COLLOQUIUM
October 9th, 2014
4:10 p.m., Room 1415 BPS Bldg.
Department of Physics and Astronomy

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Center for Nonlinear Science, School of Physics
Georgia Institute of Technology, Atlanta

Recurrent flows: The clockwork behind turbulence

In the world of moderate Reynolds number, everyday turbulence of fluids flowing across planes and down pipes, a velvet revolution is taking place. Experiments are almost as detailed as the numerical simulations, DNS is yielding exact numerical solutions that one dared not dream about a decade ago, and dynamical systems visualization of turbulent fluid's state space geometry is unexpectedly elegant.

We shall take you on a tour of this newly breached, hitherto inaccessible territory. Mastery of fluid mechanics is no prerequisite, and perhaps a hindrance: the talk is aimed at anyone who had ever wondered why - if no cloud is ever seen twice - we know a cloud when we see one? And how do we turn that into mathematics?

Nobel Prize in Physics – Invention of Efficient Blue LEDs

- Isamu Akasaki and Hiroshi Amano of Japan
- Shuji Nakamura of the University of California, Santa Barbara

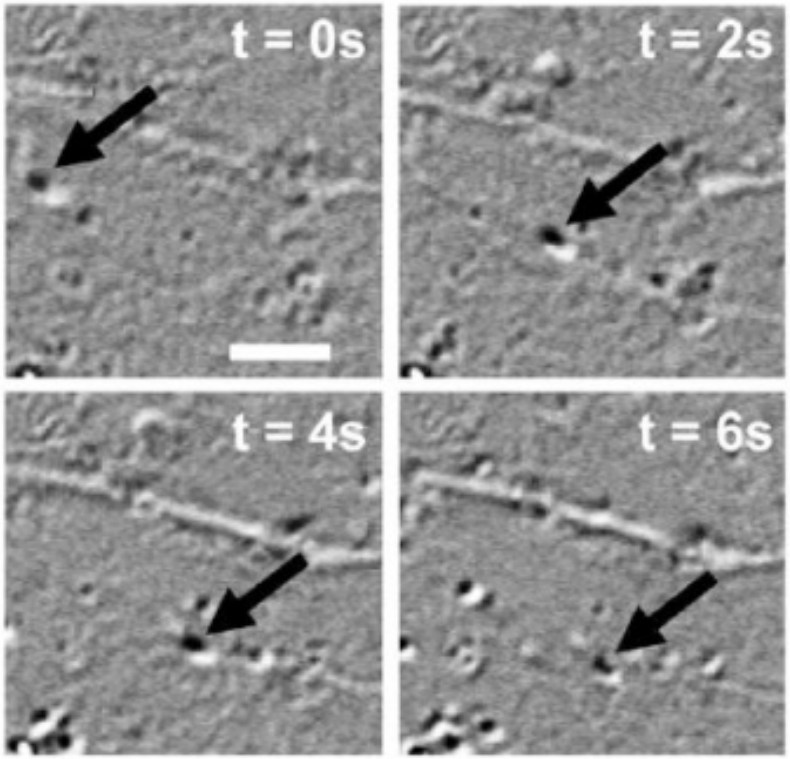
Why is this such a big deal?

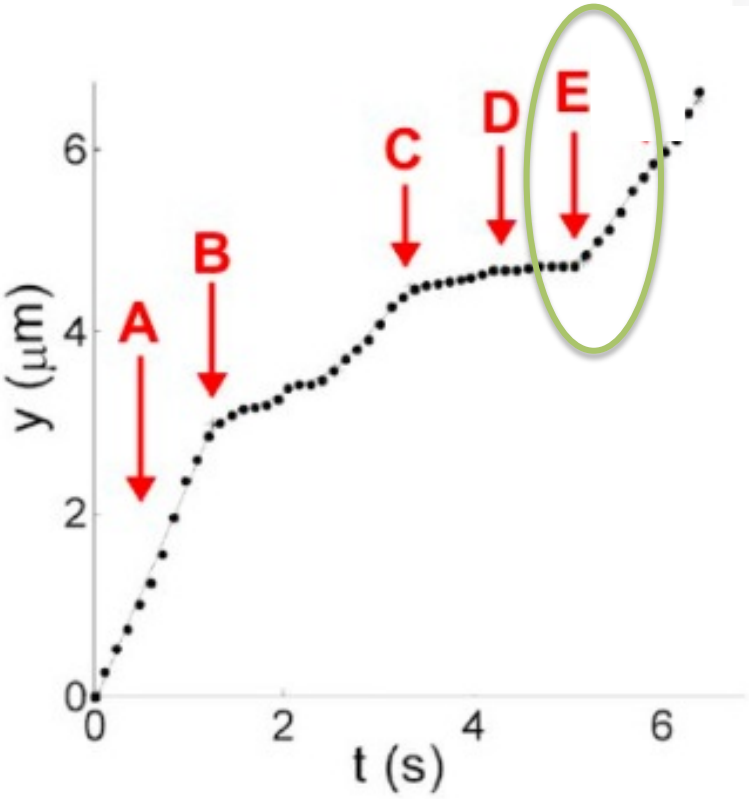
1) It took producing a very special chemical to dope the semiconductors to produce blue light efficiently
2) Without blue LEDs we couldn't produce white light for LED bulbs in your house

Announcements

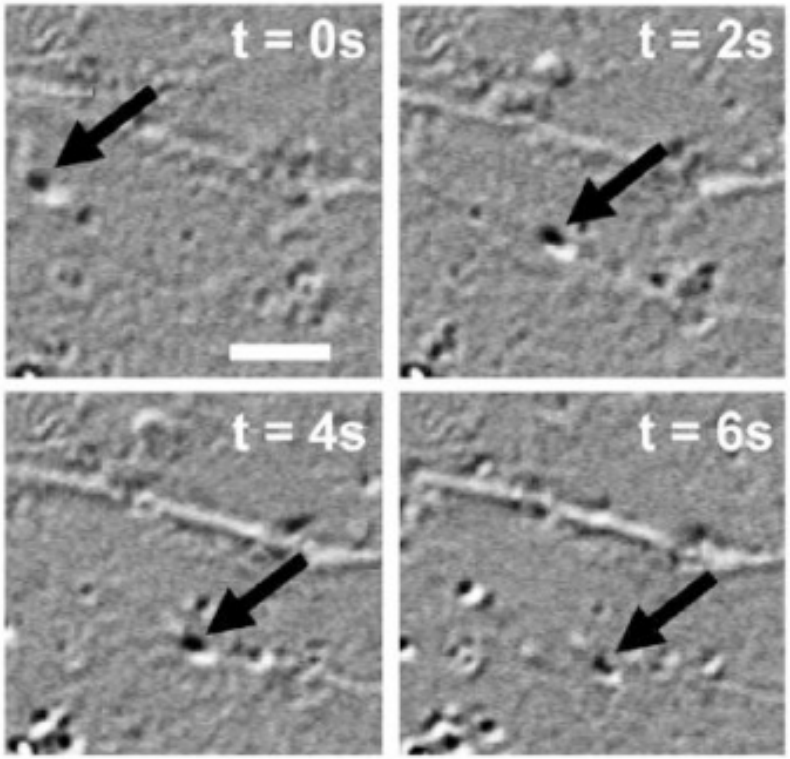
- Chapter 8 reading question due tomorrow
  - SKIP section 8.3
- Homework for Ch 6 & 7 due on Friday
  - Sorry about the 6 tries thing, that was a snafu. I've reset it to 99 for the majority of problems
- Put up a worked-through solution to Pre-Class Questions 1 & 2 in response to a number of reading questions

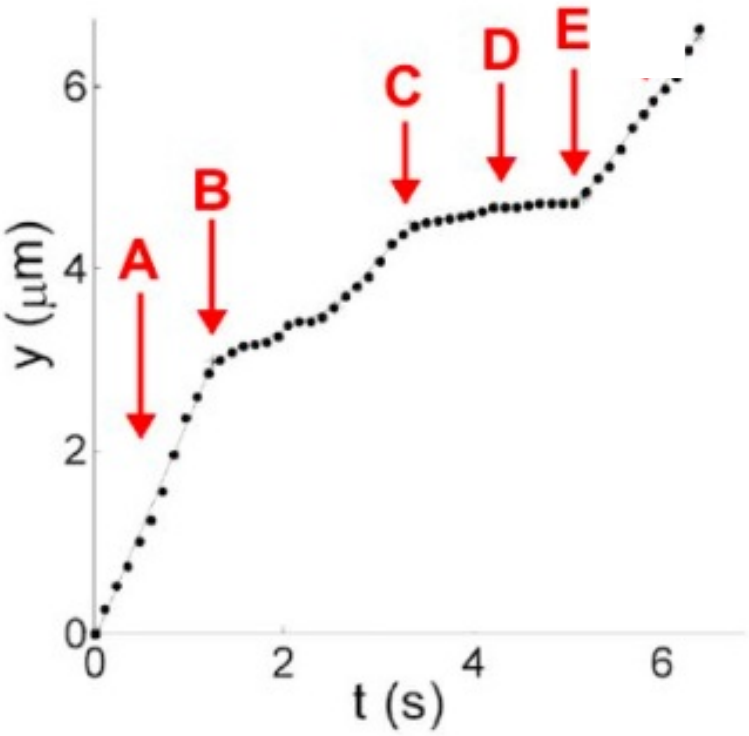
Which label on the graph would best describe the instant of time at which the magnitude of the acceleration is the largest?





Which label on the graph would best describe the instant of time at which the vesicle feels the largest force?





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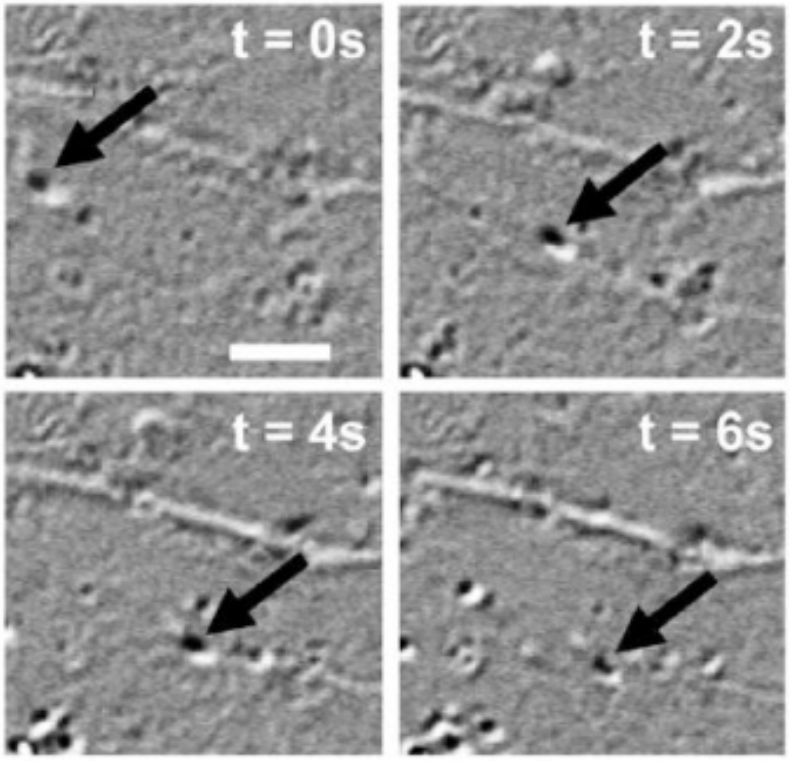

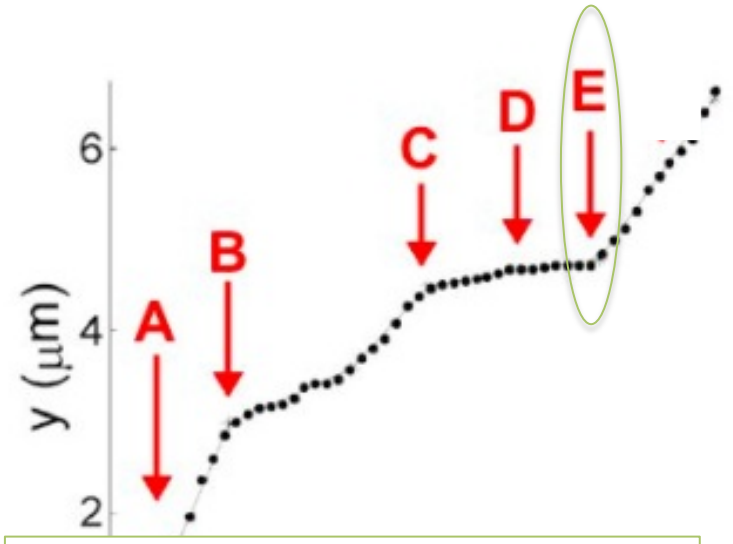

The acceleration tells you about the mangnitude of the force. So it's the same answer as the acceleration.

Little Timmy has fallen down the well! To get him out, rescue workers lower a rope attached to a machine and Timmy ties it around his waist. The machine reels in the rope at a slow steady rate. Timmy weighs 250 N, which means gravity pulls him downward with a force of magnitude 250 N.

As Timmy is pulled upward at a constant speed, does the rope exert an upward force *greater than*, *less than*, or *equal to* 250 N?.

A. Greater than 250N
B. Less than 250N
C. Equal to 250N
D. Something else

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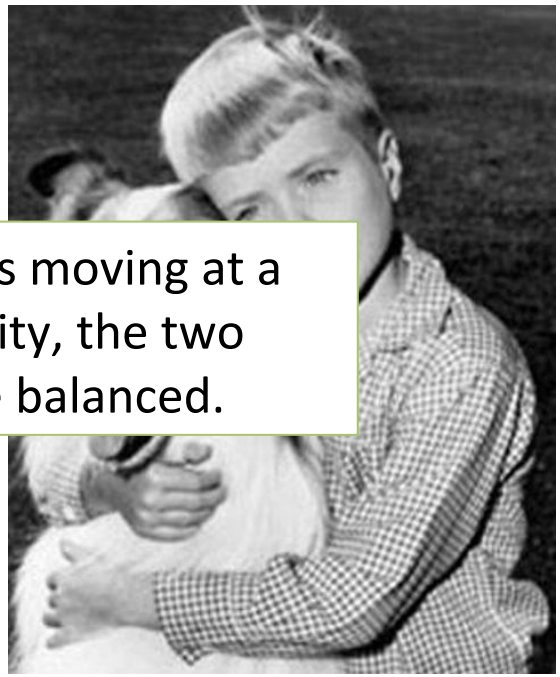

When Timmy is moving at a constant velocity, the two forces must be balanced.

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In order to get Timmy started moving from rest, does the rope exert an upward force *greater than*, *less than*, or *equal to* 250 N?.

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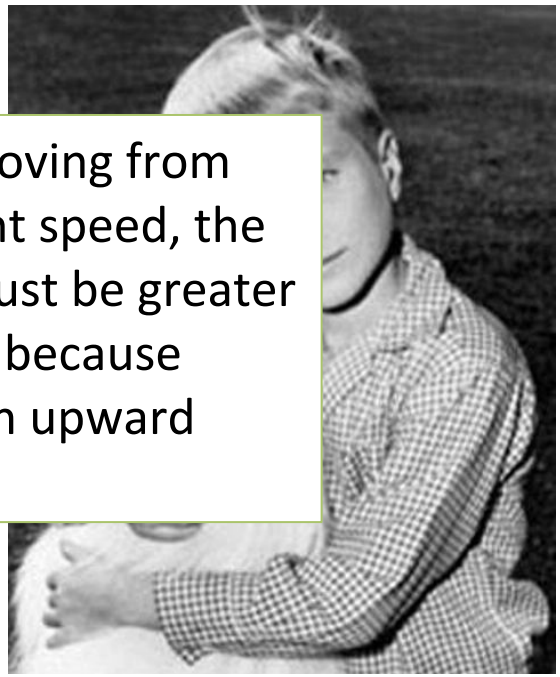
To get Timmy moving from rest to a constant speed, the force exerted must be greater than his weight, because there must be an upward acceleration.



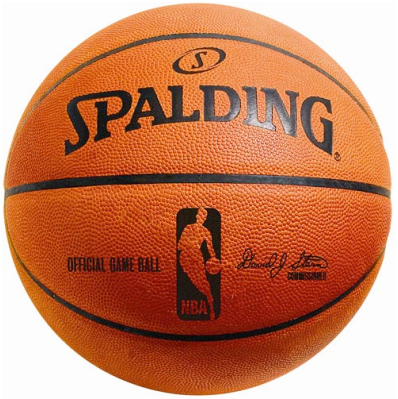
Newton's 2nd Law

- In order to keep things moving at a steady rate, a net force of 0 must be applied because the momentum (or velocity) isn't changing.
- In order to get things moving from rest, a non-zero net force must be applied because the momentum is changing
  - The direction of that net force is the same direction as the change in momentum

RQ: Why do all objects, no matter the weight, fall at the same acceleration? Why is the mass independent?

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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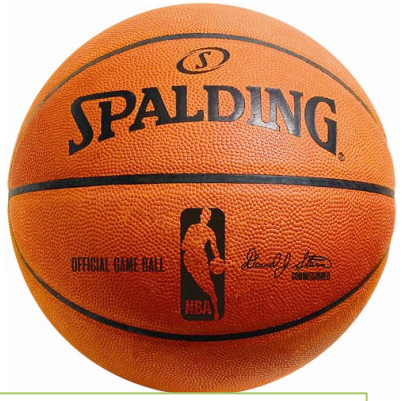
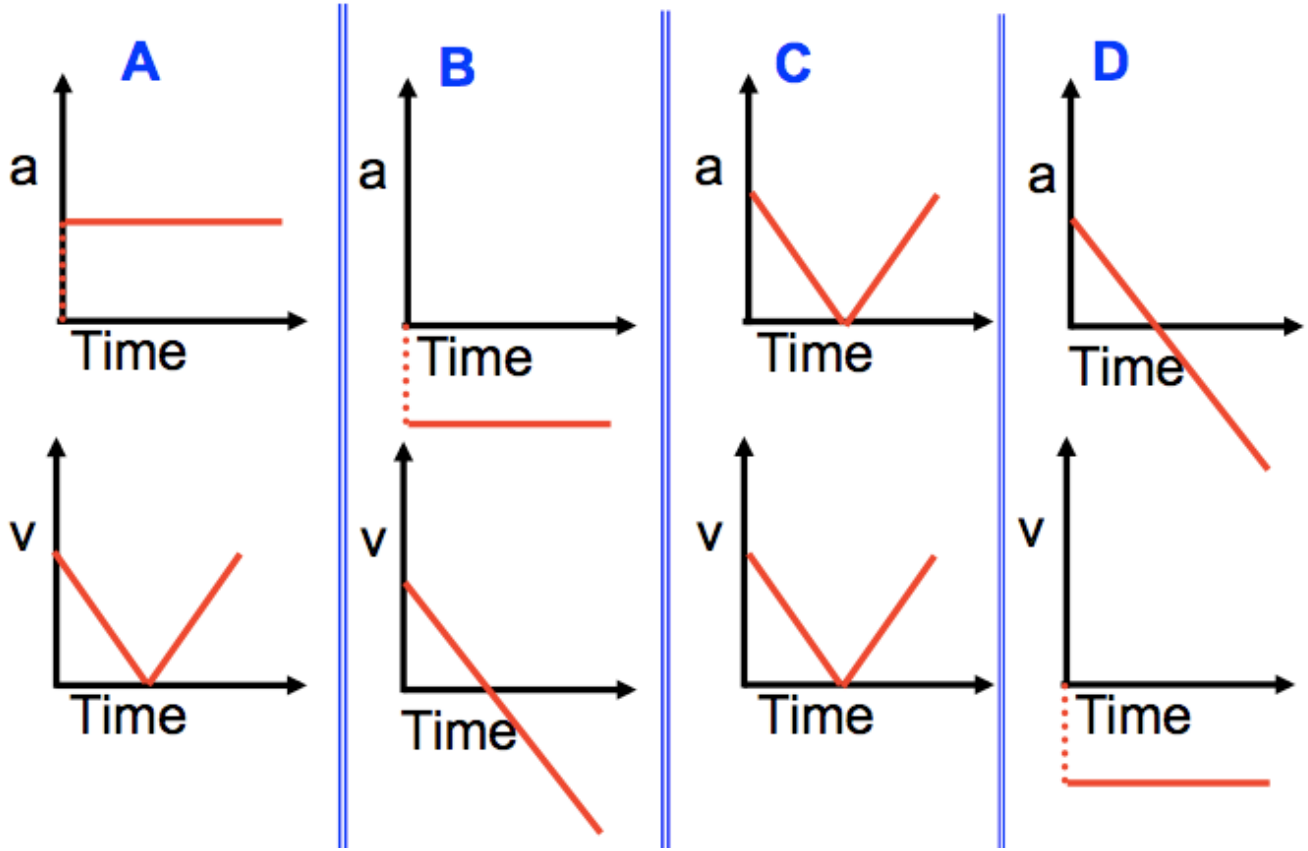


See the following problems.

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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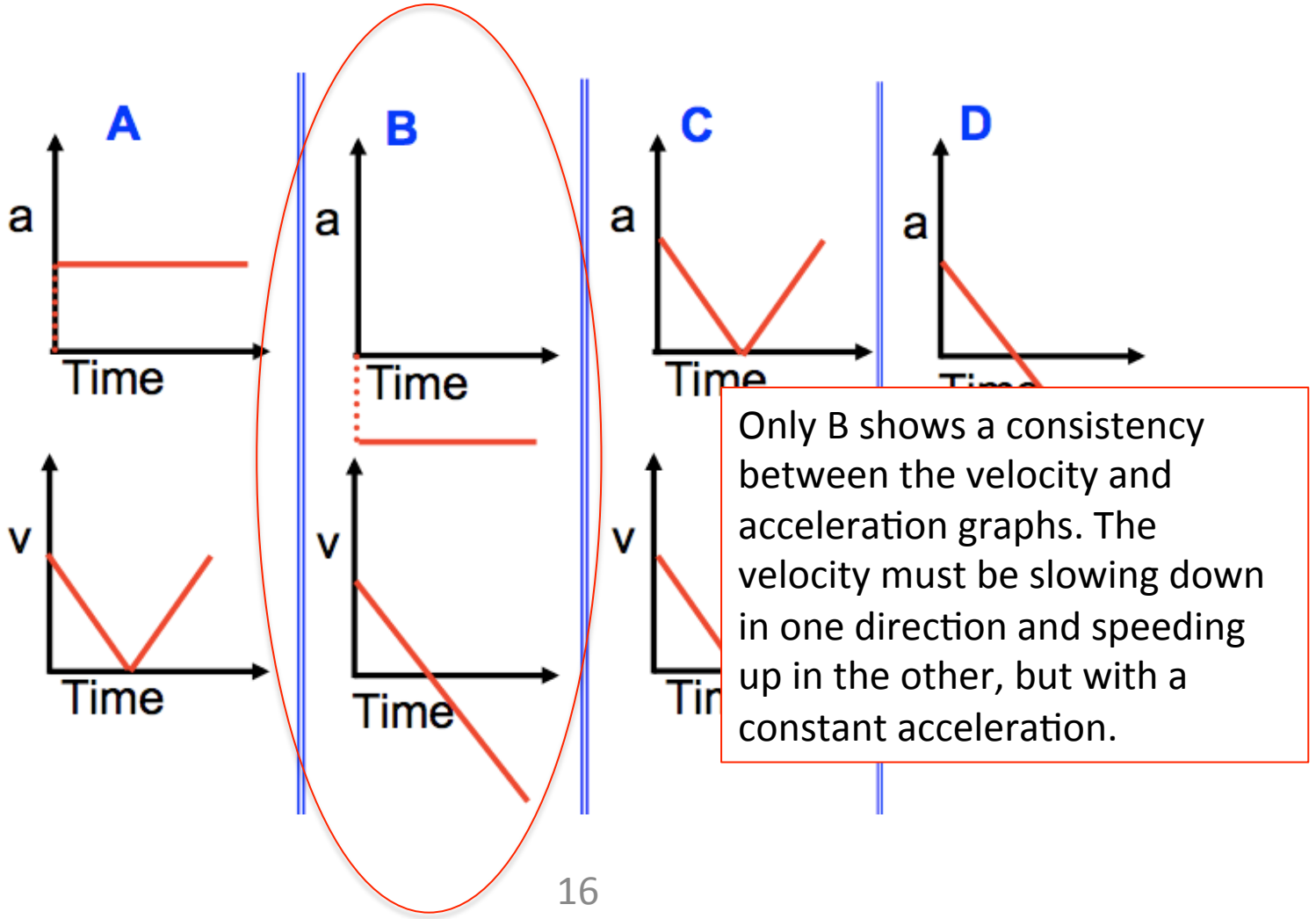
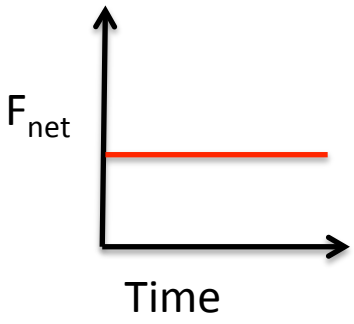


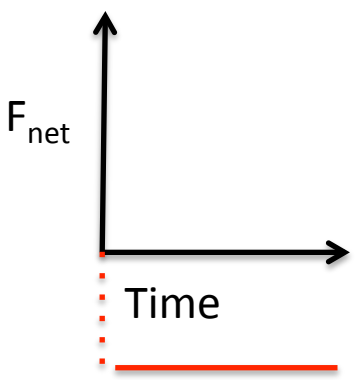
Only B shows a consistency between the velocity and acceleration graphs. The velocity must be slowing down in one direction and speeding up in the other, but with a constant acceleration.

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 force vs. time during this process? (ignoring air resistance)

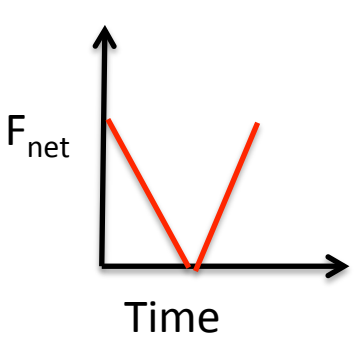
A



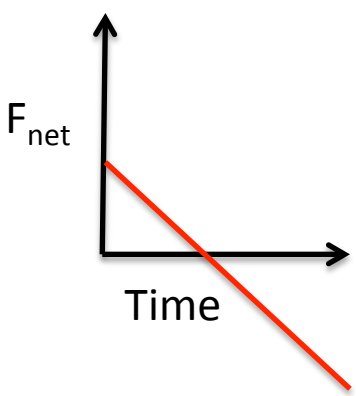
B



C



D



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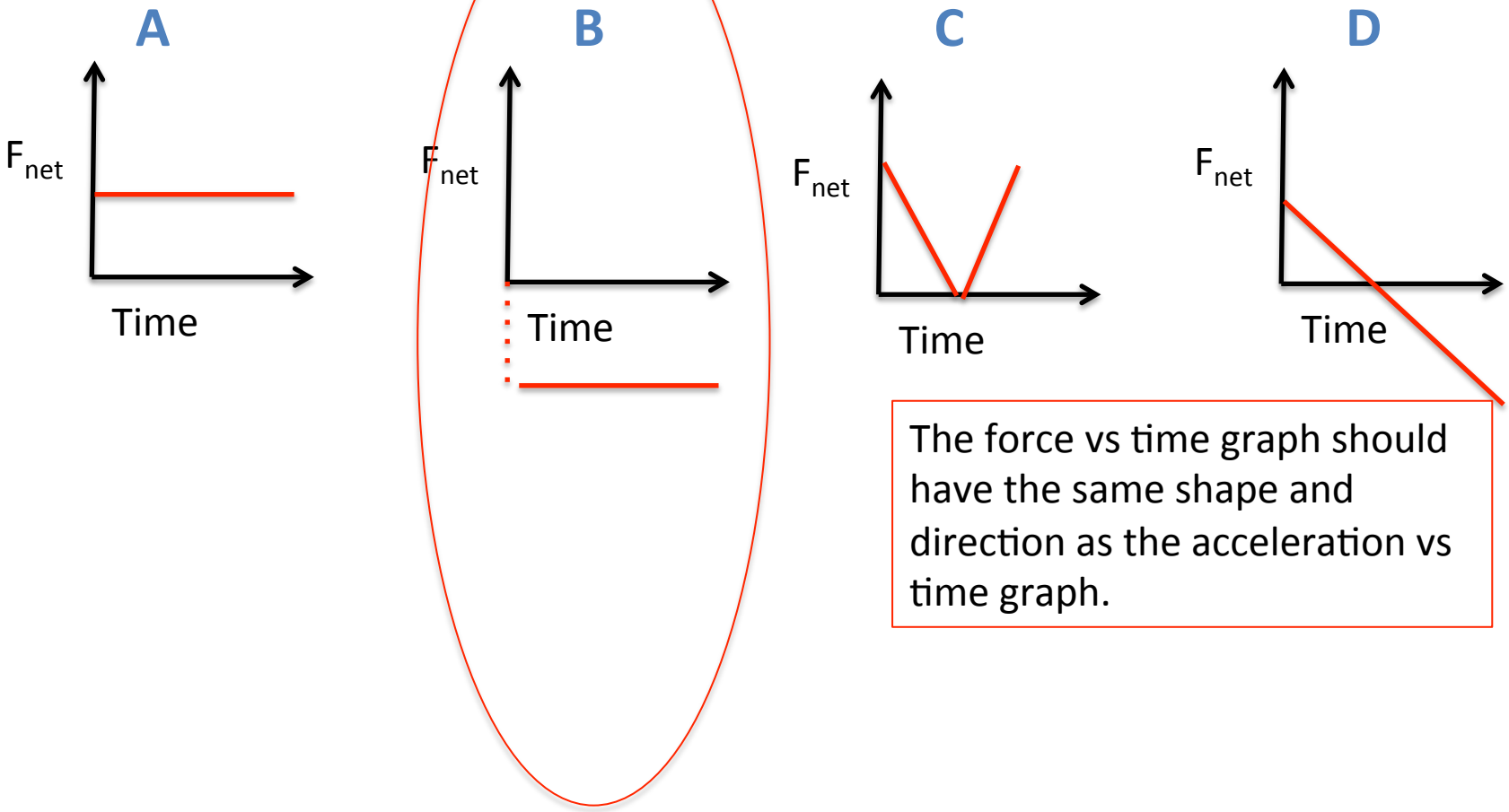


The force vs time graph should have the same shape and direction as the acceleration vs time graph.

How should impulse be represented on a velocity time graph. Would impulse just also be the change in velocity, because I feel like it should be represented as more than this...

Please talk more about how impulse, momentum change, and force are related.

Impulse is it a force?

Can you explain why the velocity and acceleration graphs for a large object falling with air resistance look exponential?

Impulse

- Momentum: a vector quantity that depends on both mass and velocity of the object of interest
- Changes in momentum are achieved by exerting a net force on the system
- If a system experiences a net force it will undergo either:
  - a change in the m… …ntum
  - a change in the di… …um
  - a change in both the magnitude and direction of its momentum

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

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

The impulse felt by a system

Impulse

- The impulse exerted on a system changes its momentum

$$\vec{p}_i + \text{impulse} = \vec{p}_f$$

$$\text{impulse} = \vec{p}_f - \vec{p}_i$$

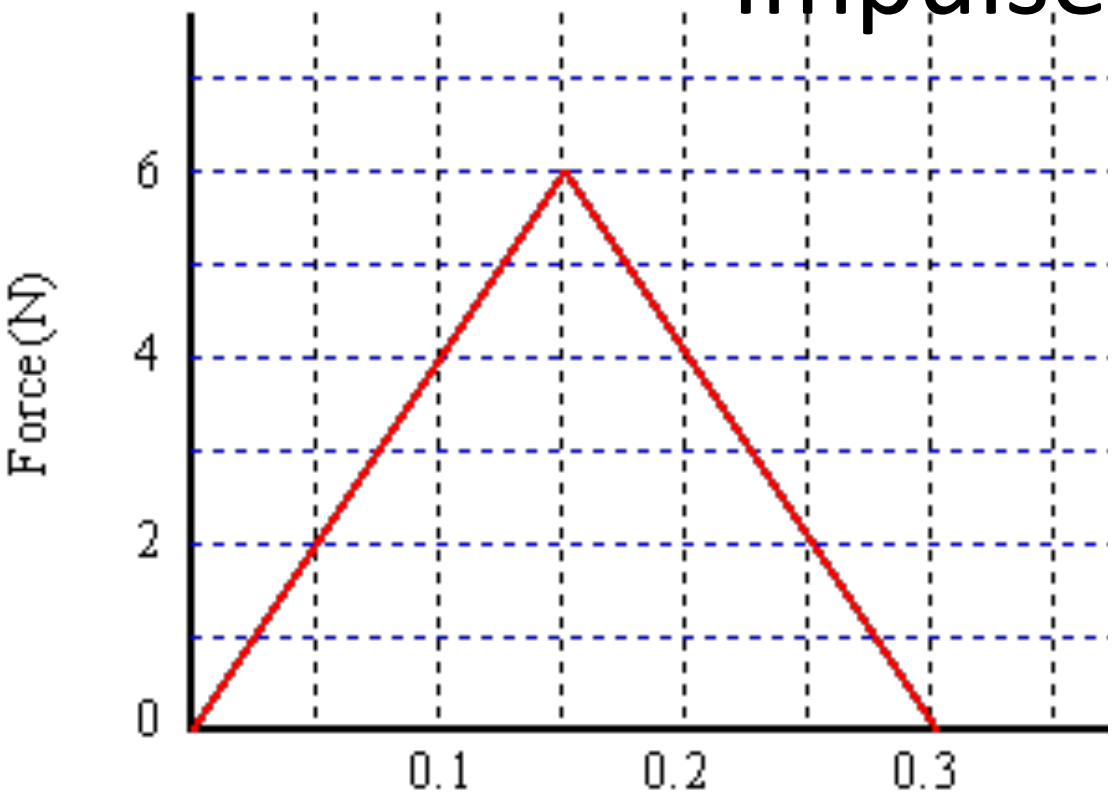
$$\text{impulse} = \Delta \vec{p}$$

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

$$\text{Impulse} = \vec{F}_{net}\,\Delta t$$

Impulse is it a force?

Impulse



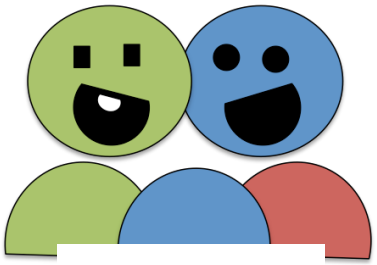
What if F_{net} is changing over time?

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

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



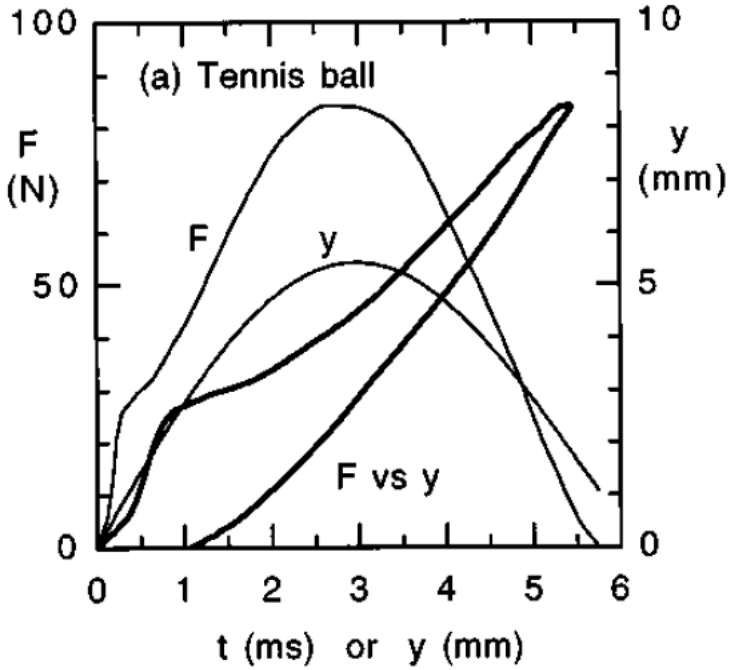
Discuss It!

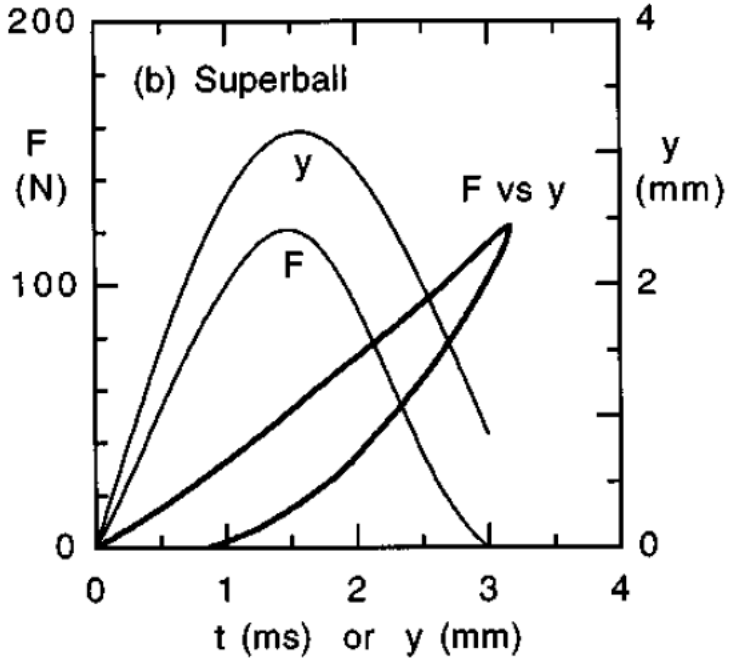
You are cruising along 496 at 70mph (31 m/s) while trying to adjust your ipod and you go careening into the guard rail, coming to a stop. Luckily you have airbags that compress .5m when impacted.

Draw a force-vs-time graph for this situation.

I will put the calculation version of this problem up on the YouTube channel.

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?





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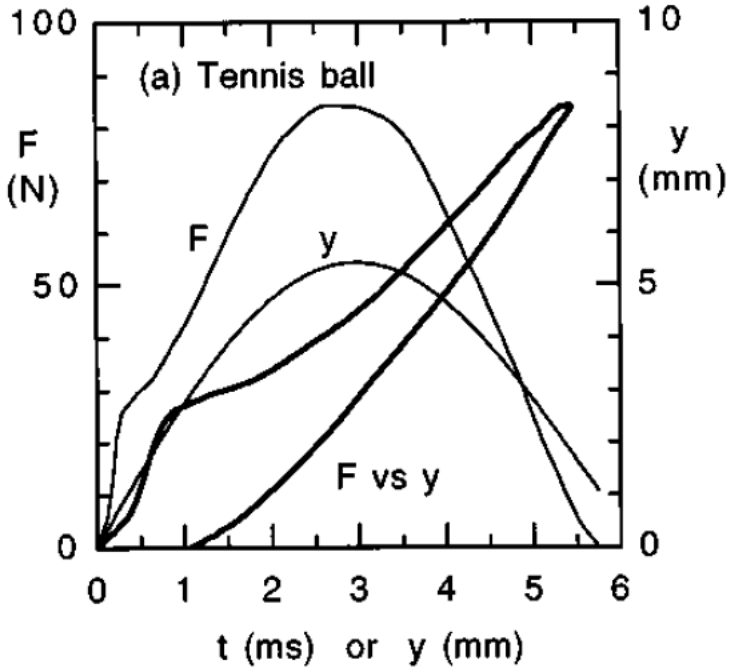

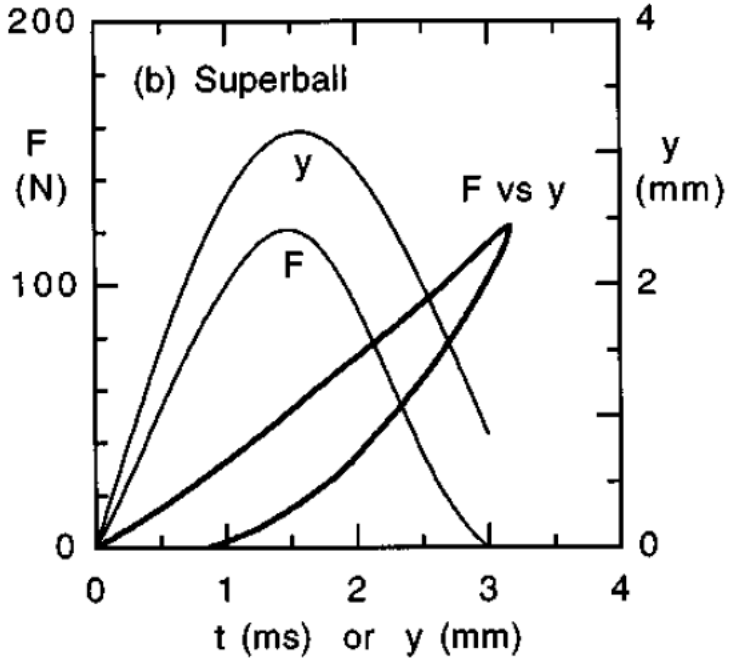

A. Tennis Ball

B. Superball

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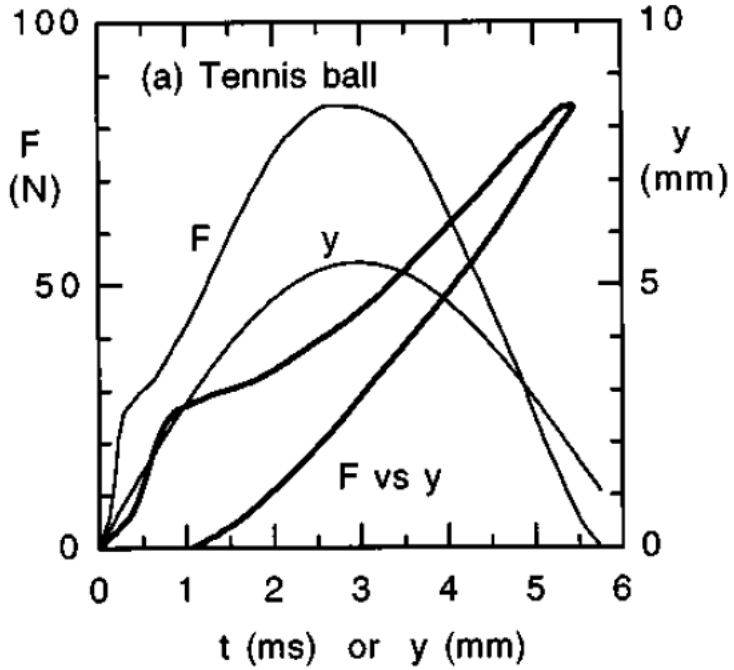
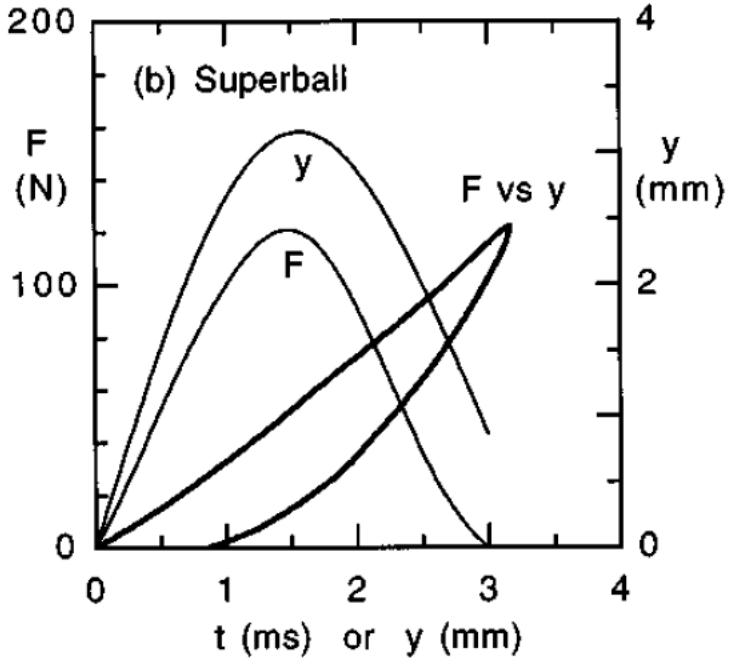
Below are two graphs of the force experienced by (a) a tennis ball and (b) a superball as function of time. Which experiences a greater *change in momentum* in the first 3 ms?





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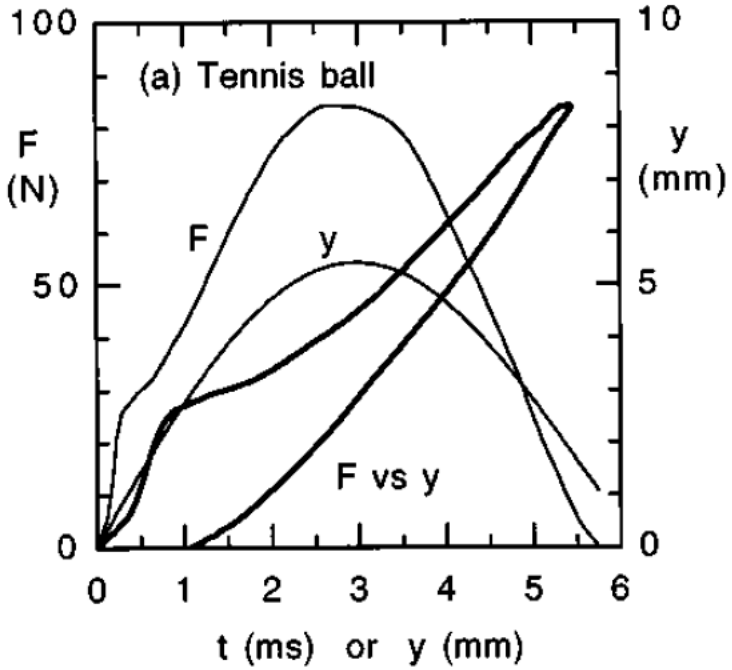

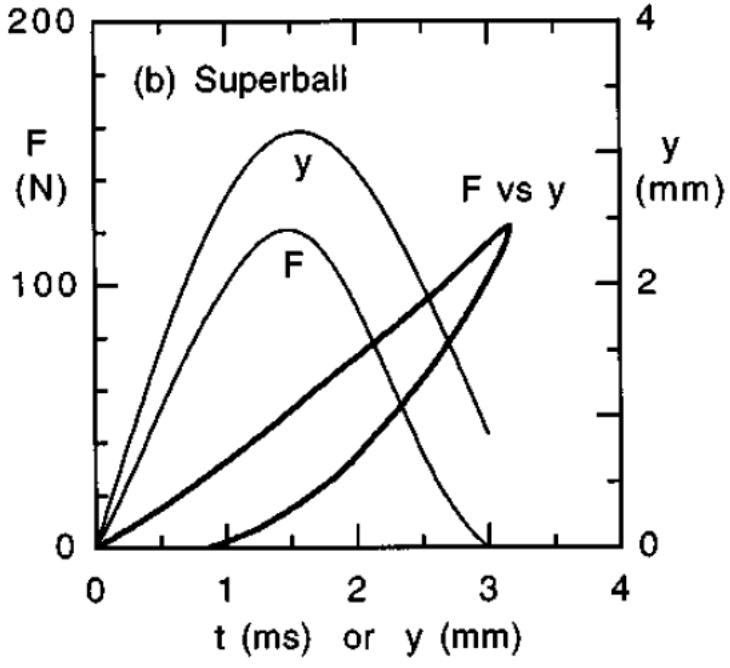

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