Exam II

Physics 101: Lecture 11
Momentum and Impulse

- Today's lecture will cover Textbook Sections 7.1-7.5

Impulse and momentum

- Impulse $I = F\Delta t$
  - » Gives change in momentum $I = \Delta p$
- Momentum $p = mv$
  - » Momentum is VECTOR

Key Ideas

- Earlier: Work-Energy
  - Σ F = m a multiply both sides by d
  - Σ F d= m a d (note a d = ½ Δv^2)
  - Σ F d= ½ m Δv^2
  - Σ W = ΔKE Define Work and Kinetic Energy

- This Time: Impulse-Momentum
  - Σ F = m a multiply both sides by Δt
  - Σ F Δt= m a Δt (note a Δt = Δv)
  - Σ F Δt= m Δv
  - Σ I = Δp Define Impulse and Momentum demo

Checkpoint 1

A magician yanks a tablecloth out from under some dishes. Miraculously, the dishes remain on the table where they were. Briefly explain why the dishes were not given much impulse by the tablecloth.

Impulse is force multiplied by time, so the dishes were not given much impulse since the time was so small.

Uh...magic. DUH. ... Good thing we know that physics is all gibberish and the real answer to these questions is magic.

The cloth must be silky smooth.

the magician is not as 'magical' as he seems-- like the members of his audience, he is a slave to the laws of physics...

Pushing Off…

Fred (75 kg) and Jane (50 kg) are at rest on skates facing each other. Jane then pushes Fred w/ a constant force F = 45 N for a time Δt=3 seconds. Who will be moving fastest at the end of the push?

A) Fred B) Same C) Jane

Fred

F = +45 N (positive direct.)

I = +45 (3) N-s = 135 N-s

$I = \Delta p$

$= mv_f - mv_i$

$I/m = v_f - v_i$

v_f = 135 N-s / 75 kg

= 1.8 m/s

Jane

F = -45 N Newton's 3rd law

I = -45 (3) N-s = -135 N-s

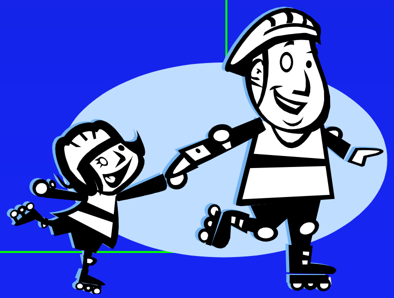
$I = \Delta p$

$= mv_f - mv_i$

$I/m = v_f - v_i$

v_f = -135 N-s / 50 kg

= -2.7 m/s



Note: $P_{fred} + P_{jane}$ = (1.8) 75 + (-2.7) 50 = 0!

Momentum is Conserved

- Momentum is “Conserved” meaning it can not be created nor destroyed
  - Can be transferred
- Total Momentum does not change with time.
- This is a BIG deal!

Impulse and Momentum Summary

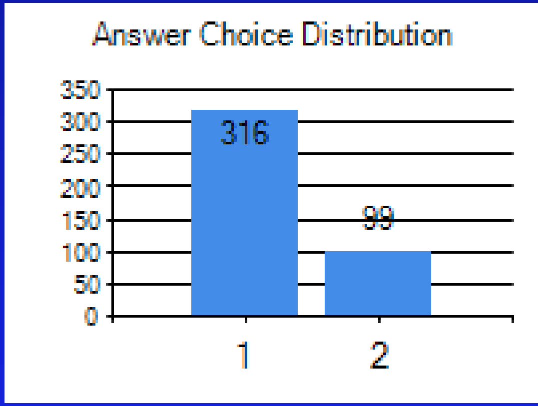
$$\boxed{F_{ave}\Delta t \equiv I = p_f - p_i = \Delta p}$$

- For single object….
  - $F = 0 \Rightarrow$ momentum conserved ($\Delta p = 0$)
- For collection of objects …
  - $\Sigma F_{ext} = 0 \Rightarrow$ total momentum conserved ($\Delta P_{tot} = 0$)
  - $F_{ext} = m_{total}\, a$

Checkpoint 2 & 3

Is it possible for a system of two objects to have zero total momentum while having a non-zero total kinetic energy?

1. YES
2. NO



correct

"two identical cars, say Porsche's, running towards each other at identical speeds … … … … and if you are Bruce Willis, it may take out a helicopter.."

"an explosion! BOOM."

"If Superman and Bizarro were flying dirrectly at each other in the vacuum of space, they would both have scalar kinectic energy, and equal and opposite momentum."

demo

Summary

- Impulse $I = F\Delta t$
  - » Gives change in momentum $I = \Delta p$

- Momentum $p = mv$
  - » Momentum is VECTOR
  - » Momentum is conserved (when $\Sigma F = 0$)
    - $\Sigma\, mv_{initial} = \Sigma\, mv_{final}$