Prof. Vashti Sawtelle
Prof. Leanne Doughty

Today:
Chapter 7

Irish Phrasebook

Slagging – *Making fun of someone in a nice way*

"They're always slagging me about my accent"

Announcements

- Ch 6 and 7 homework (LON-CAPA and on-paper) due Friday 30th
- Exam 2 – Monday Nov. 2nd
  - Ch 3.5 – Ch 7
  - Practice Materials on LON-CAPA (remember to look at previous Exam 1's also)
  - Review sessions:
    - Tonight at 7pm in C104 Holmes
    - Tomorrow at 9:15pm in C106 Holmes

Chapter 7
Getting Started & Moving Around: What Makes Motion Change?

Newton's 2nd Law AKA: "The Momentum Principle"

- Momentum: a vector quantity that depends on both mass and velocity of the object of interest

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

- Changes in momentum are achieved by exerting a net force on the system

$$\overrightarrow{\Delta p} = \overrightarrow{F_{net}}\,\Delta t$$

- If a system experiences a net force it will undergo either:
  - a change in the magnitude of its momentum
  - a change in the direction of its momentum
  - a change in both the magnitude and direction of its momentum

Newton's 2nd Law: Connecting Back to Acceleration

- We define the momentum of an object, A:

$$\vec{p}_A = m_A \vec{v}_A$$

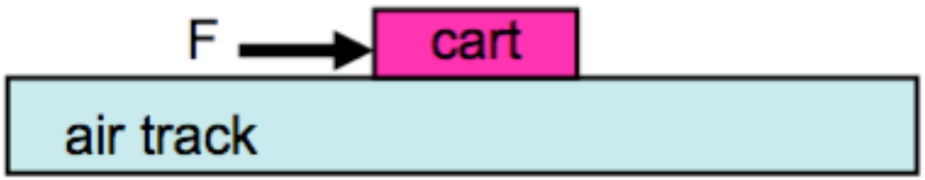
- Our form of the momentum principle can be rewritten

$$\vec{F}_A^{net} = \frac{\Delta \vec{p}_A}{\Delta t} = \frac{\Delta\left(m_A \vec{v}_A\right)}{\Delta t}$$

$$\vec{F}_A^{net} = m_A \frac{\Delta \vec{v}_A}{\Delta t} = m_A \vec{a}_A$$

Newton's 2nd Law is a way to quantify the impact of an external force acting on a system for a period of time.

A constant force is exerted on a cart that is initially at rest on a frictionless air track. The force acts for a short time interval and gives the cart a final speed. To reach the same speed using a force that is half as big, the force must be exerted for a time interval that is…



A. Four times as long
B. Twice as long
C. The same length
D. Half as long
E. A quarter as long

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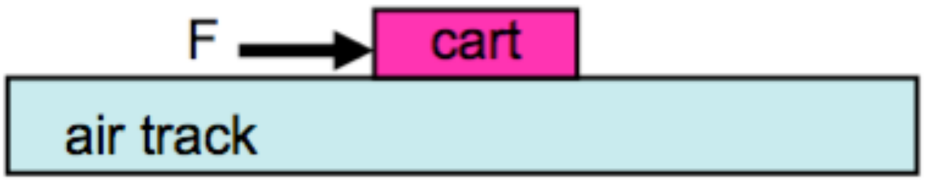

A. Four times as long
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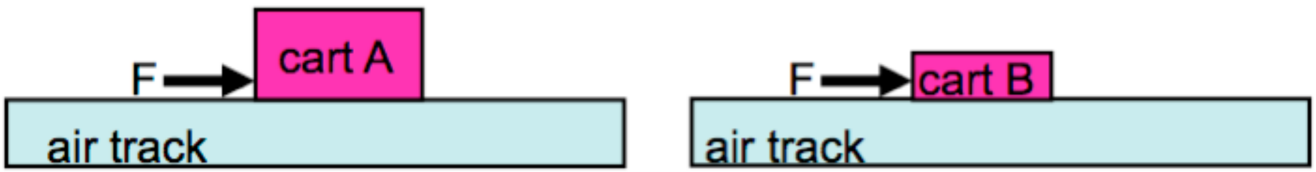
$dp = F_{net}\, dt$

$F_{net} = dp/dt$

So if F_{net} goes down by ½, dt must increase by 2 to compensate

Two carts - A and B - on frictionless air tracks are initially at rest. Cart A is twice as massive as cart B. Now you exert the same constant force on both carts for 1 second. One second later, the momentum of cart A is...



A. Twice the momentum of cart B
B. The same as the momentum of cart B
C. Half the momentum of cart B
D. Not enough information to determine

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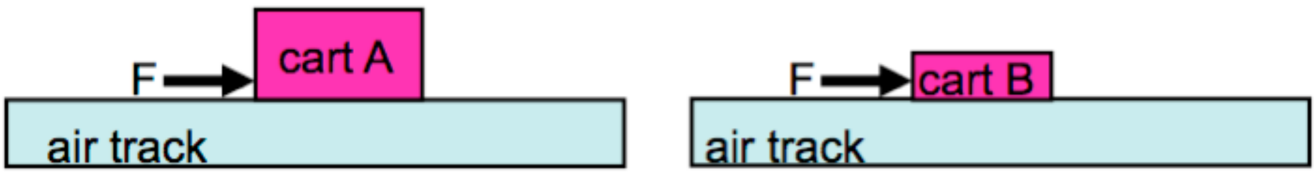


A. Twice the momentum of cart B

B. The same as the momentum of cart B

C. Half the momentum of cart B

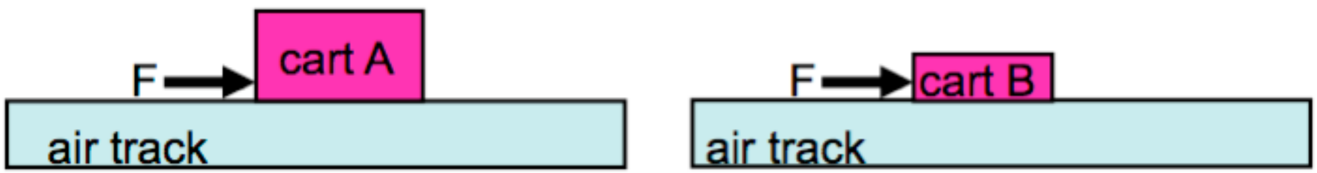
D. No … mine

$dp_A = F_{net\text{-}A}\, dt_A$ $dp_B = F_{net\text{-}B}\, dt_B$

We know $F_{net\text{-}A} = F_{net\text{-}B}$ and $dt_A = dt_B$

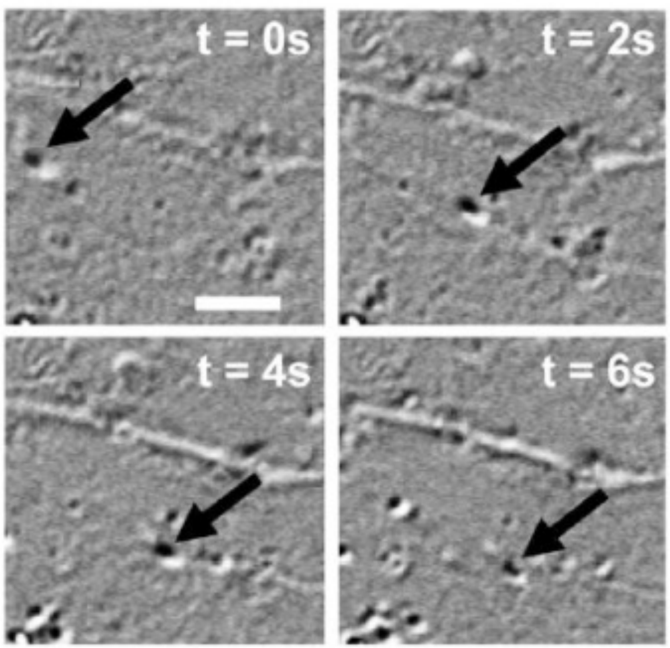
Thus $dp_A = dp_B$, but $v_A < v_B$

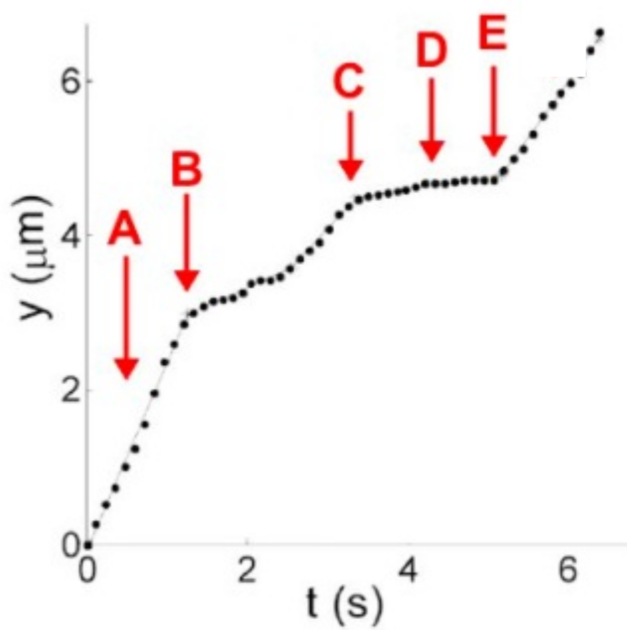
Two carts - A and B - on frictionless air tracks are initially at rest. Cart A is twice as massive as cart B. Now you exert the same constant force on both carts for 1 second. One second later, the velocity of cart A is...



A. Twice the velocity of cart B
B. The same as the velocity of cart B
C. Half the velocity of cart B
D. Not enough information to determine

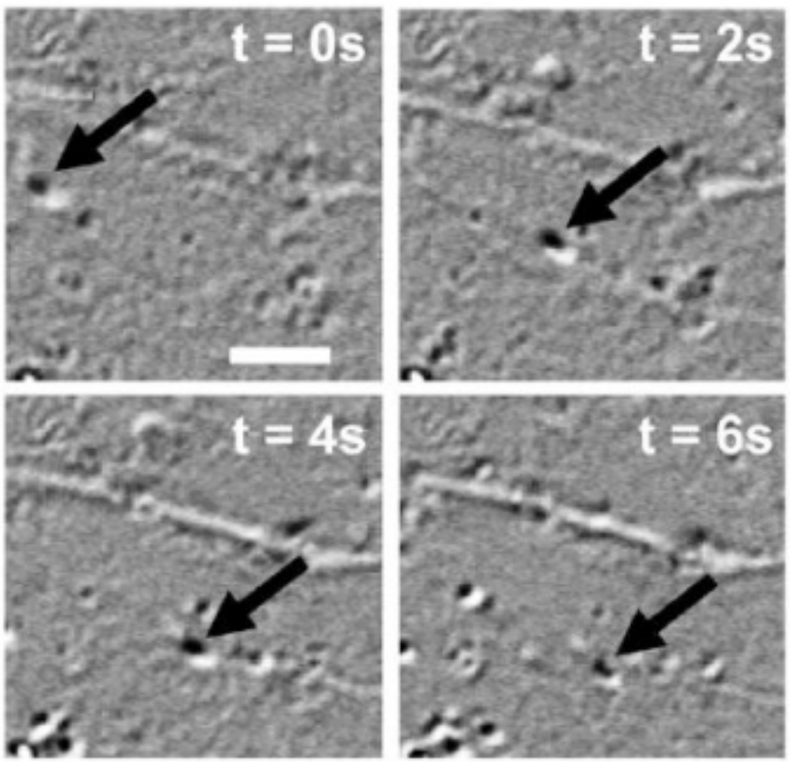
In a study of the forces involved when motor proteins move subcellular structures in cells, Shtridleman et al.* extracted the position of a vesicle using video. Some of the frames are shown in the figure below and a graph of the position of one of the vesicles that moved along a straight line (in a direction they call y) is shown at the right.

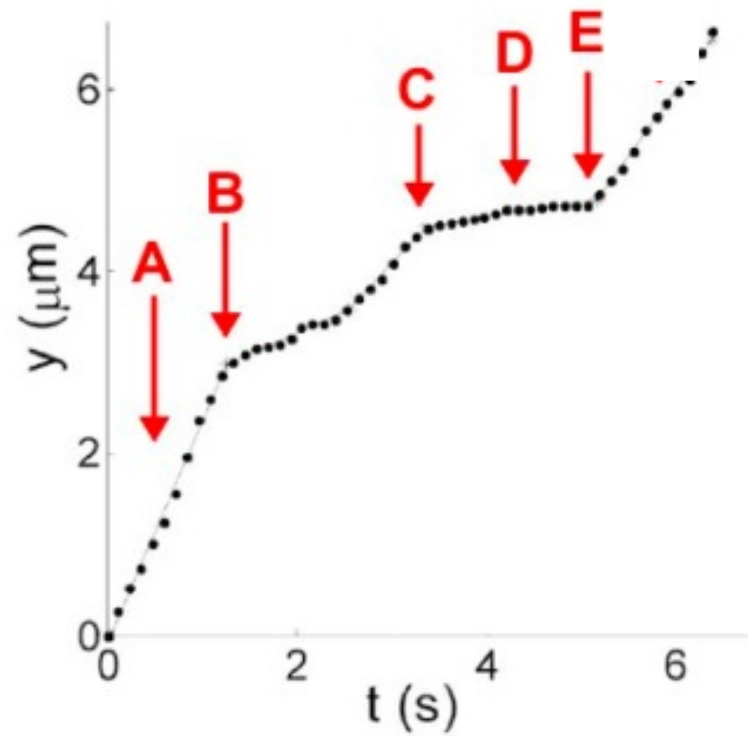




* Force-Velocity Curves of Motor Proteins Cooperating In Vivo, Y. Shtridelman, et al., *Cell Biochem Biophys*. (2008) 52(1): 19–29

Which label on the graph would best describe the instant of time at which the vesicle is moving with the highest speed?





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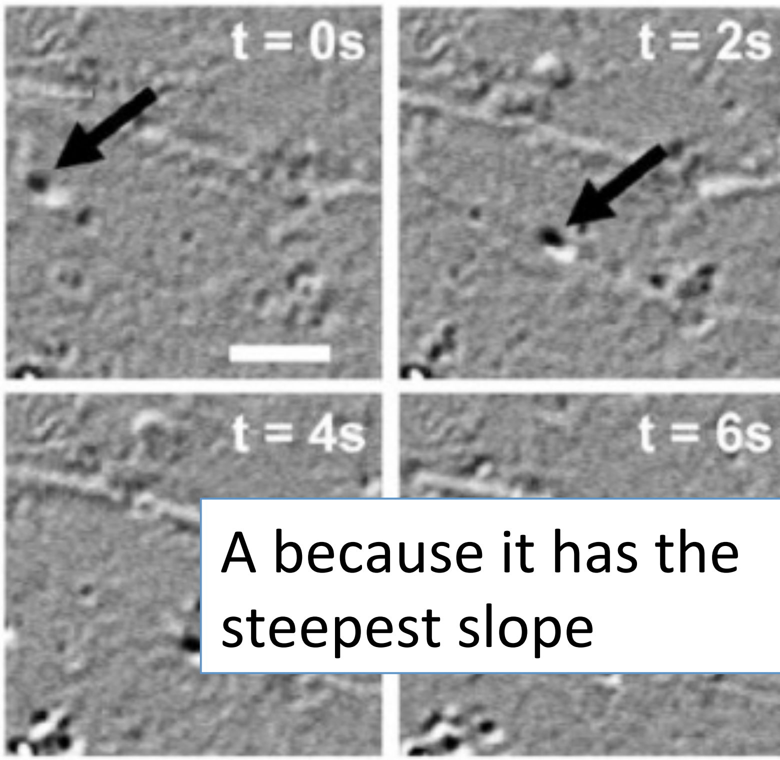
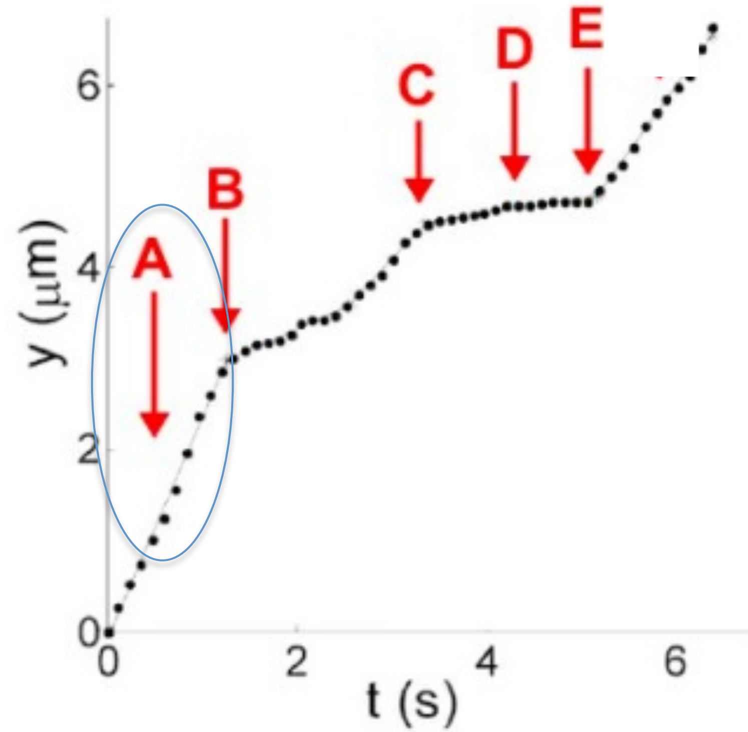
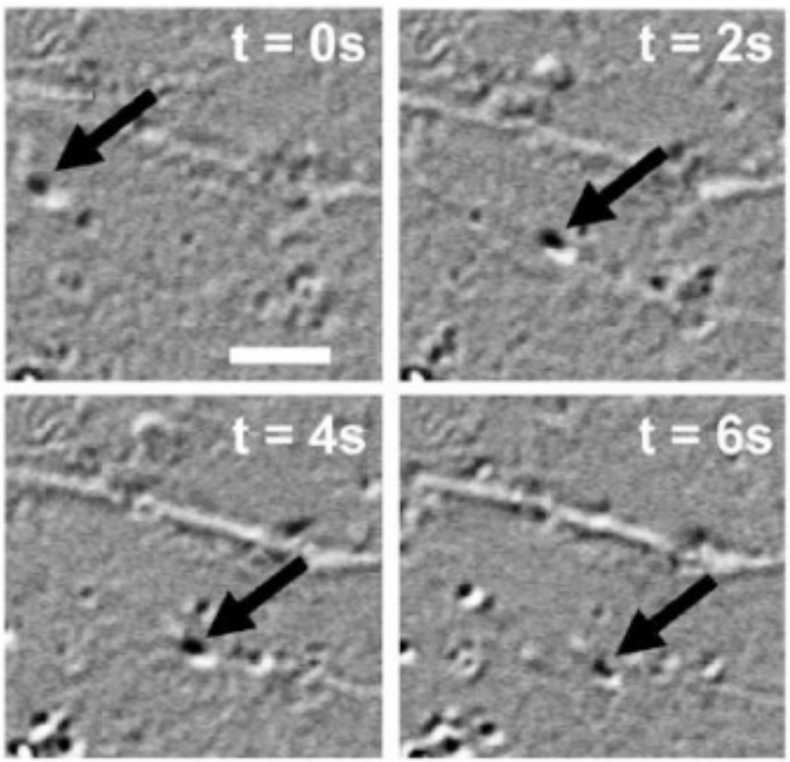
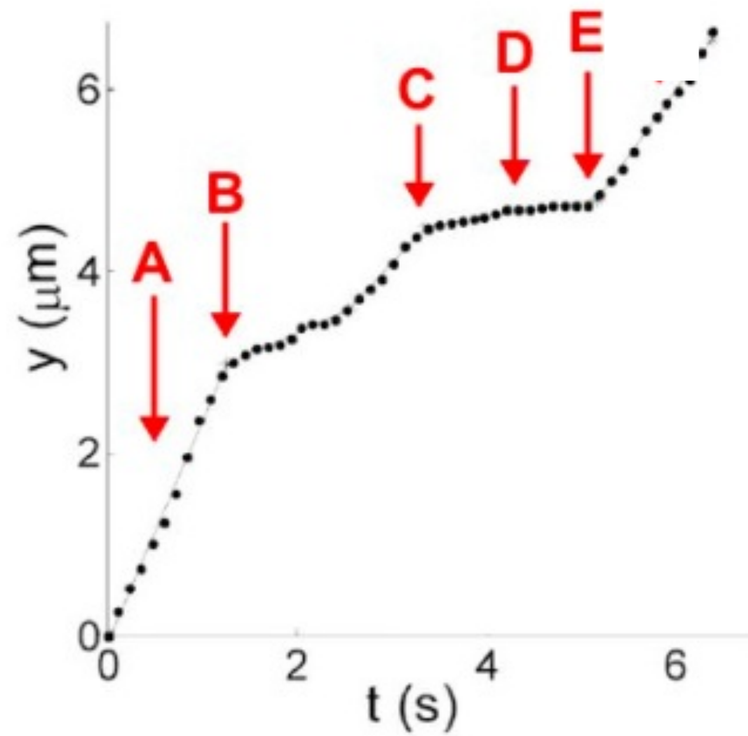


A because it has the steepest slope



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





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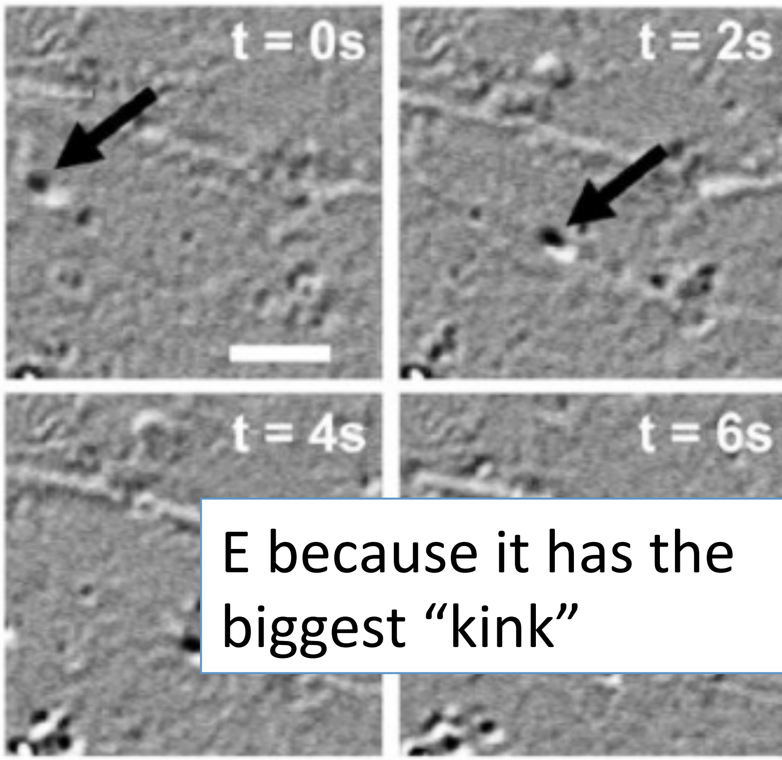
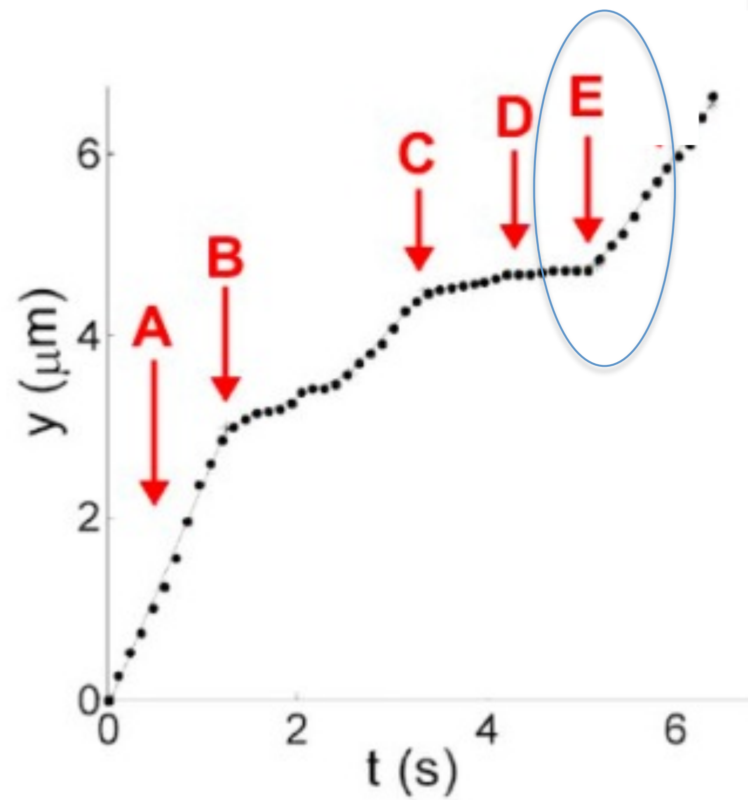
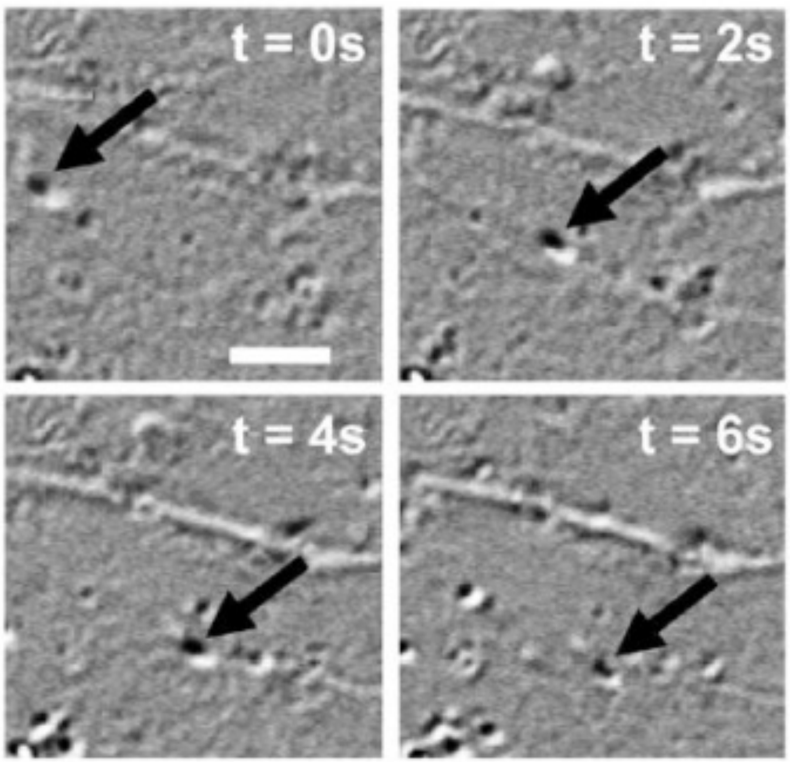
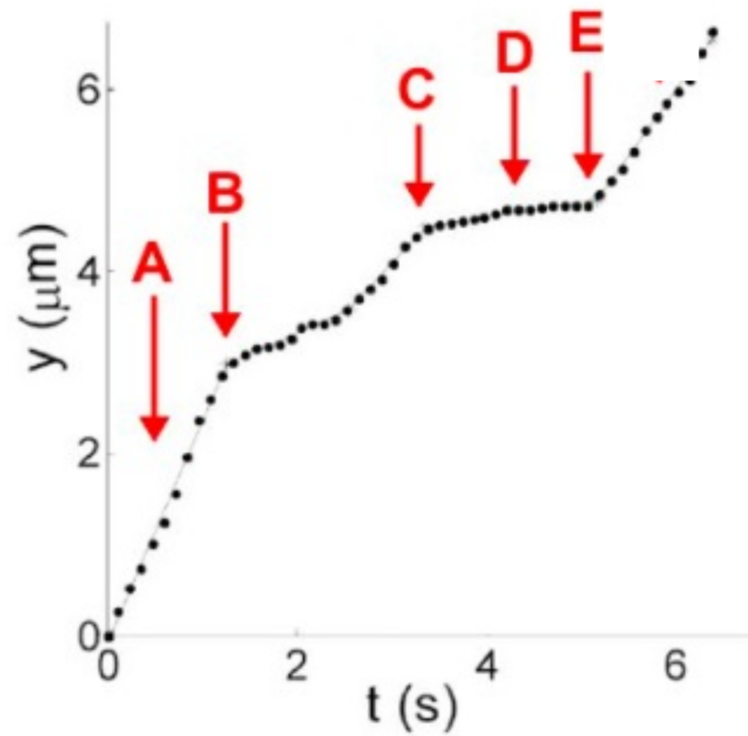


E because it has the biggest "kink"



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





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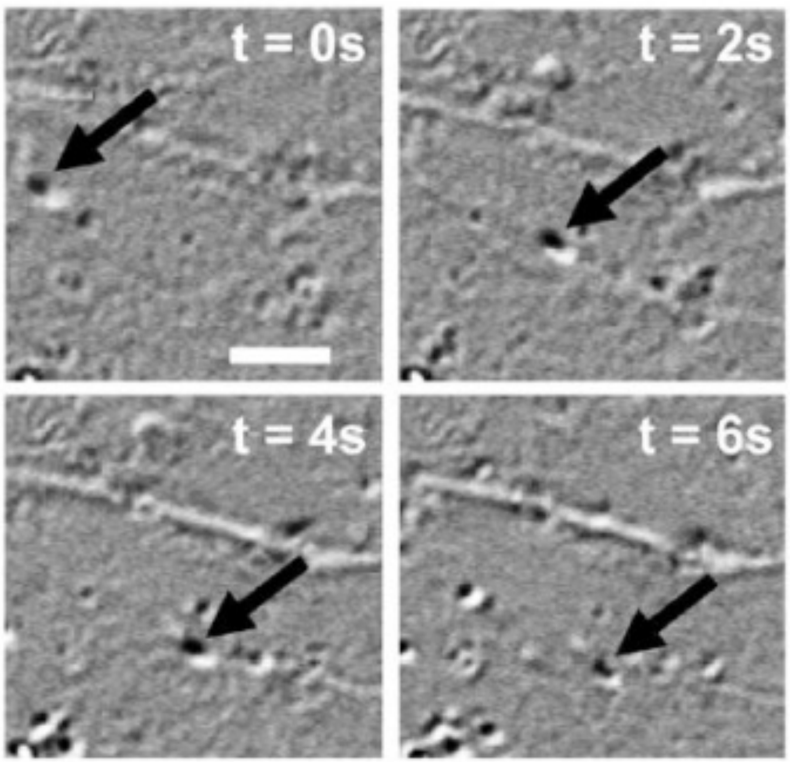

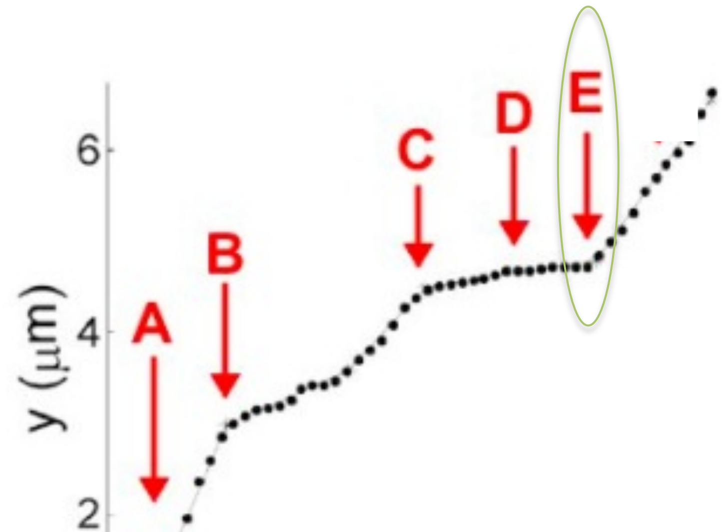

The acceleration tells you about the mangnitude of the force. So it’s the same answer as the acceleration.

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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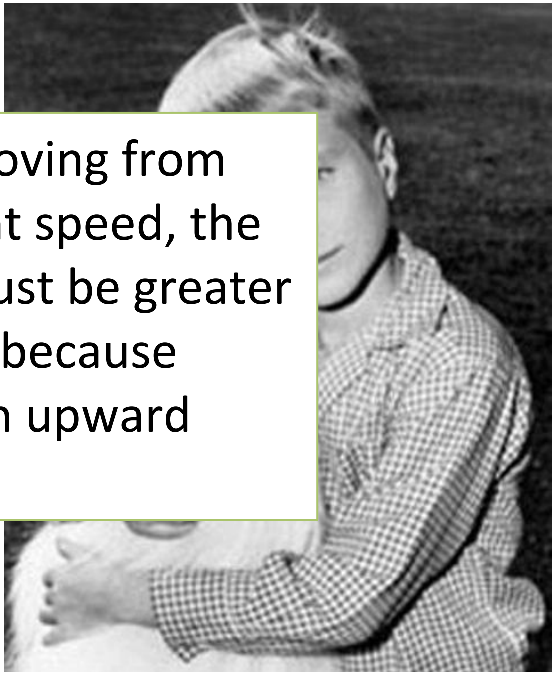

To get Timmy moving from rest to a constant speed, the force exerted must be greater than his weight, because there must be an upward acceleration.

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

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