

Physics 101: Lecture 11

Momentum and Impulse

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



Physics 101: Lecture 9, Pg 1

Power (Rate of Work)

- $P = W / \Delta t$
 - Units: Joules/Second = Watt
- How much power does it take for a (70 kg) student to run up the stairs in 141 (5 meters) in 7 seconds?

Last Time

- Last Time: Work-Energy

- $\sum F = m a$ multiply both sides by d

- $\sum F d = m a d$ (note $a d = \frac{1}{2} \Delta v^2$)

- $\sum F d = \frac{1}{2} m \Delta v^2$

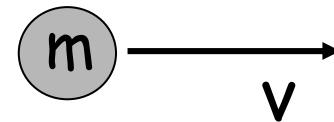
- $\sum W = \Delta KE$ Define Work and Kinetic Energy

- This Time: Impulse-Momentum

Momentum and Impulse

Momentum:

- $p = m v$ – a vector
- units: kg m / s



$$\sum F = m a$$

multiply both sides by Δt

$$\sum F \Delta t = m a \Delta t$$

note $a \Delta t = \Delta v$

$$\sum F \Delta t = m \Delta v$$

$$\sum F \Delta t = \Delta p$$

Impulse:

- $I = \sum F \Delta t$ – also a vector
- $I = \Delta p$

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

Preflight 1

A magician yanks a tablecloth out from under some dishes. Briefly explain why the dishes were not given much impulse by the tablecloth.

ACT

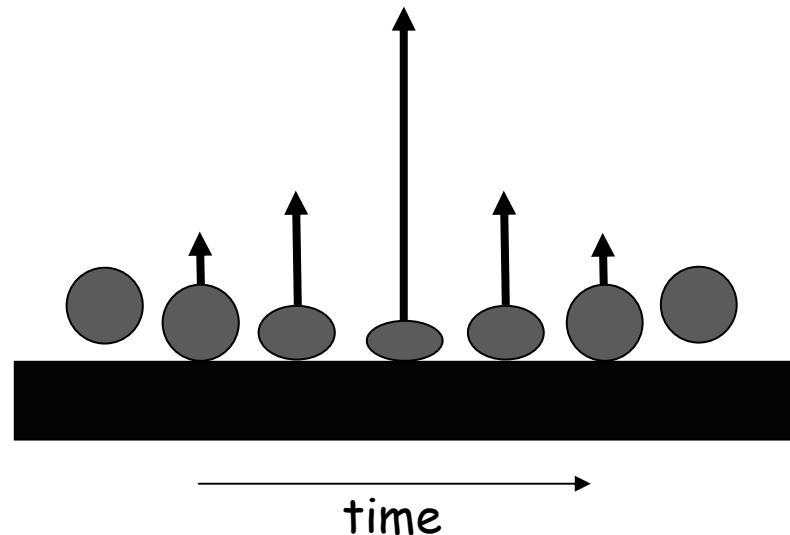
Two identical balls are dropped from the same height onto the floor. In each case they have velocity v downward just before hitting the floor. In case 1 the ball bounces back up, and in case 2 the ball sticks to the floor without bouncing. In which case is the magnitude of the impulse given to the ball by the floor the biggest?

- A. Case 1
- B. Case 2
- C. The same

ACT

In both cases of the above question, the direction of the impulse given to the ball by the floor is the same. What is this direction?

- A. Upward
- B. Downward



ACTs

You drop an egg onto 1) the floor 2) a thick piece of foam rubber. In both cases, the egg does not bounce.

In which case is the impulse greater?

- A) Floor
- B) Foam
- C) the same

In which case is the average force greater

- A) Floor
- B) Foam
- C) the same

Pushing Off...

Fred (75 kg) and Jane (50 kg) are on skates facing each other.

Jane then pushes Fred w/ a constant force $F = 45 \text{ N}$ for a time $\Delta t=3$ seconds. Who will be moving faster at the end of the push?

- A) Fred
- B) Same
- C) Jane



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!

Momentum ACT

A car w/ mass 1200 kg is driving north at 40 m/s, and turns east driving 30 m/s. What is the magnitude of the car's change in momentum?

- A) 0
- B) 12,000
- C) 36,000
- D) 48,000
- E) 60,000

Preflight 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

ACT

Movies often show someone firing a gun loaded with blanks. In a blank cartridge the lead bullet is removed and the end of the shell casing is crimped shut to prevent the gunpowder from spilling out. When a gun fires a blank, is the recoil greater than, the same as, or less than when the gun fires a standard bullet?

- A. greater than
- B. same as
- C. less than



Summary

- Momentum $p = mv$
 - » Momentum is VECTOR
 - » Momentum is conserved (when $\Sigma F = 0$)
 - $\sum mv_{\text{initial}} = \sum mv_{\text{final}}$
- Impulse $I = F\Delta t$
 - » Gives change in momentum $I = \Delta p$