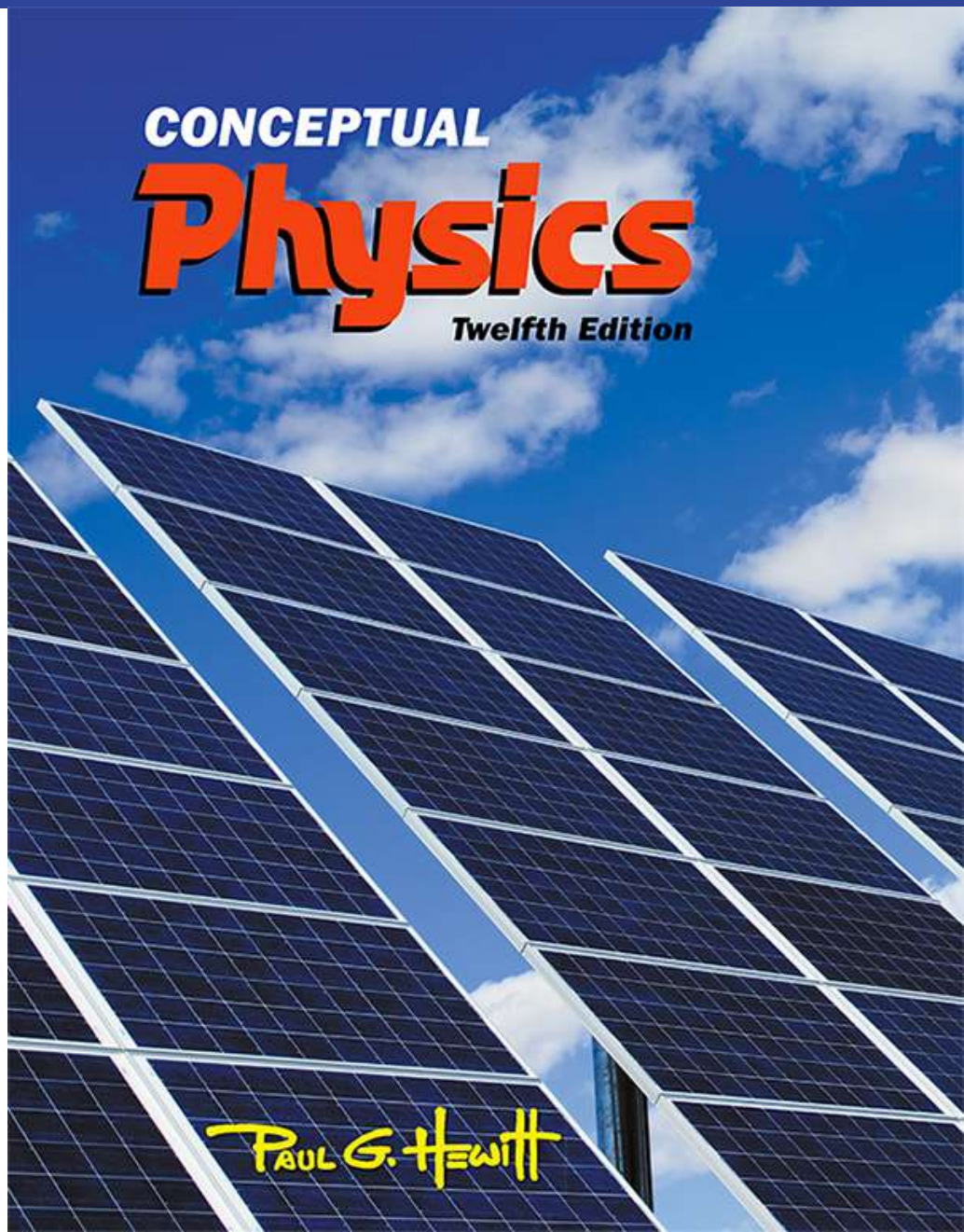
Lecture Outline

Chapter 6: Momentum

Impulse Changes Momentum

Bouncing



Momentum

- a property of moving things
- means inertia in motion
- in equation form:

momentum = mass x velocity

= mv

Impulse

- Product of force and time (force x time)
- In equation form: Impulse = $F \cdot t$

Impulse Changes Momentum

Start with Newton's second law: $F = m \cdot a$

Re-write the acceleration: $F = m \cdot \frac{\Delta v}{t}$

Multiply both sides by t: $F\,t = m\,\Delta v$

Rearrange to this: $F\,t = \Delta(mv)$

impulse = Δ momentum

- The greater the impulse exerted on something, the greater the change in momentum.

$$Ft = \Delta(mv)$$

Impulse Changes Momentum, Continued

- Case 1: increasing momentum
  - Apply **the greatest force** for **as long as possible** and you extend the time of contact.
  - Examples:
    - Golfer swings a club and
    - follows through.
    - Baseball player hits a ball and
    - follows through.

Impulse Changes Momentum
CHECK YOUR NEIGHBOR

When the force that produces an impulse acts for twice as much time, the impulse is

A. not changed.
B. doubled.
C. quadrupled.
D. halved.

Impulse Changes Momentum
CHECK YOUR ANSWER

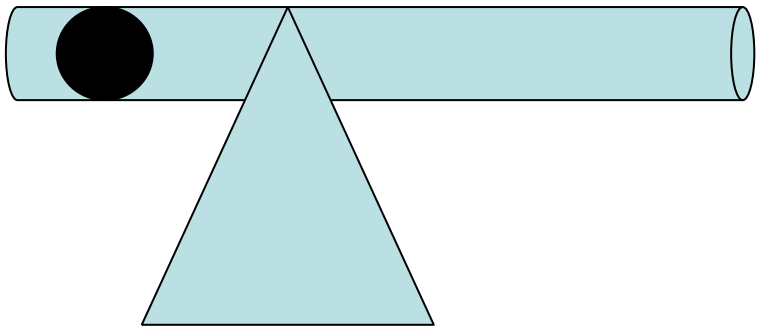
When the force that produces an impulse acts for twice as much time, the impulse is

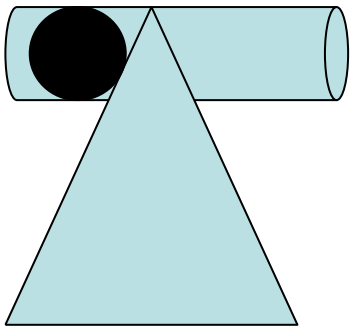
B. doubled.

Impulse Changes Momentum
CHECK YOUR NEIGHBOR, Continued

A cannonball shot from a cannon with a long barrel will emerge with greater speed because the cannonball receives a greater

A. average force.
B. impulse.
C. Both of the above.
D. None of the above.





Impulse Changes Momentum
CHECK YOUR ANSWER, Continued

A cannonball shot from a cannon with a long barrel will emerge with greater speed because the cannonball receives a greater

B. impulse.

Explanation:

The average force on the cannonball will be the same for a short- or long-barreled cannon. The longer barrel provides for a longer time for the force to act, and therefore, a greater impulse. (The long barrel also provides a longer distance for the force to act, providing greater work and greater kinetic energy to the cannonball.)

- Case 2: decreasing momentum over a long time
  - extend the time during which momentum is reduced

Ex: Drop two identical eggs from the same height:

one on the hard floor

one on soft grass

Which has more speed when it hits?

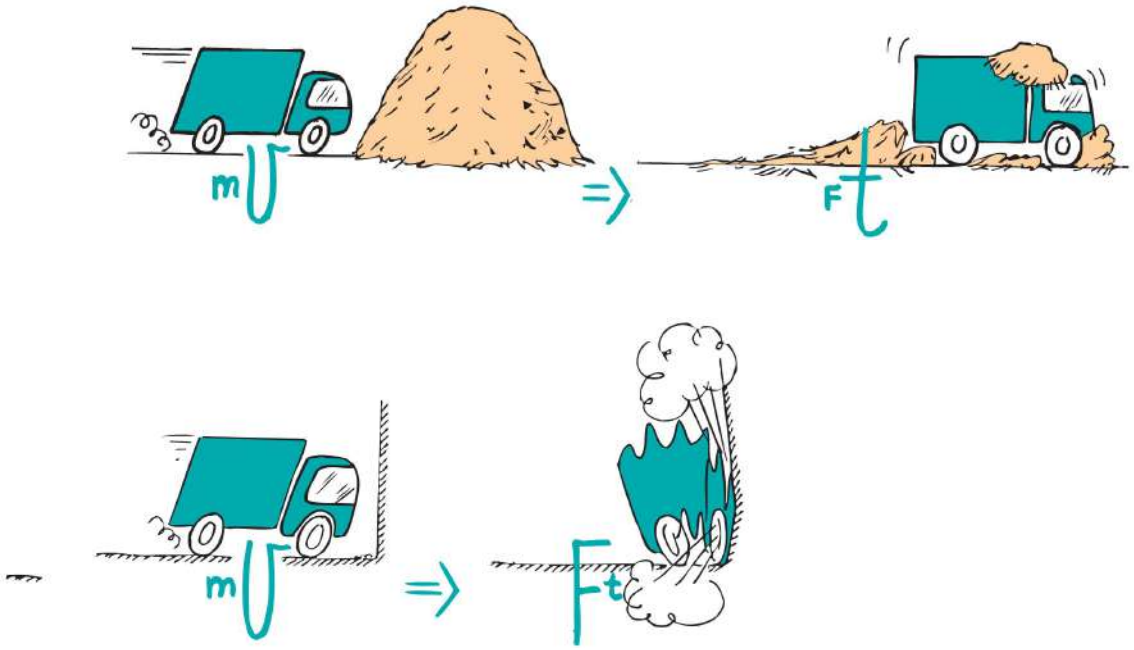
Which has more momentum?

Which is more likely to break?

Why?

Impulse Changes Momentum, Continued-2

- Examples:
  - When a car is out of control, it is better to hit a haystack than a concrete wall.
- Physics reason: Same impulse either way, but extension of hitting time reduces the force.



Impulse Changes Momentum
CHECK YOUR ANSWER, Continued-1

A fast-moving car hitting a haystack or hitting a cement wall produces vastly different results.

1. Do both experience the same change in momentum?
2. Do both experience the same impulse?
3. Do both experience the same force?

B. Yes for 1 and 2

Explanation:

Although stopping the momentum is the same whether done slowly or quickly, the force is vastly different. Be sure to distinguish among momentum, impulse, and force.

Impulse Changes Momentum
CHECK YOUR NEIGHBOR, Continued-1

A fast-moving car hitting a haystack or hitting a cement wall produces vastly different results.

1. Do both experience the same change in momentum?
2. Do both experience the same impulse?
3. Do both experience the same force?

A. Yes for all three

B. Yes for 1 and 2

C. No for all three

D. No for 1 and 2

Impulse Changes Momentum
CHECK YOUR NEIGHBOR, Continued-2

When a dish falls, will the change in momentum be less if it lands on a carpet than if it lands on a hard floor? (Careful!)

A. No, both are the same.
B. Yes, less if it lands on the carpet.
C. No, less if it lands on a hard floor.
D. No, more if it lands on a hard floor.

Impulse Changes Momentum
CHECK YOUR ANSWER, Continued-2

When a dish falls, will the change in momentum be less if it lands on a carpet than if it lands on a hard floor? (Careful!)

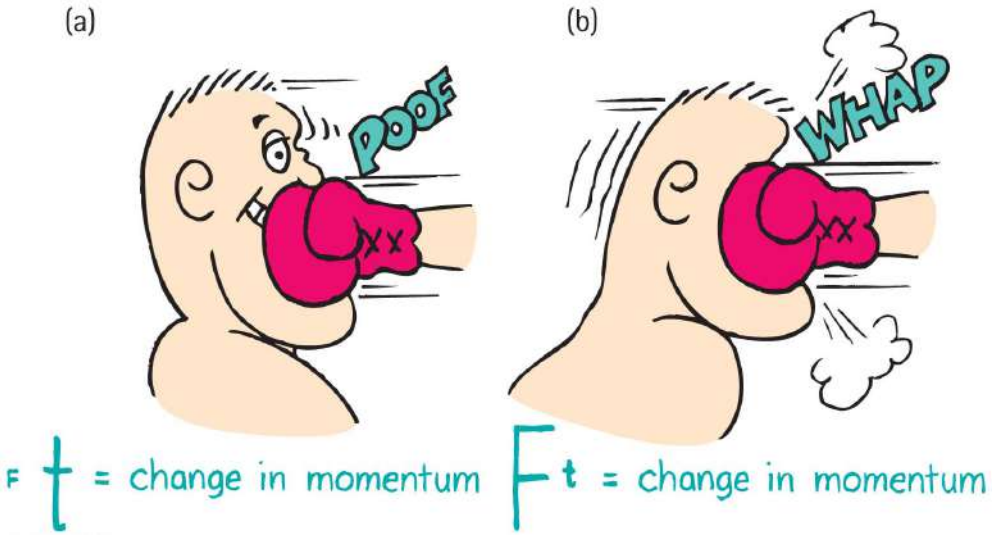
A. No, both are the same.

Explanation:

The momentum becomes zero in both cases, so both change by the same amount. Although the momentum change and impulse are the same, the force is less when the time of momentum change is extended. Be careful to distinguish among force, impulse, and momentum.

Impulse Changes Momentum, Continued-3

- Example (continued):
  - In jumping, bend your knees when your feet make contact with the ground because the extension of time during your momentum decrease reduces the force on you.
  - In boxing, ride with the punch.



Impulse Changes Momentum, Continued-4

- Case 3: decreasing momentum over a short time
  - short time interval produces large force.

- Example: Karate expert splits a stack of bricks by bringing her arm and hand swiftly against the bricks with considerable momentum. Time of contact is brief and force of impact is huge.

Bouncing

- Impulses are generally greater when objects bounce.
  - Example:
    - Catching a falling flower pot from a shelf with your hands. You provide the impulse to reduce its momentum to zero. If you throw the flower pot up again, you provide an additional impulse. This "double impulse" occurs when something bounces.

Bouncing, Continued

- Pelton wheel designed to "bounce" water when it makes a U-turn on impact with the curved paddle.

- → water changes momentum more
- → more impulse on wheel
- → wheel turns faster

Homework:

- On page 103-104, do the

Reading Check Questions #5-11

Wednesday: No online chat

→ work on homework

→ study for Test

Friday: Test on both Chapters 5 & 6