Today:
Chapter 11 – Conservation of Momentum
Chapter 8 – Circular Motion

Irish Phrasebook

Acting the maggot *– Fooling and messing around*

Announcements

- No assignments due this week

- Upcoming assignments:
  - LON-CAPA HW for Ch8 will be due Fri. 13th (will open tomorrow)
  - Reading Q's for Ch9 will be due Tues. 10th (will be open tomorrow)

Momentum of System of Particles

- Momentum: a vector quantity that depends on both mass and velocity of the object of interest

$$\vec{p} = m\vec{v}$$

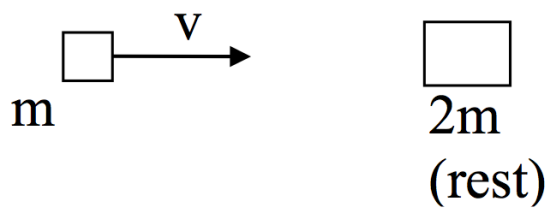
- A system of particles would have a total momentum that is equal to the sum of the individual momentums

$$\vec{p}_{\,total} = \sum_i \vec{p}_i = \sum_i m_i v_i = m_1 \vec{v}_{\,i} + m_2 \vec{v}_2 + m_3 \vec{v}_3 + \ldots$$

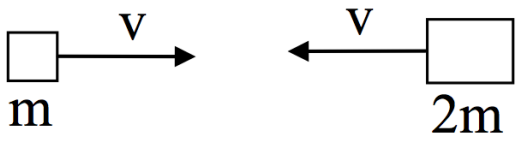
In which situation is the magnitude of the momentum the largest?

A. Situation I has the larger total momentum
B. Situation II has the larger total momentum
C. Same magnitude of total momentum in both cases

I:



II:



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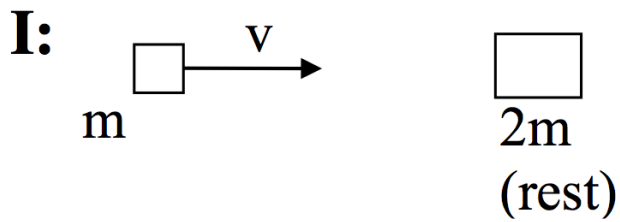
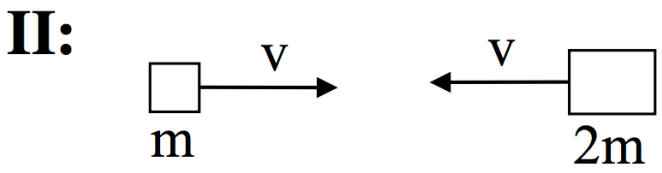




If both blocks are in the system
I: p = mv +0 = mv
II: p = mv -2mv = -mv
So in terms of magnitude they are equal

$$\vec{p}_{\,total} = \sum_i \vec{p}_i = \vec{p}_1 + \vec{p}_2 + \vec{p}_3 + \ldots$$

$$\frac{d\vec{p}}{dt} = \frac{d(\vec{p}_1 + \vec{p}_2 + \vec{p}_3 + \ldots)}{dt}$$

$$\frac{d\vec{p}}{dt} = \frac{d\vec{p}_1}{dt} + \frac{d\vec{p}_2}{dt} + \frac{d\vec{p}_3}{dt} + \ldots$$

$\vec{F}_{net\ (on\ 1)}$

$$\vec{F}_{\,net->1} = \vec{F}_{2->1} + \vec{F}_{3->1} + \vec{F}_{external->1} + \ldots.$$

Momentum of System of Particles

- For a *system* of particles, the rate of change of of the total momentum (p_{tot}) is equal to the net external force on the system

$$\frac{d\vec{p}_{sys}}{dt} = \vec{F}_{external}$$

- What happens when the external force is zero (or very small compared to the internal interactions)?

$$\frac{d\vec{p}_{sys}}{dt} = 0$$

Momentum is conserved

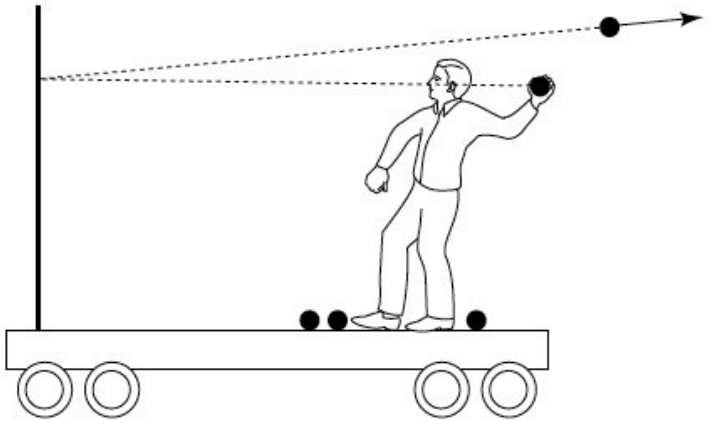
A 5 kg skateboard is moving across a frictionless floor at 2.0 m/s. A 70 kg boy, riding the skateboard, jumps off so that he hits the floor with zero velocity. What's the velocity of the board after the boy jumps off?

A. 30 m/s
B. 75 m/s
C. 2 m/s
D. 16 m/s
E. Something else

A 5 kg skateboard is moving across a frictionless floor at 2.0 m/s. A 70 kg boy, riding the skateboard, jumps off so that he hits the floor with a velocity of 1.0 m/s in the opposite direction. What's the velocity of the board after the boy jumps off?

A. 30 m/s
B. 75 m/s
C. 2 m/s
D. 44 m/s
E. Something else

Suppose you are on a cart, initially at rest on a track with negligible friction. You throw balls at a partition that is rigidly mounted on the cart. The balls bounce straight back as shown in the figure.



Is the total horizontal momentum conserved in the process of throwing the balls and having them bounce off the partition?

A. Yes.
B. No.
C. You are not given enough information to decide.

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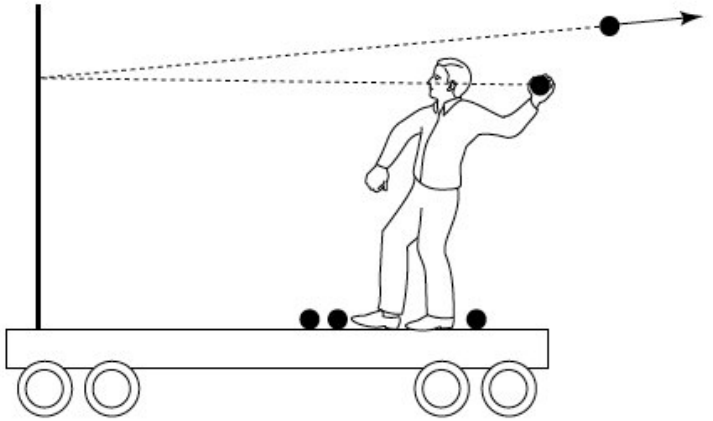

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A. Yes.
B. No.
C. You are not given enough information to decide.

It depends on the system!!

If the balls, cart, person, and partition are all in the system, then YES conserved!

If any one of the above are outside the system, then NO not conserved!