Impulse - Change in Momentum Relation

$$Ft = mv_f - mv_i$$

Impulse

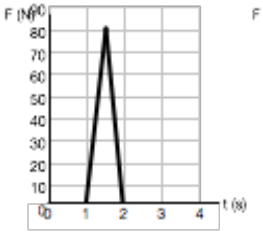
Either area on the graph

or $(F_{avg})t$

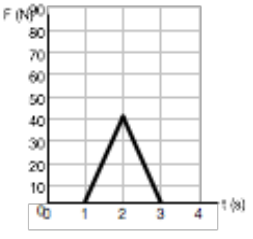
Change in momentum

Δp

Ball A



Ball B



1. Two identical balls receive the impulses shown in the graphs.

a) What all can you calculate, just from the graphs?
b) What can you say about Ball A compared to Ball B?

A

Impulse = $\frac{1}{2}bh$

$\frac{1}{2}(1s)(80N)$

$= 40Ns$

B

Impulse = $\frac{1}{2}bh$

$= \frac{1}{2}(2s)(40N)$

$= 40Ns$

2. A 100 kg quarterback collides with a defensive end, going from 6 m/s down to 2 m/s.

a) What is the change in momentum of the quarterback?
b) What impulse was delivered to the quarterback?
c) If the collision lasted 1.2 seconds, what was the average force delivered to the quarterback?

a) $\Delta p = mv_f - mv_i$

$= (100)(2) - (100)(6)$

$= 200 - 600$

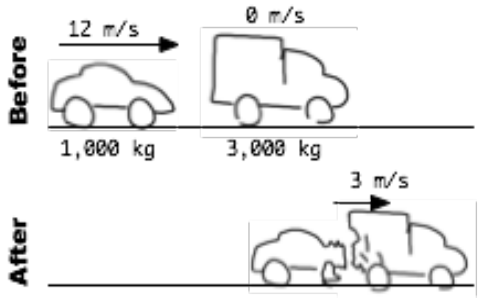
$= -400$ kg m/s

b) Impulse $= -400$ N s

c) Impulse $= F_{av}\, t$

$-400 = F_{av}\,(1.2)$

$-333_N = F_{av}$



3. The car collides with the truck, as shown. Afterward, they are moving at the same speed.

a) Calculate the change in momentum of the car.
b) What impulse was delivered to the car?
c) Calculate the change in momentum of the truck.
d) What impulse was delivered to the truck?

a) $\Delta p = mv_f - mv_i$

$= (1000)(3) - (1000)(12)$

$= 3000 - 12000$

$= -9{,}000 \text{ kgm/s}$

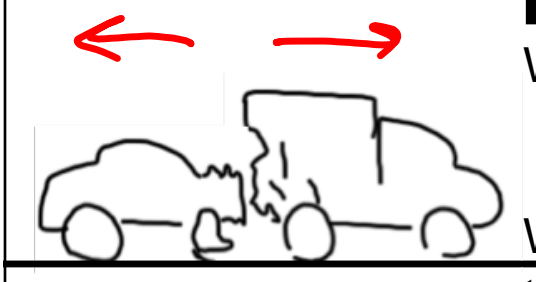
b) $-9{,}000 \text{ Ns}$

c) $\Delta p = mv_f - mv_i$

$= (3000)(3) - (3000)(6)$

$= 9{,}000 \text{ kgm/s}$

d) Impulse $= 9{,}000 \text{ Ns}$



(Ft) $(-Ft)$

But wait...

What do we know about the forces?

equal + opposite

What do we know about the times they are contact with each other?

equal

Therefore what is true of the Impulses?

equal + opposite

And what must be true of the Changes in Momentum?

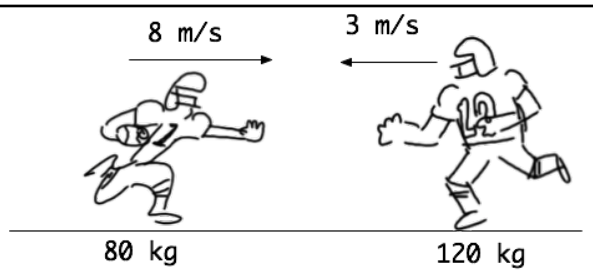
equal + opposite

That means the total must be the same!

If there are no outside forces in a collision,

The total momentum before the collision must equal the total momentum afterward.

Let's practice adding up the total momentum of a system.



a) Find the total momentum of the system.
b) If one player grabs the other and the stay together, do you think they would be going right or left?

$p_{tot} = m_1v_1 + m_2v_2 + \cdots$

$= (80kg)(8m/s) + (120kg)(-3m/s)$

$= 640 kgm/s + -360 kgm/s$

$= 280 kgm/s$

c) v after the collision?

$p = mv$

$280 kgm/s = (80+120)v$

$280 = 200v$

$\frac{280}{200} = v$

$1.4 m/s = v$

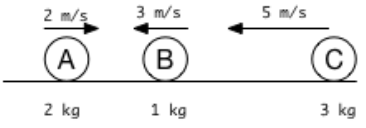
Cycle 25 Momentum

2. Total Momentum

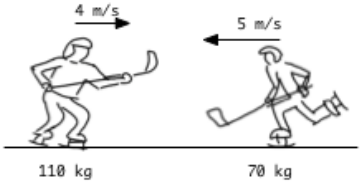
selected answers

FOR ALL PROBLEMS, ASSUME THERE ARE NO OUTSIDE FORCES

1. a) Find the total momentum of the system.
   b) If B were to collide with A, and then rebound and collide with C, what would the total momentum be?



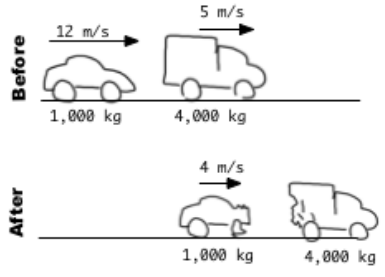
a) -14 kgm/s



2. a) Find the total momentum.
   b) If they were to collide and hold on to each other, what would their combined momentum be?
   c) What would their velocity be?

a) +90 kgm/s

c) +0.5 m/s



3. a) Find the total momentum before the collision.
   b) What should the total momentum after the collision be?
   c) Calculate the momentum of the car after the collision and deduce what the truck's momentum must be.
   d) What is the truck's velocity afterward?

a) +32,000 kgm/s

d) +7 m/s

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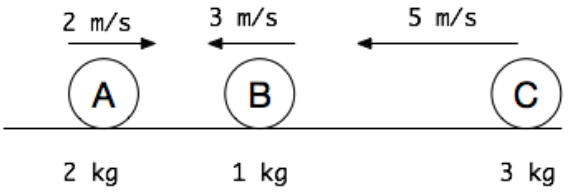

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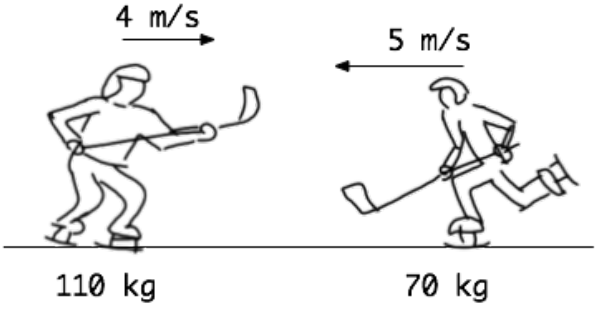

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