§7.3 Conservation of Momentum

Recall Newton's 3rd Law:

$$\vec{F}_A = -\vec{F}_B$$

Recall Impulse-momentum theorem:

$\vec{F}\Delta t = m\Delta\vec{v}$

$(\vec{J} = \Delta\vec{p})$

$$\vec{F}_A \Delta t = -\vec{F}_B \Delta t$$

(impulse) (impulse)

$$m_A \Delta\vec{V}_A = -m_B \Delta\vec{V}_B$$

$$m_A(\vec{V}_{A2} - \vec{V}_{A1}) = -m_B(\vec{V}_{B2} - \vec{V}_{B1})$$

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

$$-m_A\vec{V}_{A1} - m_B\vec{V}_{B1} = -m_A\vec{V}_{A2} - m_B\vec{V}_{B2}$$

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

$$\vec{P}_A + \vec{P}_B = \vec{P}_A' + \vec{P}_B'$$

Law of Conservation of Momentum

$$\vec{P}_{total} = \vec{P}'_{total}$$

In an isolated system (i.e. no friction), the total momentum before is equal to the total momentum after.

Another way to think of it is that one object's loss in momentum is the other object's gain in momentum.

i.e. $\Delta\vec{P}_A = -\Delta\vec{P}_B$

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EAST (+)

	BEFORE		AFTER
	car 1	car 2	car 1+2
m	1.75×10^4 kg	2.00×10^4 kg	3.75×10^4 kg
v	+5.45 m/s	0	v
p	95375 kg·m/s	0	$(3.75\times10^4 \text{ kg})v$

p = mv

$\vec{p}_{total}$ (before), $\vec{p}'_{total}$ (after)

$$95375 \text{ kg·m/s} + 0 = (3.75\times10^4 \text{ kg})v$$

$$95375 \text{ kg·m/s} = (3.75\times10^4 \text{ kg})v$$

$$v = +2.54 \text{ m/s}$$

$$\vec{v} = 2.54 \text{ m/s [E]}$$

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(+) forward.

	BEFORE: You + canoe	AFTER: You	AFTER: canoe
m	180 kg	65 kg	115 kg
v	0	+0.75 m/s	v
p	0	48.75 kg·m/s	(115 kg) v

Before: $\vec{p}_{total}$ After: $\vec{p}\,'_{total}$

$$0 = (48.75\ kg \cdot m/s) + (115\ kg)v$$

$$-48.75\ kg \cdot m/s = (115\ kg)v$$

$$v = -0.42\ m/s$$

$$\vec{v} = 0.42\ m/s \text{ [opp your direction]}$$

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