Oct 30, 2015 LB 273, Physics I

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Prof. Leanne Doughty

Today:
Chapter 7 – Changing Motion
Chapter 11 – Conservation of Momentum

Irish Phrasebook

Acting the maggot – *Fooling and messing around*

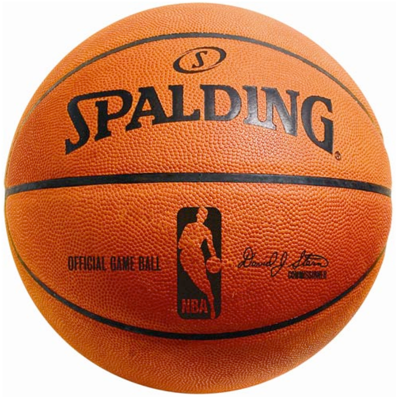
Announcements

- Ch 6 and 7 LON-CAPA homework due tonight
- Exam 2 – Monday Nov. 2nd
  - Extra practice materials on LON-CAPA
- Ch 8.1-8.3 reading questions due Tuesday Nov. 3rd

You throw a ball vertically upward. Which statement best describes the direction and magnitude of the net force on the ball while the ball is still moving up?

(ignore air resistance)

A. Upward, constant magnitude
B. Upward, decreasing magnitude
C. Downward, constant magnitude
D. Downward, decreasing magnitude
E. Zero acceleration



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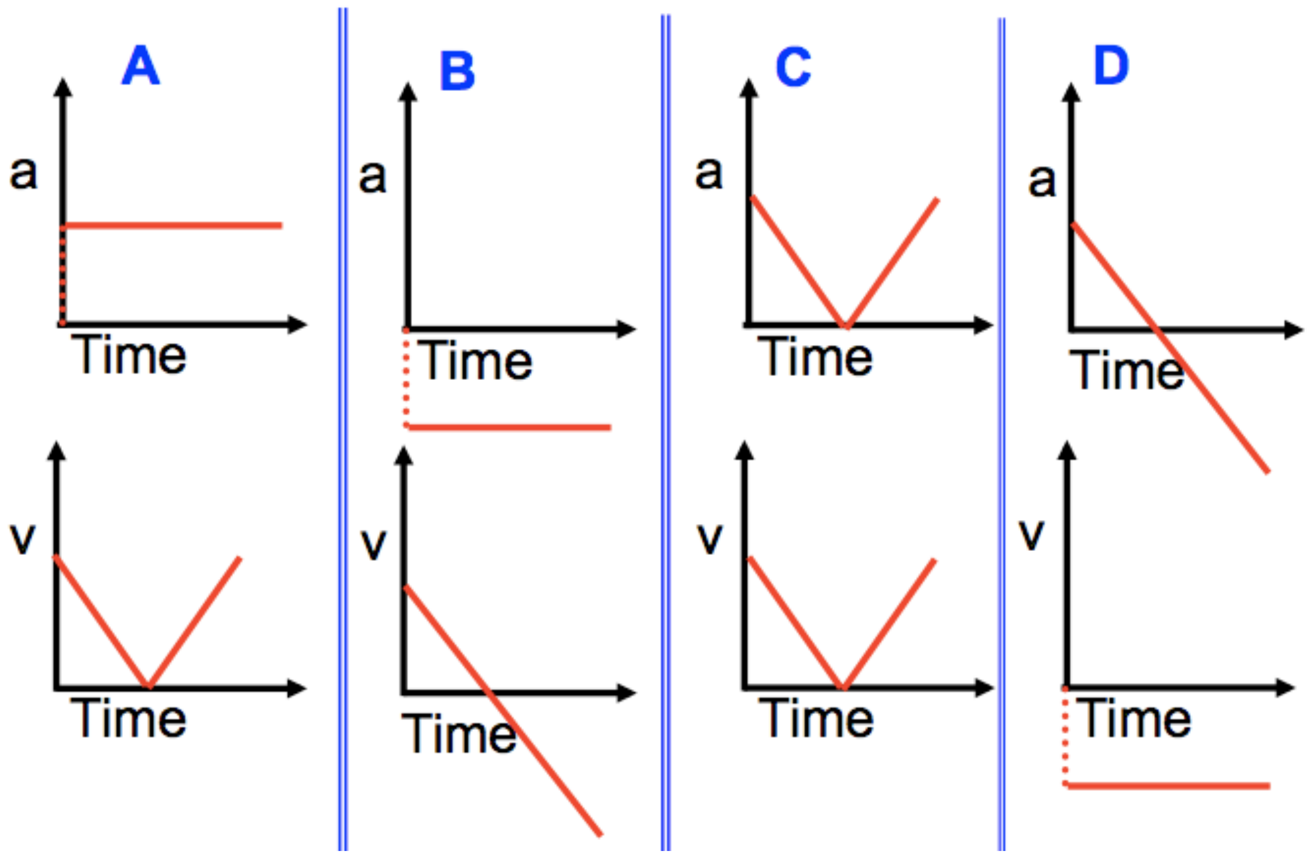
You throw a ball vertically upward. The ball moves up, reaches its highest point, and finally falls down. Which of the following graphs best represents the ball's <u>acceleration and velocity vs. time</u> during this process? (ignoring air resistance)



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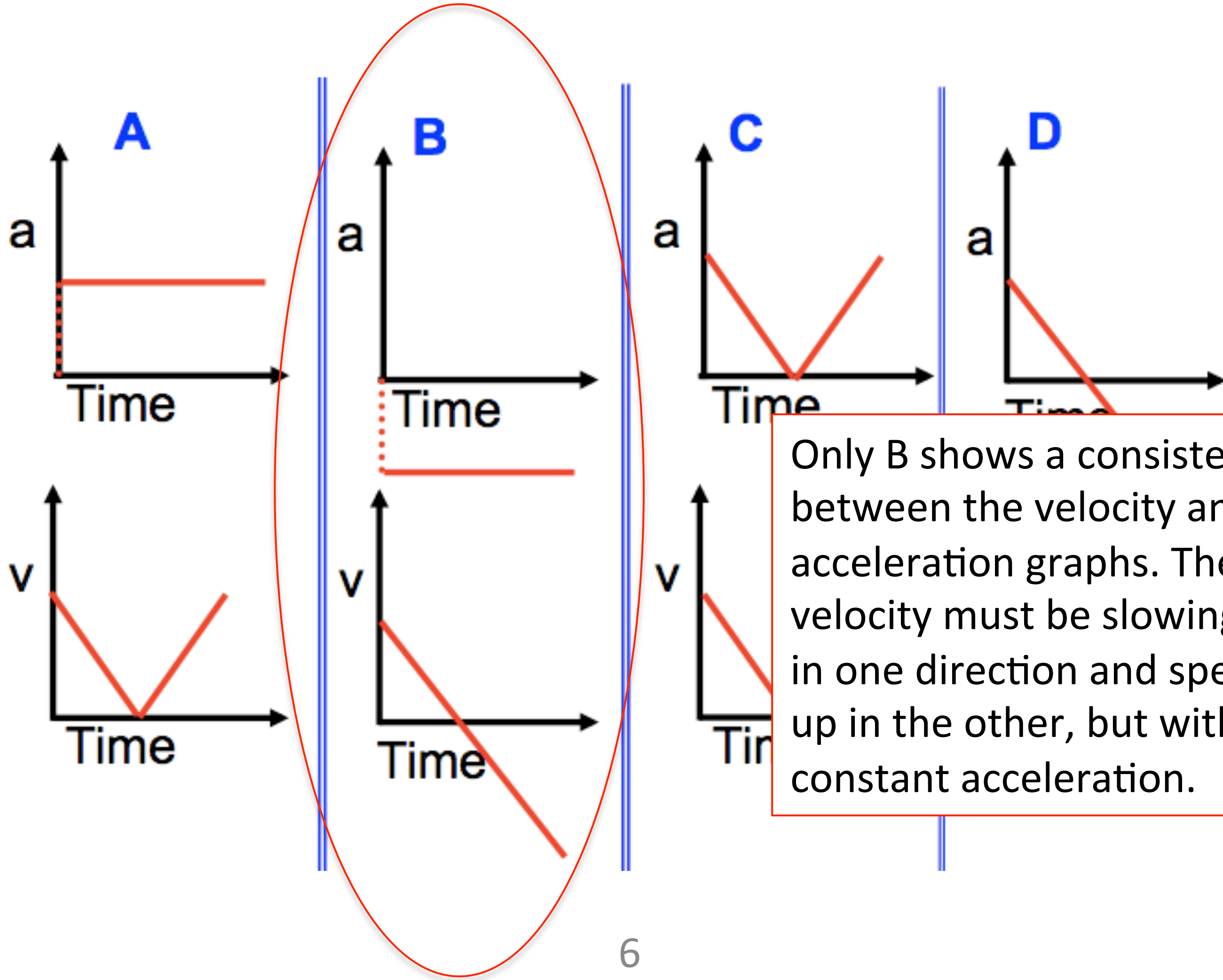
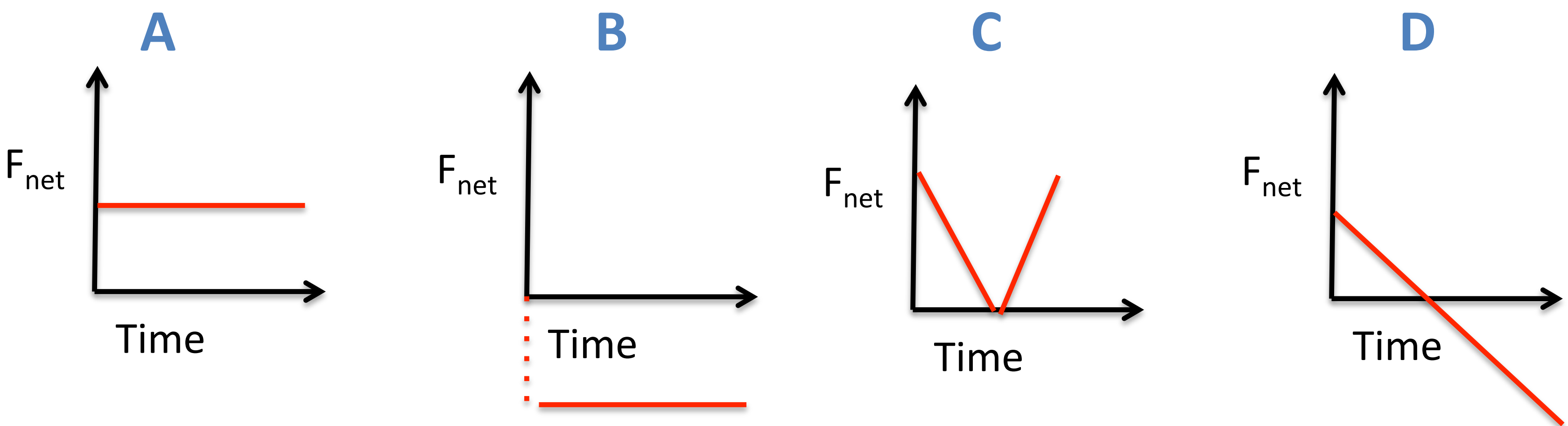


Only B shows a consistency between the velocity and acceleration graphs. The velocity must be slowing down in one direction and speeding up in the other, but with a constant acceleration.

You throw a ball vertically upward. The ball moves up, reaches its highest point, and finally falls down. Which of the following graphs best represents the ball's <u>force vs. time</u> during this process? (ignoring air resistance)



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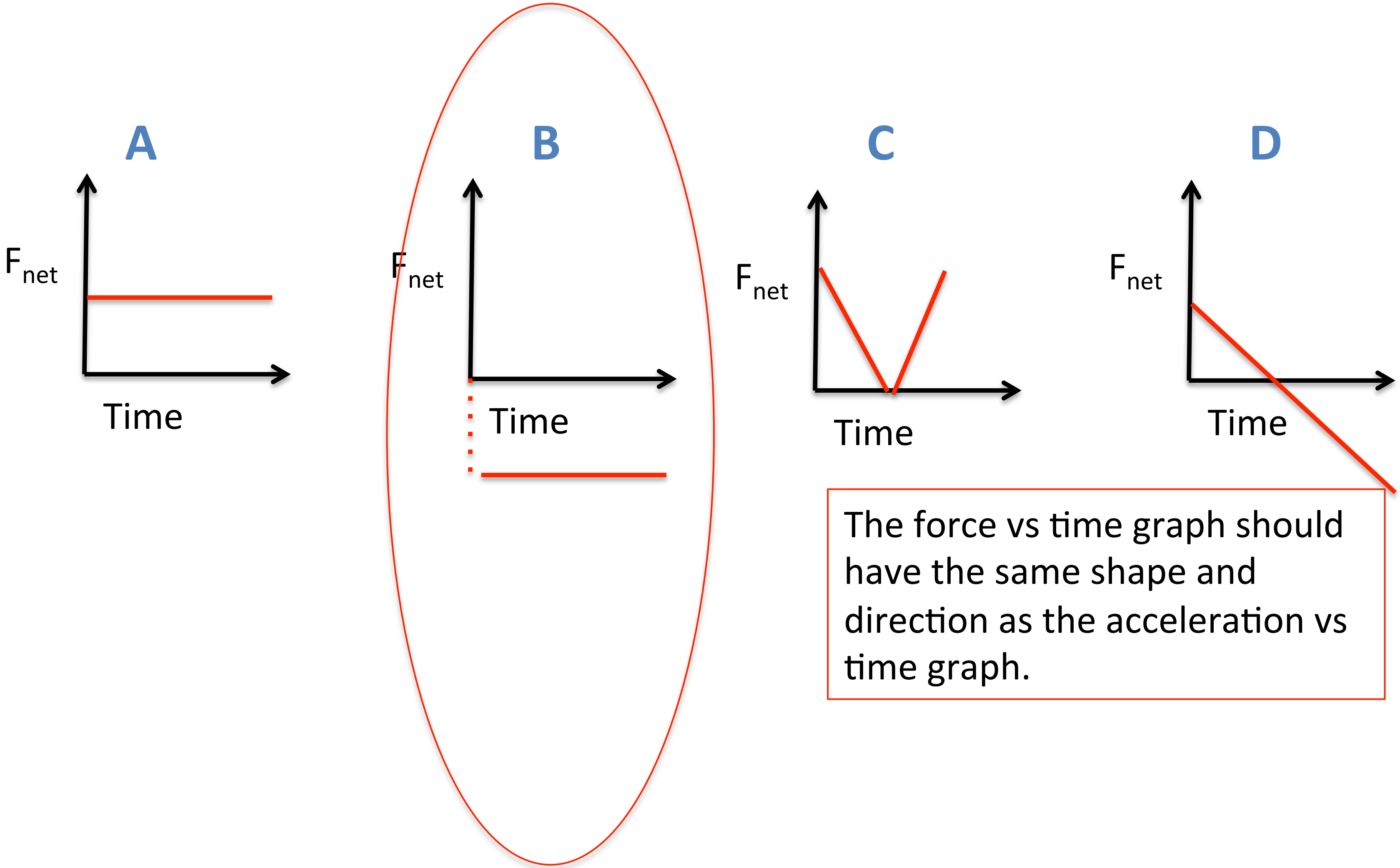


The force vs time graph should have the same shape and direction as the acceleration vs time graph.

Equations of motion (Ch 6)

$$\int ds = s = \int v dt = \int (at + v_i) dt = \frac{1}{2}a(t_f - t_i)^2 + v_i(t_f - t_i) + C$$

where C is a new constant of integration. Just as above, we can determine this by applying the boundary condition that $s = s_i$ when $t_f = t_i$, we have:

$$s_f = s_i + v_i(t_f - t_i) + \frac{1}{2}a(t_f - t_i)^2$$

Now we have two kinematic equations to work with in situations where the acceleration is constant:

$$v_f = v_i + a(t_f - t_i)$$
$$s_f = s_i + v_i(t_f - t_i) + \frac{1}{2}a(t_f - t_i)^2$$

It is possible to combine these two to eliminate $(t_f - t_i)$ and set up a third kinematic equation. The derivation of this third equation is straightforward:

$$(t_f - t_i) = \frac{(v_f - v_i)}{a}$$
$$(s_f - s_i) = v_i\frac{(v_f - v_i)}{a} + \frac{1}{2}a\frac{(v_f - v_i)^2}{a^2}$$

Or

$$2a(s_f - s_i) = (v_f - v_i)[2v_i + (v_f - v_i)] = (v_f - v_i)(v_f + v_i) = v_f^2 - v_i^2$$

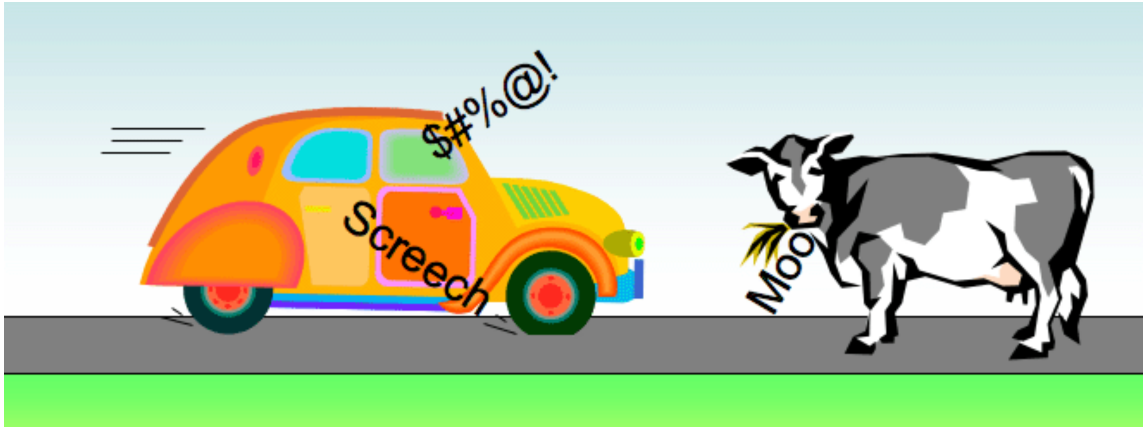
to finally give:

$$v_f^2 - v_i^2 = 2a(s_f - s_i)$$

For convenience, it may be useful to lay out all three of these 'kinematic equations' for motion under the influence of constant acceleration together:

$$v_f = v_i + a(t_f - t_i)$$
$$s_f = s_i + v_i(t_f - t_i) + \frac{1}{2}a(t_f - t_i)^2$$
$$v_f^2 - v_i^2 = 2a(s_f - s_i)$$

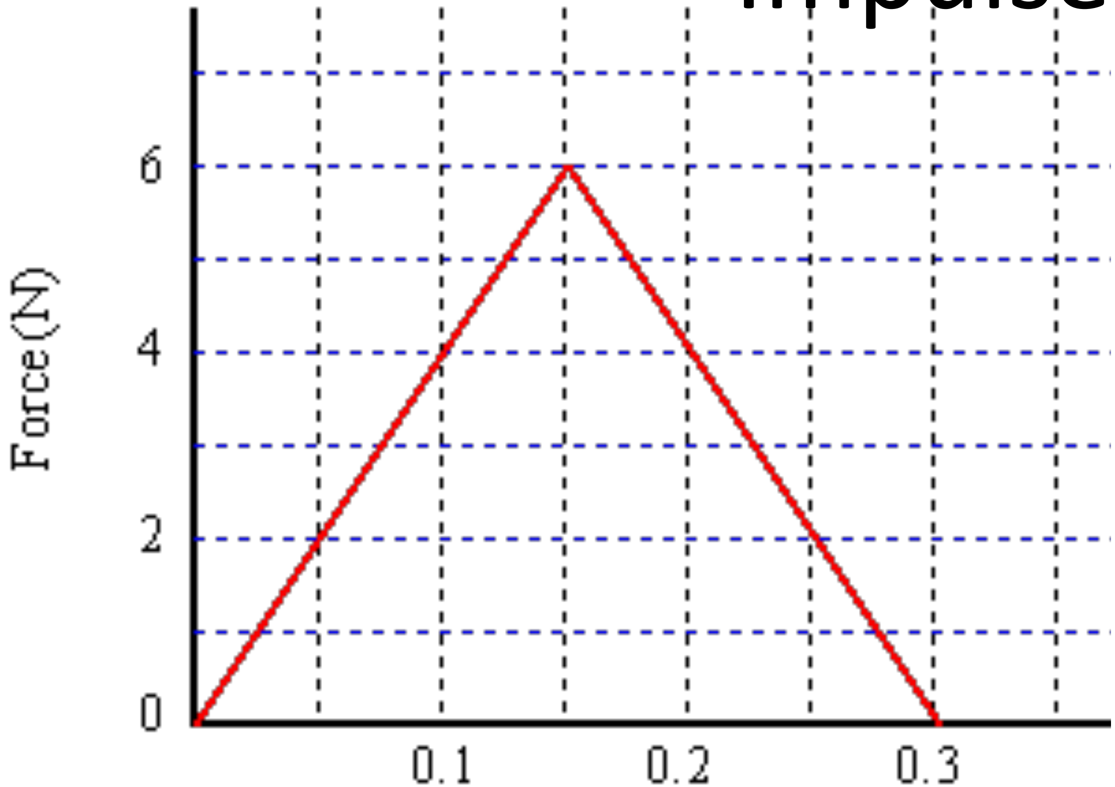
You are cruising along 496 at 70mph (31 m/s) while trying to adjust your ipod and you go careening into the guard rail, coming to a stop. Luckily you have airbags that compress .5m when impacted. Time to slow you down?



You are driving across Michigan State University campus at 13.7 m/s, when suddenly a cow steps out onto the road 18 meters ahead of you. You immediately brake as hard as you can and your wheels lock. What would need to be the minimum coefficient of kinetic friction between the tires and the road, so you don't hit the cow?

Some slides on impulse we didn't get to in class…

Impulse



What if F_{net} is changing over time?

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

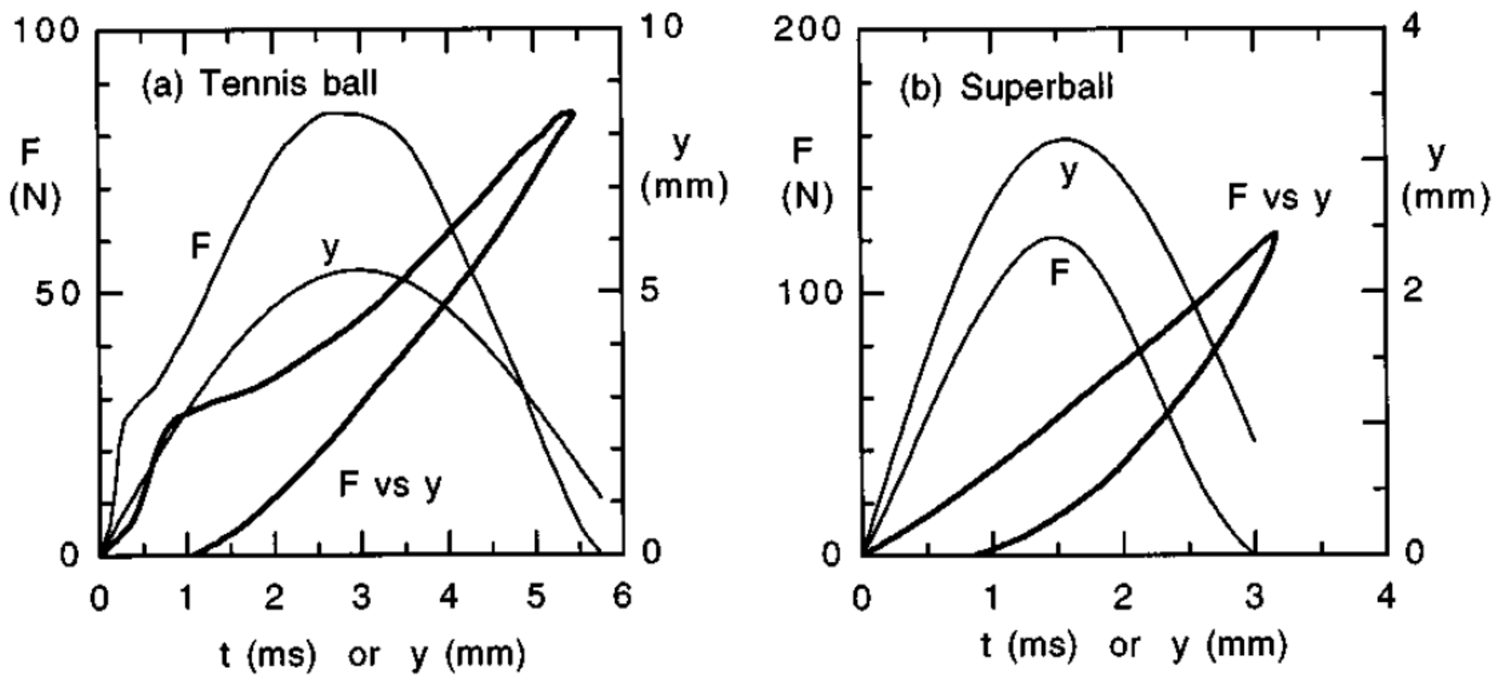
change in momentum over a small time interval

$$dp = F_{net}(t)\, dt$$

sum ("Σ") in the changes in momentum over many small time intervals

$$p_f - p_i = \sum dp = \int F_{net}(t)\, dt$$

Below are two graphs of the force experienced by (a) a tennis ball and (b) a superball as function of time. Which experiences a greater *impulse* in the first 3 ms?



A. Tennis Ball B. Superball C. They are equal

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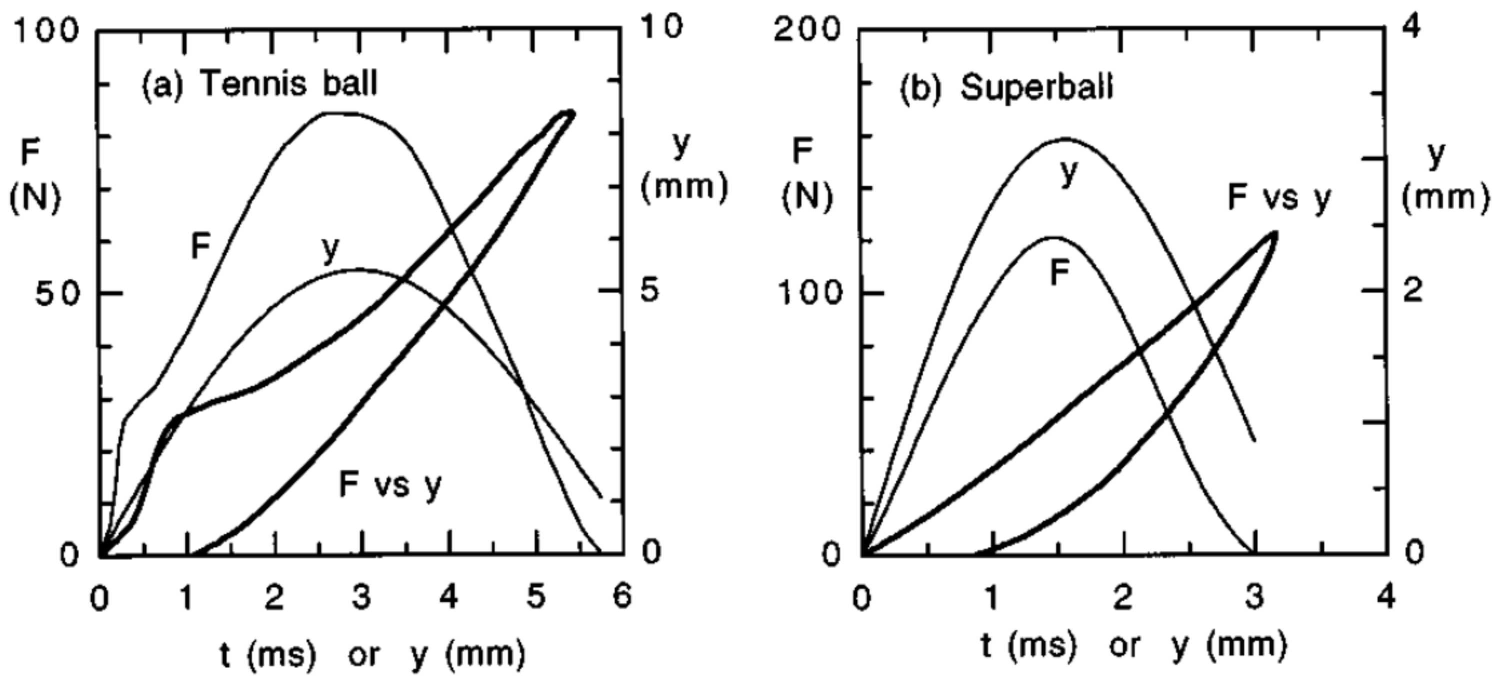

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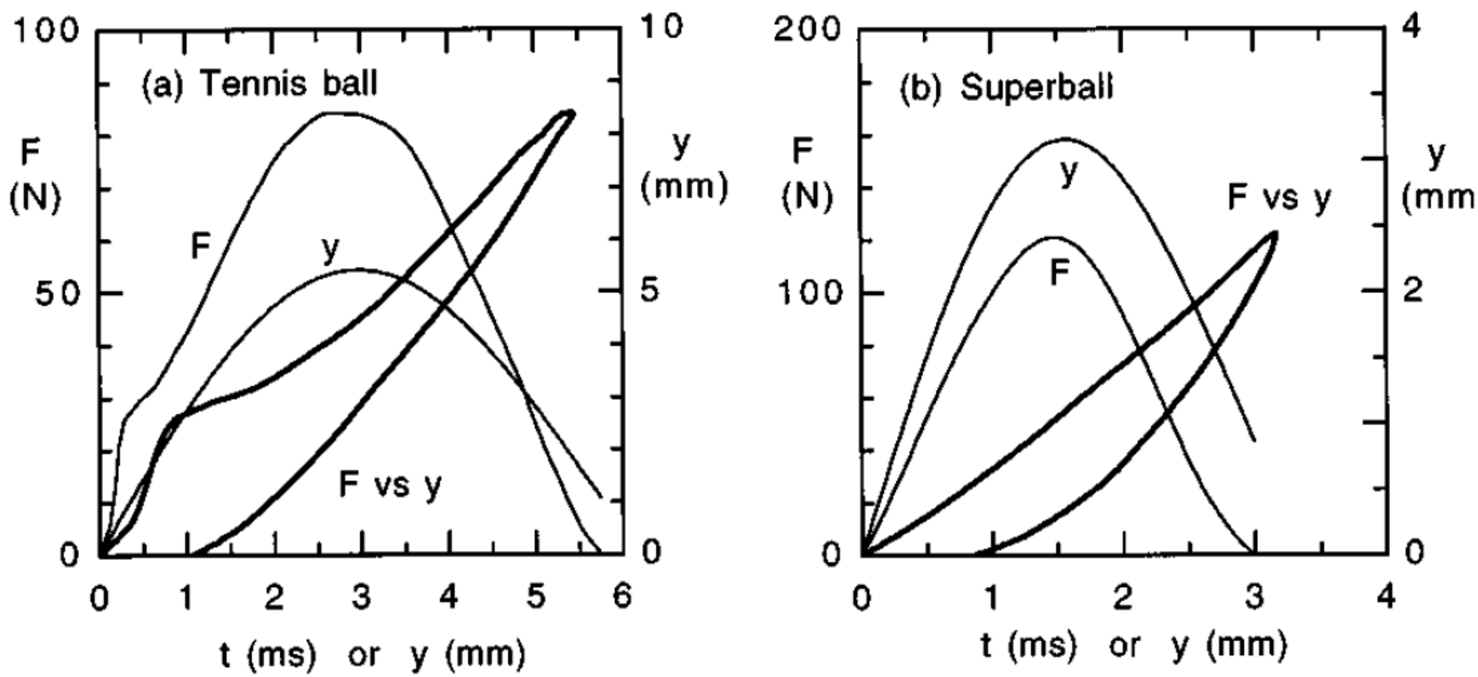
C. They are equal

Below are two graphs of the force experienced by (a) a tennis ball and (b) a superball as function of time. Which experiences a greater *change in momentum* in the first 3 ms?



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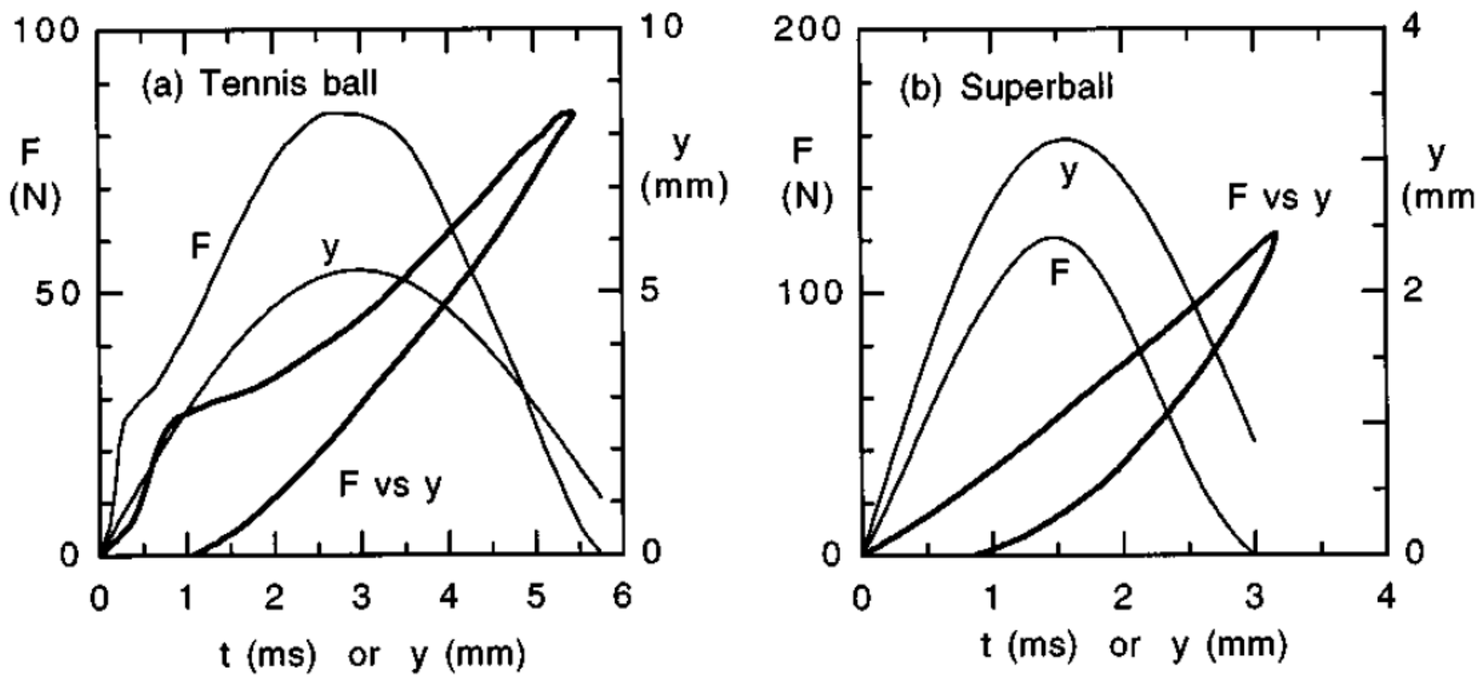

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