Wednesday's Quiz: Energy and Today's Stuff (40% multiple choice)

WARNING:

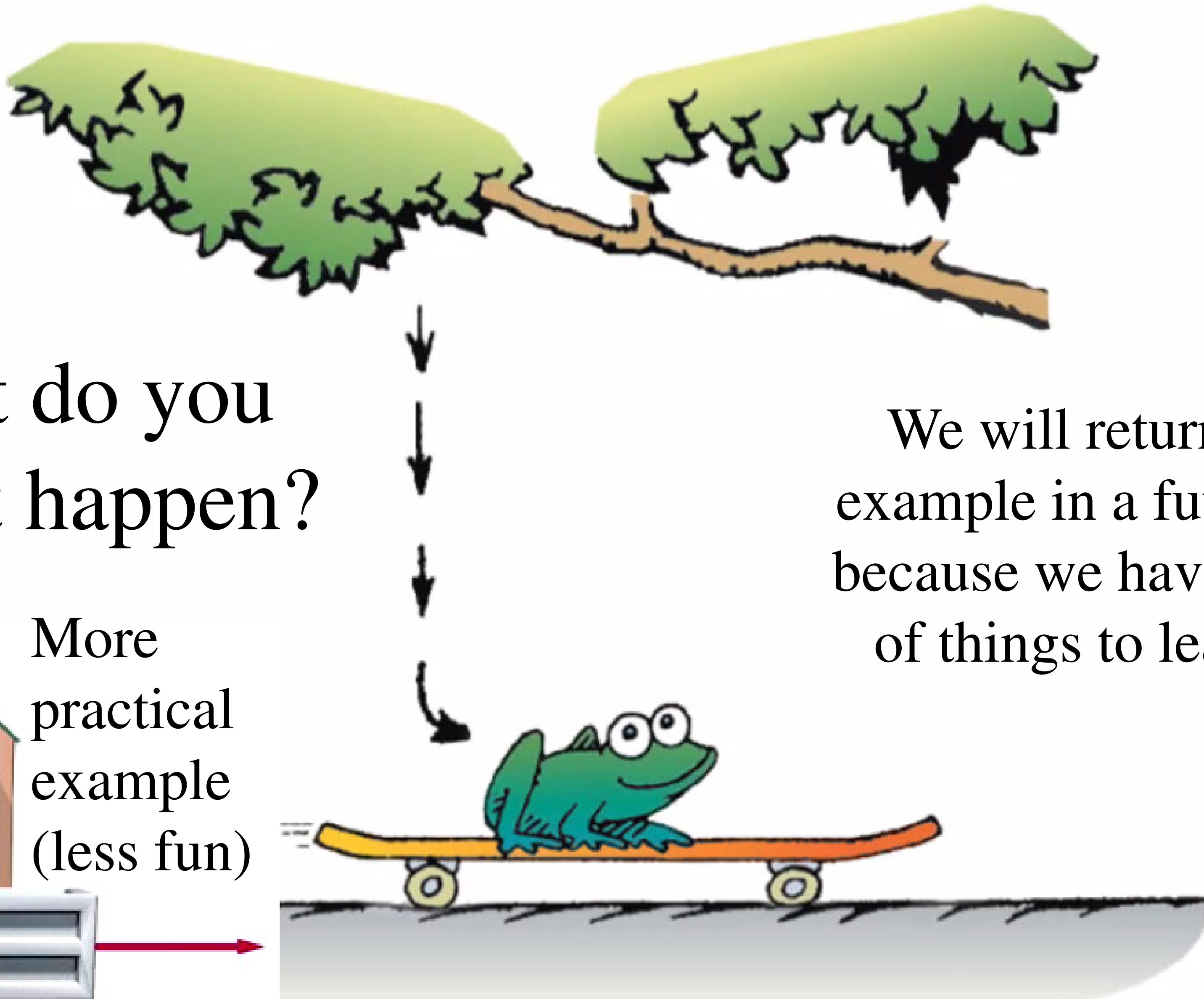
The following quiz will have 2 review questions.

One practicing utilizing free body diagrams.

One on projectile motion.

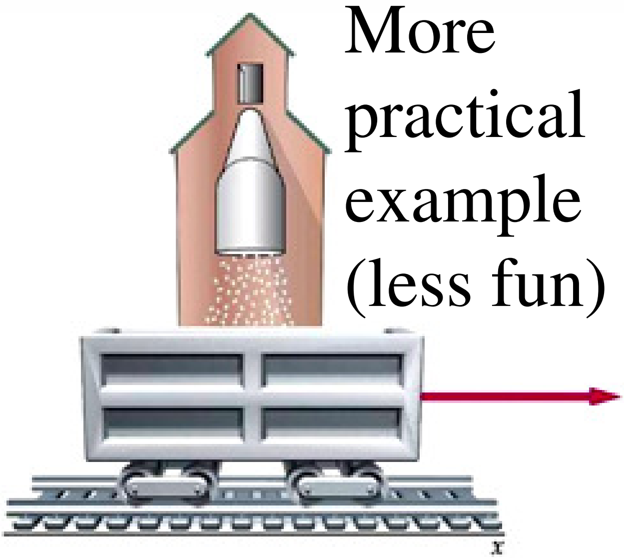
Unless Cengage can fix it in the next day or two, I'm going to regrade the last quiz so that question 3 (incline) doesn't count.

Introducing a New Physics Concept



What do you expect happen?

We will return to this example in a future class, because we have a couple of things to learn first.



More practical example (less fun)

Main Ideas in Class Today

After class, you should be able to:

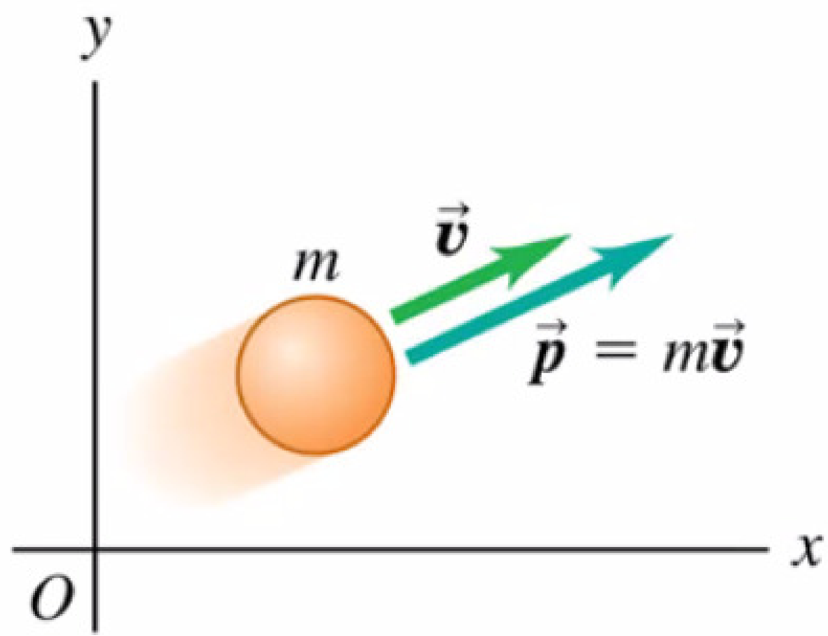
- Understand and calculate linear momentum and impulse
- Determine the average/maximum forces acting on an object (including from a graph)

Extra Practice Problems: 6.1, 6.5, 6.7, 6.9, 6.11, 6.13, 6.19

How we will deal with collisions

Ball and bat, cars, etc.

Momentum ($\vec{p}$)



- $\vec{p} = m\vec{v}$
  - *vector quantity (can be + or – in 1D)*
  - *direction is the same as the direction of the velocity*
  - *SI units: kilogram · meter/second (kg·m/s)*

Example Review

A pitcher claims he can throw a 0.145 kg baseball with as much momentum as a 3.00 g bullet moving with a speed of 1500 m/s!

What must the baseball's speed be if the pitcher's claim is valid?

If momentum same, which has greater kinetic energy?

A. the ball

B. the bullet

C. they are the same

Q69

Newton's Second Law

- Goal: Write Newton's Second Law $\vec{F}_{net} = m\vec{a}$ in terms of momentum.

$$\vec{F}_{net} = m\vec{a} = \frac{m\Delta\vec{v}}{\Delta t} = \frac{m(\vec{v} - \vec{v}_o)}{\Delta t} = \frac{m\vec{v} - m\vec{v}_o}{\Delta t}$$

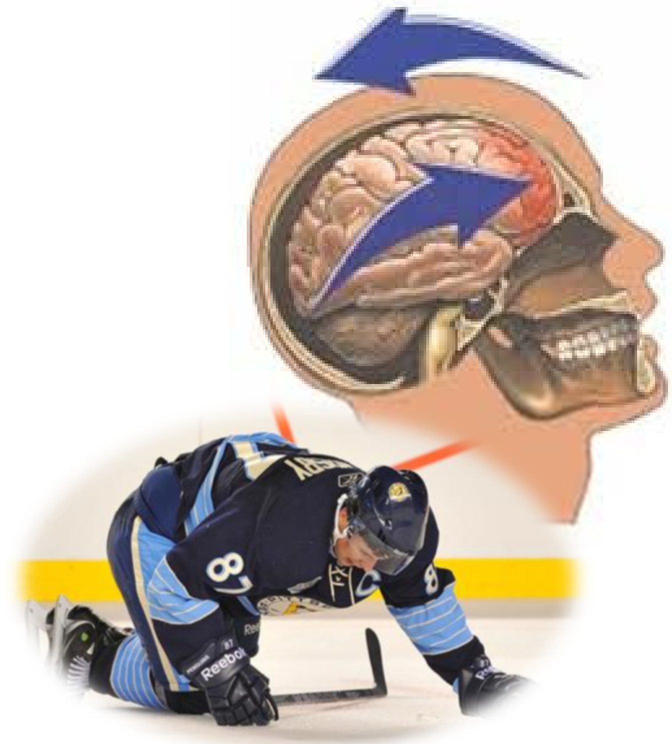
$$\boxed{\vec{F}_{net} = \frac{\Delta\vec{p}}{\Delta t}}$$

$$\vec{p} = m\vec{v}$$

This is the general form of Newton's 2nd Law and applies even if mass changes, like in a rocket burning fuel (end of this chapter). **Rockets not on test.**

Impulse

If a constant (or average) force **F** acts on an object, the impulse **I** delivered to the object over a time Δt is:



$$I = F_{avg} \Delta t$$

Not falling time!!!

$$units = kgm/s$$

Notes:

1. A force must act on an object for impulse to occur.
2. The time is the collision time (just before touching to after)
3. In a collision, an impulse occurs in the direction of the force acting on the object [when I walk into the wall?]

A 100-g lump of clay hits a wall at 60 cm/s and sticks. A 100-g rubber ball hits the same wall at 60 cm/s and rebounds with a speed of 30 cm/s.

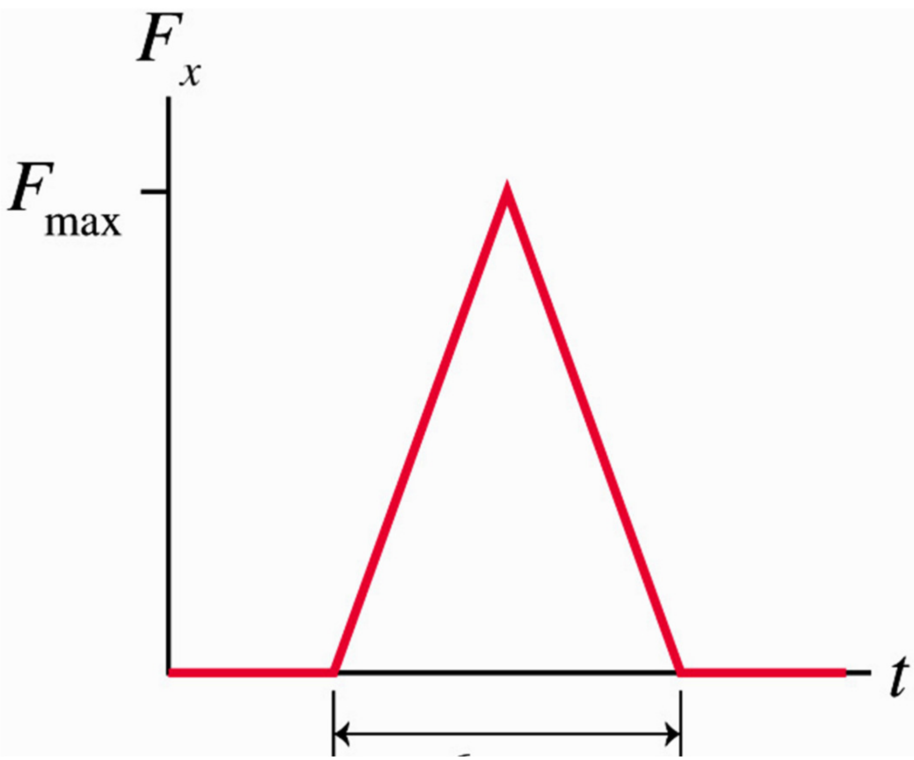
Which object experiences the larger impulse delivered by the wall during the collision?

A. The clay
B. The ball
C. Both impulses are the same.
D. Cannot be determined.

Q71

Impulse = Force * contact time

What if that force isn't constant?



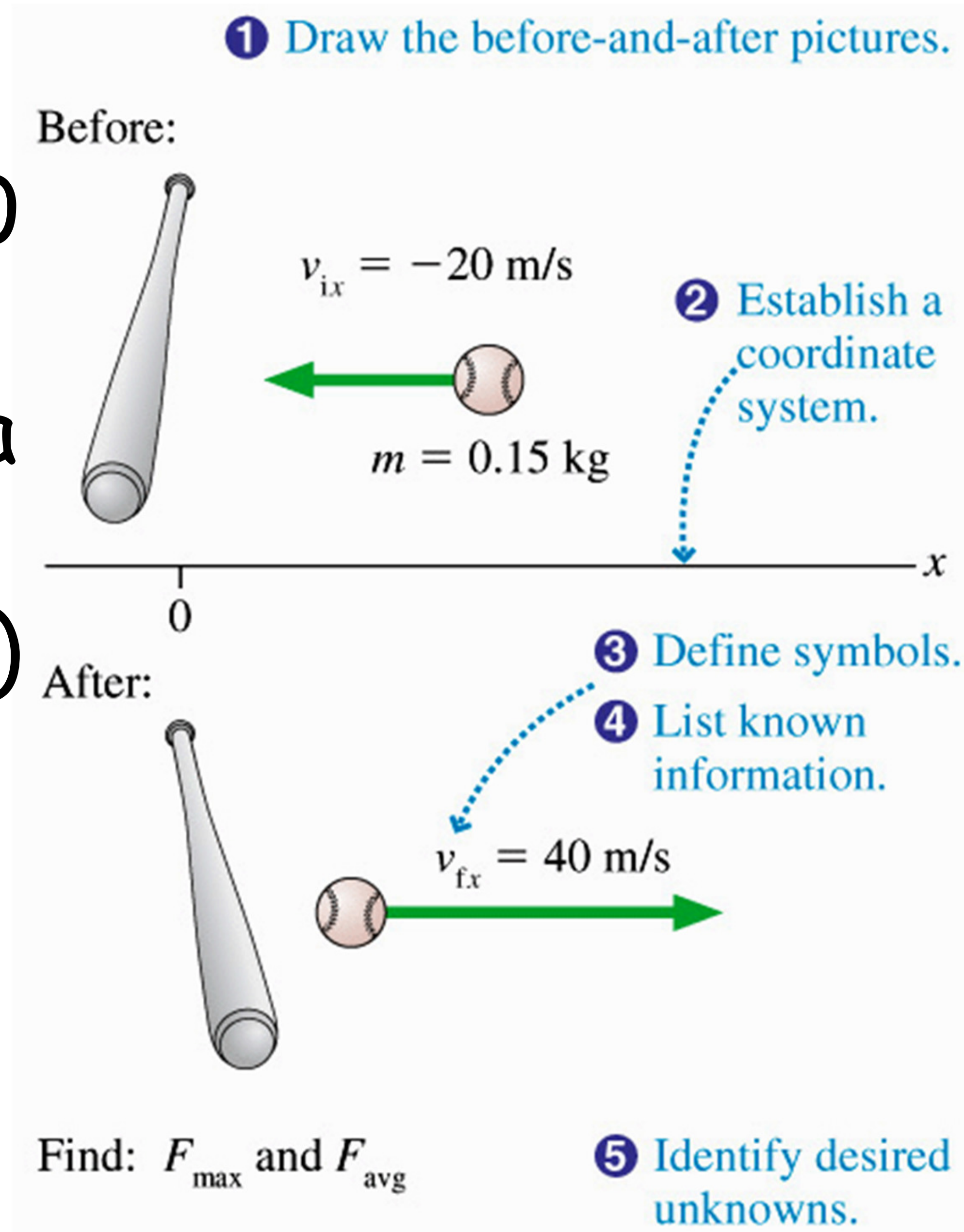
Can you think of an example?

Hitting a Baseball

A 150 g baseball is thrown at a speed of 20 m/s. It is hit straight back to the pitcher at a speed of 40 m/s. (Contact time is 0.006s)

What is the impulse and average force F_{av} that the bat exerts on the ball?

Similar approach to Gwen Stacy!

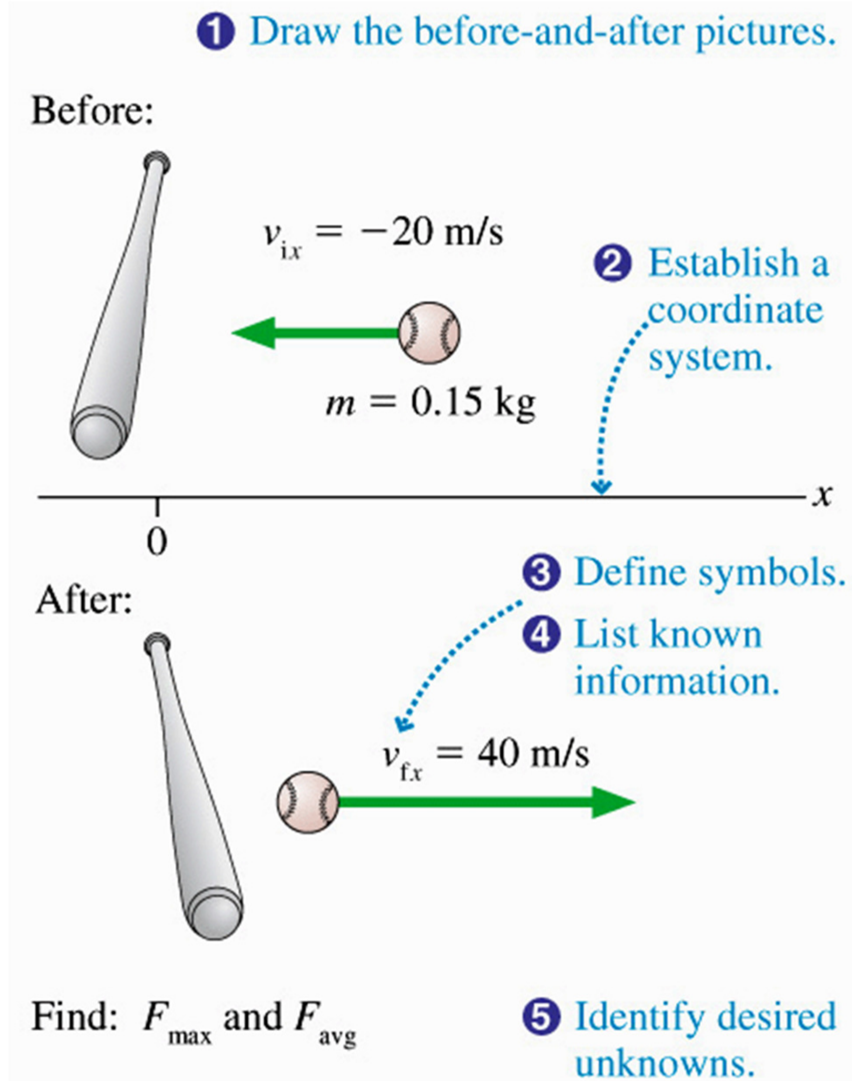


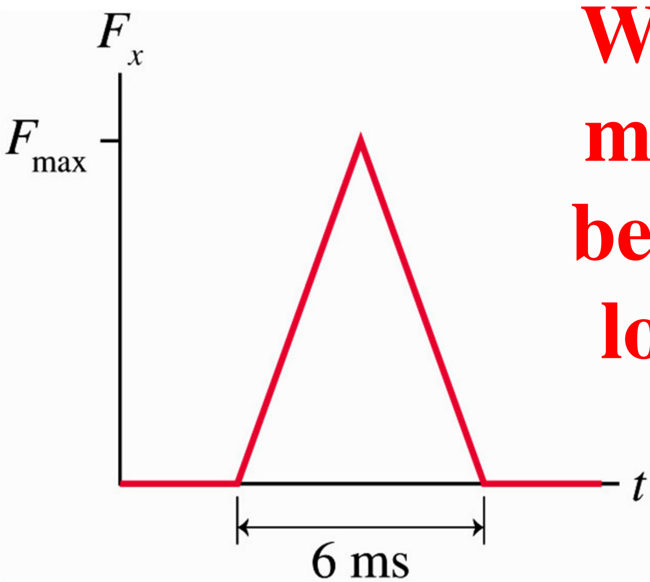
Possible to do this with Chapters 2&4 stuff instead

Hitting a Baseball: Consider just before and just after ball touches bat

$$\Delta p_x = mv_{fx} - mv_{ix} = m(v_{fx} - v_{ix})$$
$$= (0.15\ \text{kg})(40\ \text{m/s} + 20\ \text{m/s})$$
$$= 9.0\ \text{kg m/s}$$

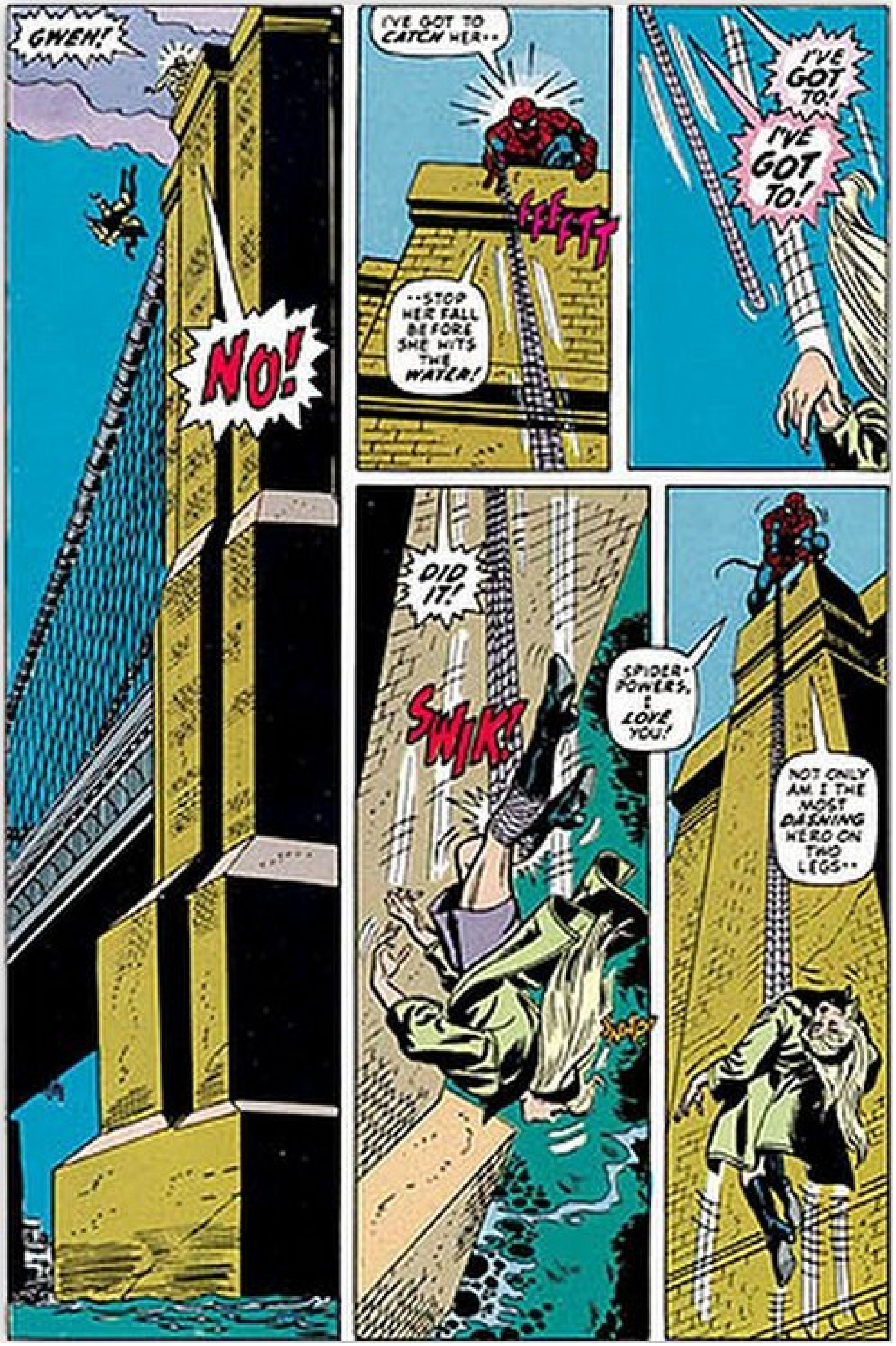
$$F_{av} = \frac{\Delta p_x}{\Delta t} = \frac{(9.0\ \text{kg m/s})}{(.006\ \text{s})} = 1{,}500\ \text{N}$$





What would the maximum force be if force graph looks like this?

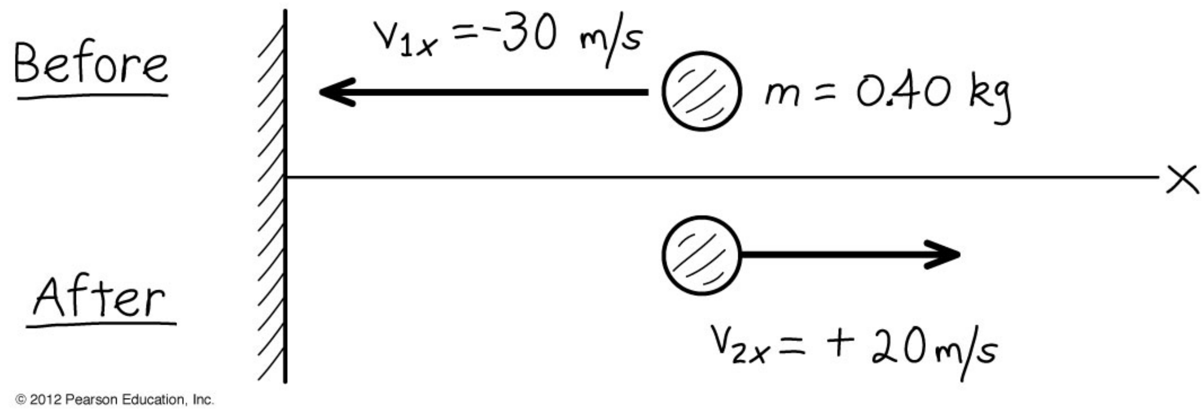
Note that the impulse is the area under this curve! (Area of triangle = ½ height * width)



Spiderman's Gwen Stacy

Gwen who weighs 50 kg falls 300 feet and is then brought to rest by Spiderman's webbing in 0.5 s. What is the impulse and force on Gwen? Ignore air resistance.

What does Spiderman do to stop this in the future?



A 0.40 kg ball is initially moving to the left at 30 m/s. After hitting the wall, the ball is moving to the right at 20 m/s. What is the impulse of the net force on the ball during its collision with the wall?

A. 20 kg • m/s to the right

B. 20 kg • m/s to the left

C. 4.0 kg • m/s to the right

D. 4.0 kg • m/s to the left

E. none of the above

Q70

More examples for impulse: Another baseball example

A baseball player of mass 84.0 kg running at 6.70 m/s slides into home plate and comes to a stop.

- What magnitude of impulse is delivered to the player by friction?
- If the slide lasts 0.750 s, what is the average friction force exerted on the player?

A 75.0 kg ice skater moving at 10.0 m/s crashes into a stationary skater of equal mass. After the collision, the two skaters move as a unit at 5.00 m/s. Suppose for this problem the average force a skater can experience without breaking a bone is 4500 N. If the impact time is 0.100 s, does a bone break for either skater?

For each skater:

$$|F_{av}| = |\Delta p| / \Delta t$$

Mass of each skater does not change

$$|F_{av}| = |\Delta p| / \Delta t = m\,|\Delta v| / \Delta t$$

Clicker Answers

69=B, 70=A, 71=B