2})_x \Rightarrow (v_{B2})_x = 3\,m/s$$

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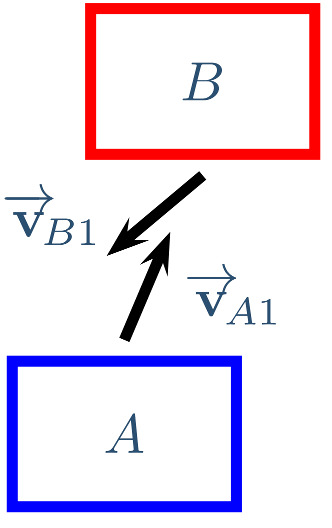

Before

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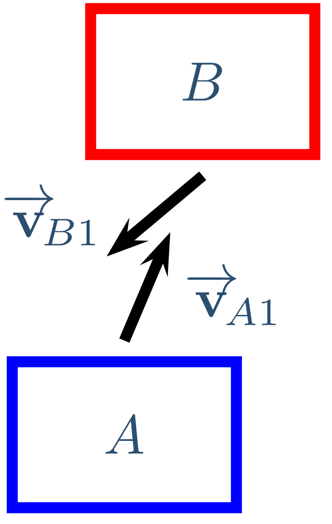

Before

$$M_A \overrightarrow{\mathbf{v}}_{A1} + M_B \overrightarrow{\mathbf{v}}_{B1}$$

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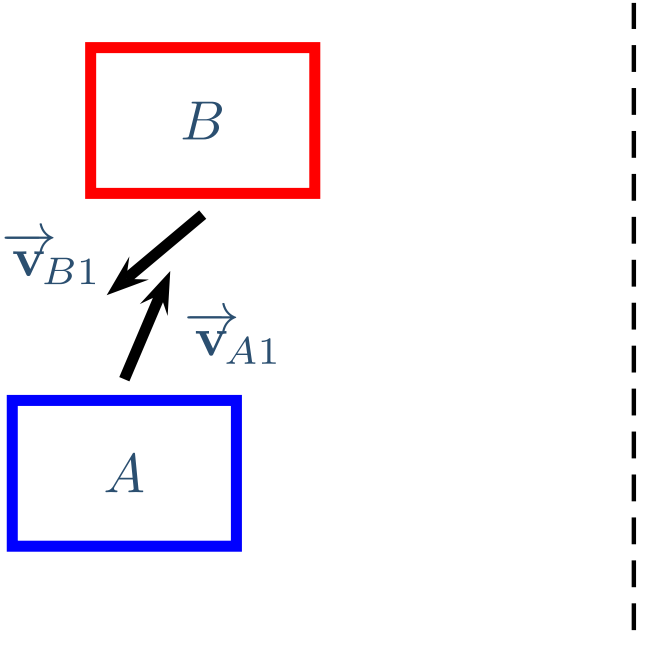

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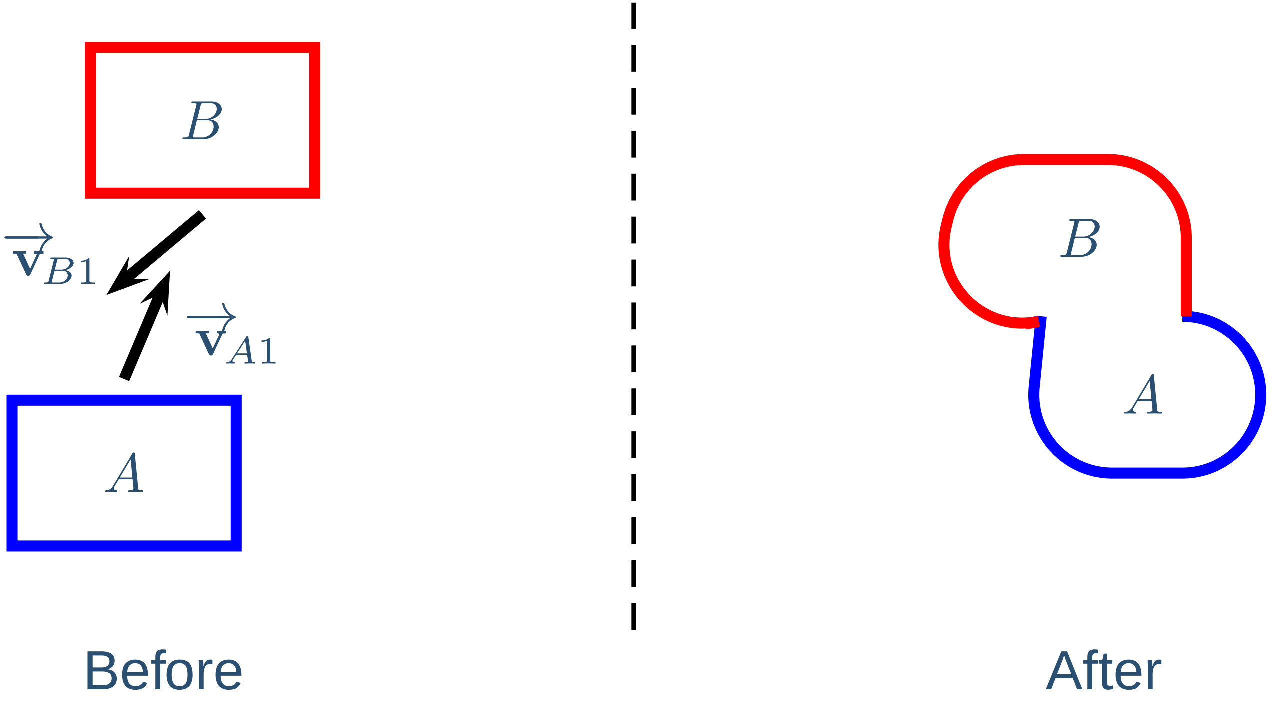

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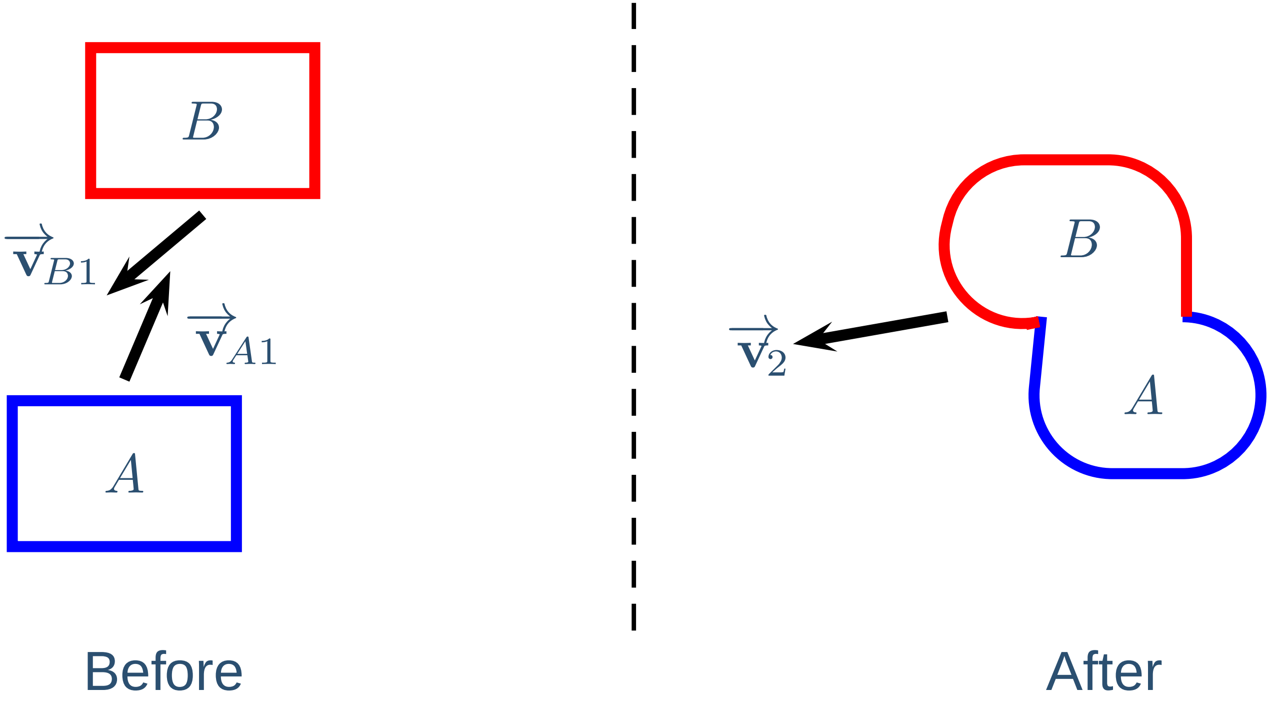

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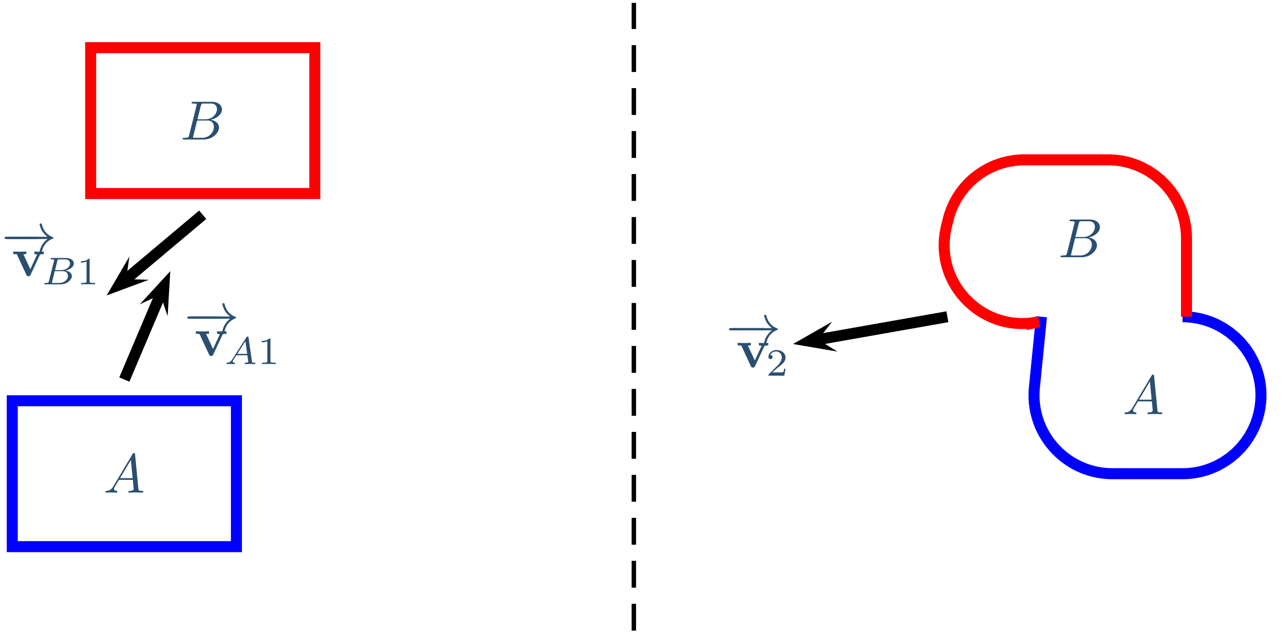

Before | After

$M_A \vec{\mathbf{v}}_{A1} + M_B \vec{\mathbf{v}}_{B1}$ $\quad$ $(M_A + M_B)\, \vec{\mathbf{v}}_2$

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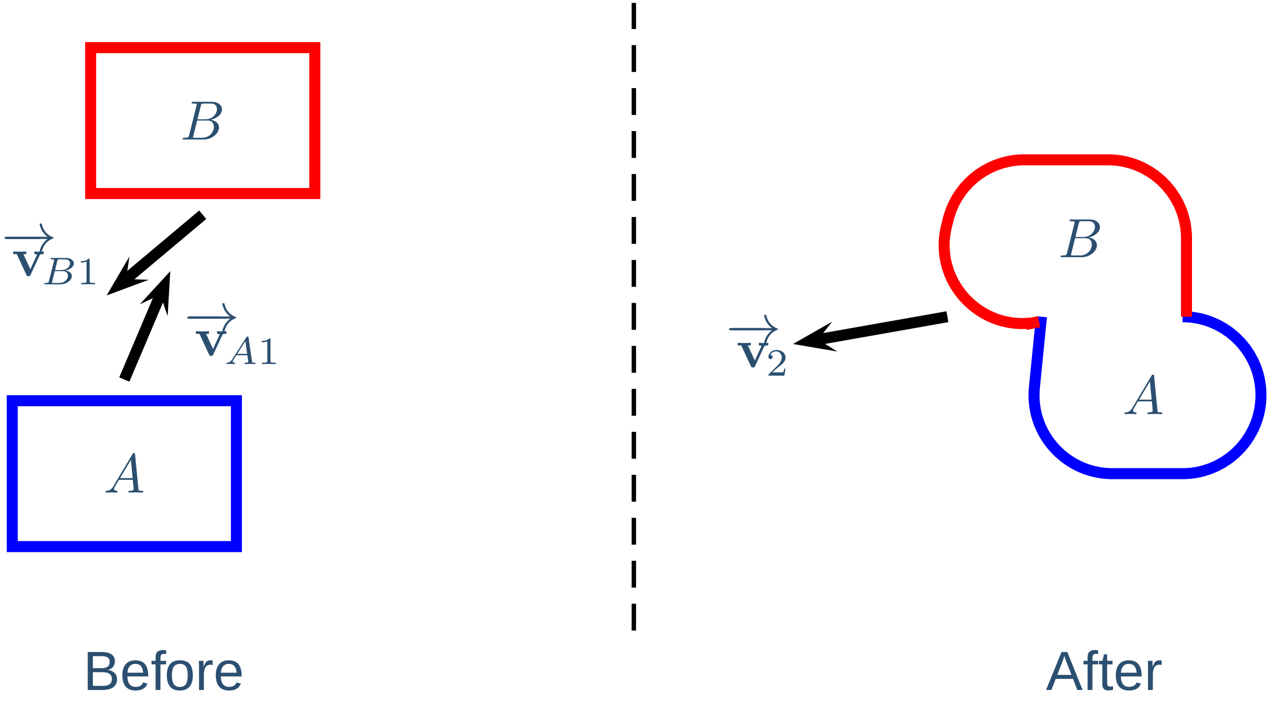

$$M_A \vec{\mathbf{v}}_{A1} + M_B \vec{\mathbf{v}}_{B1} = (M_A + M_B)\,\vec{\mathbf{v}}_2$$

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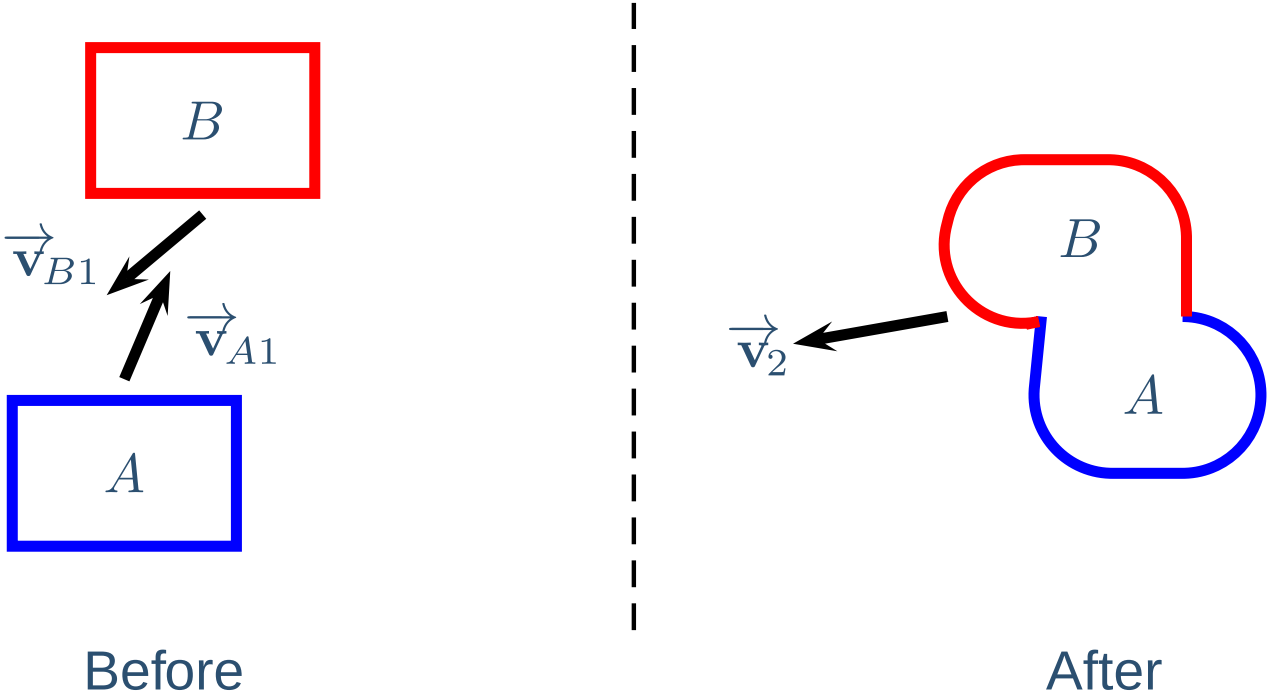


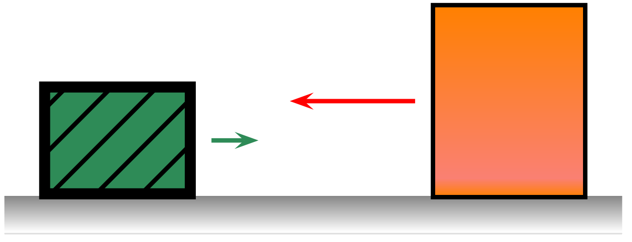
$$M_A \vec{\mathbf{v}}_{A1} + M_B \vec{\mathbf{v}}_{B1} \quad = \quad (M_A + M_B)\, \vec{\mathbf{v}}_2$$

Components:

$$M_A\,(v_{A1})_x + M_B\,(v_{B1})_x = (M_A + M_B)\,(v_2)_x$$
$$M_A\,(v_{A1})_y + M_B\,(v_{B1})_y = (M_A + M_B)\,(v_2)_y$$

Conservation Exercise IV

A $1\,kg$ mass sliding to the right with speed $1\,m/s$ on a frictionless floor collides with a $2\,kg$ mass going to the left at $2\,m/s$. If the masses stick to each other, how fast is the combo going after?



BEFORE

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(a) $(5/3)\ m/s$

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(a) $(5/3)\ m/s$ (b) $-(5/3)\ m/s$

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(d) $3\,m/s$ (e) $-3\,m/s$

Conservation: $(1\,kg)(1\,m/s) + (2\,kg)(-2\,m/s) = (1\,kg + 2\,kg)(v_2)_x$

$(1\,kg \cdot m/s) - (4\,kg \cdot m/s) + (3\,kg)(v_2)_x \Rightarrow (v_2)_x = -1\,m/s$