L02 - Impulse

Impulse: Product of the net force on an object and the time interval during an interaction. Impulse *causes* a change in the momentum of the object. Impulse is a vector quantity.

$$\underbrace{\vec{F}\Delta t}_{\text{Impulse}} = \underbrace{m\Delta\vec{v}}_{\Delta\vec{p}}$$

Causes

$\text{Impulse} = \vec{F}\Delta t$

$\text{Impulse} = m\Delta\vec{v}$

Yesterday

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

Derivation:

$$\vec{F} = m\vec{a}$$

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

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

Impulse and Safety

$\vec{F}\Delta t = m\Delta\vec{v}$ (Impulse = $\vec{F}\Delta t$; Fixed: $m\Delta\vec{v}$)

How do we deal with a change in momentum?

- Airbags
- Bungee Rope
- Landing in a Crouch
- Egg Drop Experiment

Increasing Δt
Minimize F

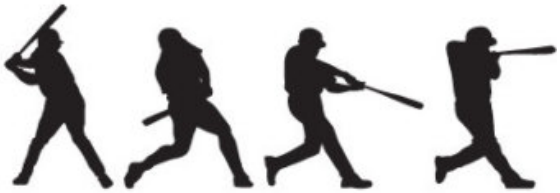
Impulse and Sports

$\vec{F}\Delta t = m\Delta\vec{v}$ (Impulse = $\vec{F}\Delta t$; Fixed: $m\Delta\vec{v}$)

Increase time w/ "follow thru"

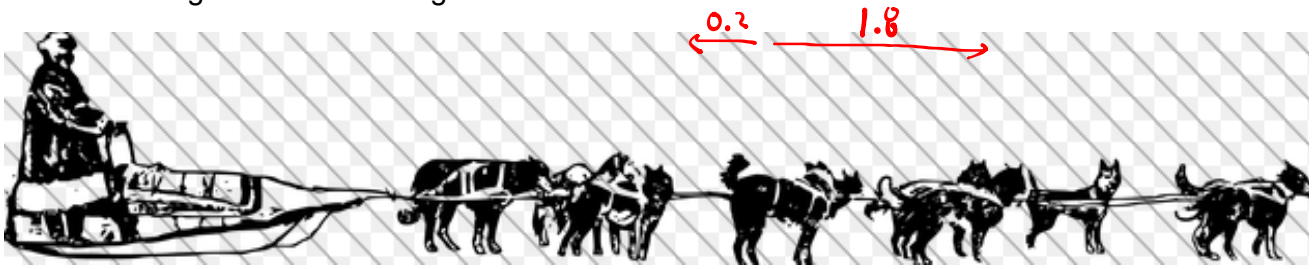
Why do we have "follow through" in a...

- Golf Swing?
- Baseball swing?
- Punch?



Larger time → Larger impulse → Larger $\Delta\vec{p}$

Q1: A dog team pulls a 400 kg sled that has begun to slide backward.In 4.20 s, the velocity of the sled changes from 0.200 m/s [backward]to 1.80 m/s [forward]. Calculate the impulse and the average net forcethe dog team exerts on the sled.



$m = 400\,kg$
$\Delta t = 4.2\,s$
$\vec{v}_i = -0.2\,m/s\,[f]$
$\vec{v}_f = +1.8\,m/s\,[f]$

$\vec{\Delta v} = \vec{v}_f - \vec{v}_i$
$= 1.8 - (-0.2)$
$= 2.0\,m/s\,[f]$

$\vec{F}\Delta t = ?$
$\vec{F} = ?$

$F\Delta t = m\Delta v$
$F\Delta t = (400)(2.0)$
$\vec{F}\Delta t = 800\ kg\ m/s$
$\vec{F}\Delta t = 800\ Ns\ [f]$

$F\Delta t = m\Delta v$
$F(4.2) = (400)(2)$
$\vec{F} = 190.476\ N\ [f]$

3-digit

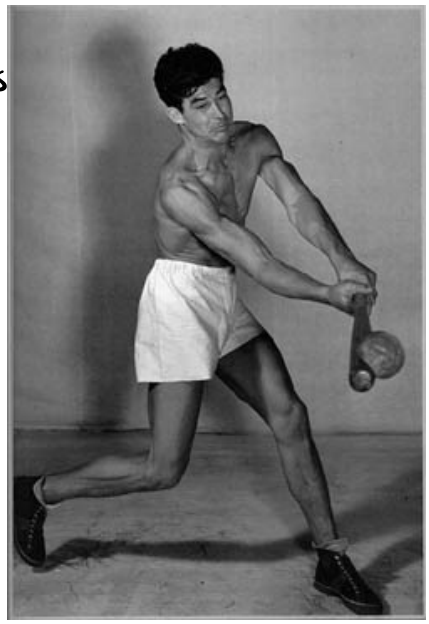
1	9	0

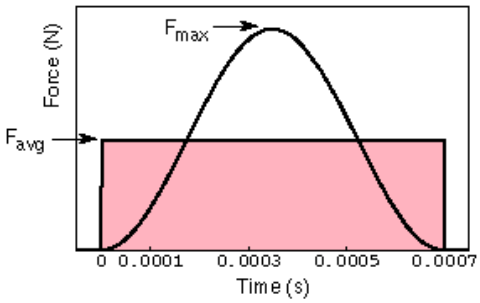
$a.bc \times 10^d$, 4-digits

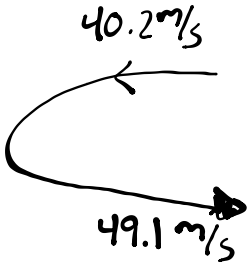
1	9	0	2

1.90×10^2

Q2: A baseball of mass 0.145kg is pitched at 40.2 m/s. The batter makes contact with the ball for 0.7 milliseconds, 0.7×10^{-3} s sending the ball returning at 49.1 m/s. Calculate the impulse and the average net force of the bat on the baseball.







$\vec{\Delta v} = 89.3\ m/s\ [F]$

$Fst = m\Delta v$

$Fst = (0.145)(89.3)$

$\vec{F}st = 12.9485\ Ns\ [F]$

$Fst = m\Delta v$

$F(0.7\times10^{-3}) = (0.145)(89.3)$

$F = 18,497.857\ N$

$a.bc\times10^{d}$

1	8	5	4

$1.8497...\times10^{4}$

$\approx 1.85\times10^{4}$

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