As you come in today, pull out a piece of paper and respond to the following prompts:

1. Write down 5 things that you value most in your life (these do not need to be school related)
2. Rate these values according to their importance to you personally
3. Write a couple of sentence about your top 3 and why they are important to you

MidSem Feedback

- Exam was different than prep material
  - I've made a "mock exam" and posted in addition to the other exam prep materials
- Exam had so much writing!
  - Practice using math/diagrams/graphs to represent your thinking.
- Exams were different than the homework
  - Yes. Exams are a different kind of assessment.
  - More aligned with class-time where you must justify your reasoning, and less aligned with just "get to the answer" in LON-CAPA

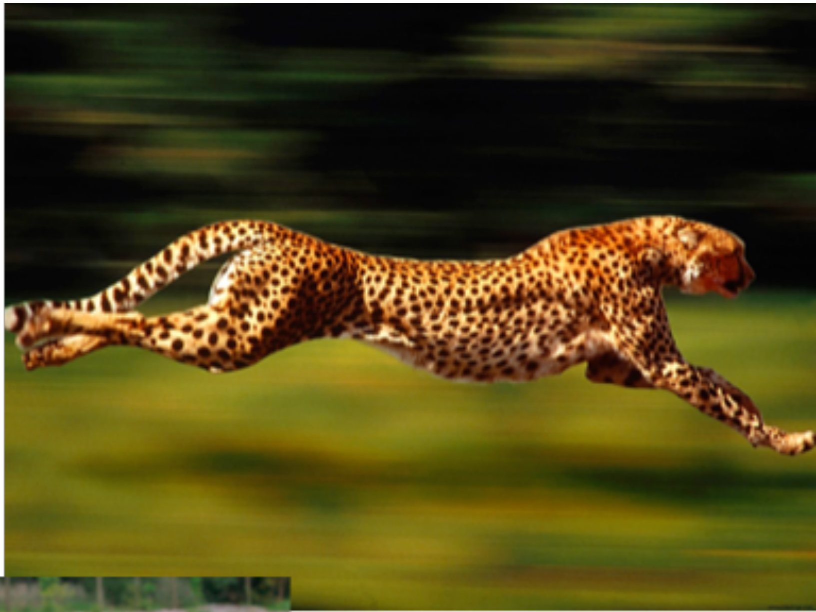
In many of your science classes you talk about "energy."

What is it?

Announcements

- Homework Ch 8 due Monday at midnight
- Reading Q's Ch 10 due Sunday at midnight
- Bring your tutorial book (NOT homework) to class next Wednesday
- Exam 2 is on Monday Oct 27th
  - Will cover material from Ch 6 – 10 (excluding rotational motion parts of Ch 8 & 9)
  - Review session next Wed 7:30pm in C-104
  - Extra office hours next Thurs 6:30pm – 7:30pm

Ch 9 – Work & Kinetic Energy



Energy

- Newton's 2^{nd} Law (or the momentum principle) tells us that a force can change an object's velocity in one of two ways:
  - It can change the speed
  - It can change the direction
- Analyzing changes in speed leads us to study energy.
- Analyzing changes in direction leads us to study rotations. (Next week)

Foothold ideas: Kinetic Energy and Work

- Newton's laws tell us how velocity changes. The Work-Energy theorem tells us how speed (independent of direction) changes.
- Kinetic energy $= \frac{1}{2}mv^2$
- Work-energy theorem tells us how the kinetic energy will change as a result of exerting an external force $W = \Delta KE$

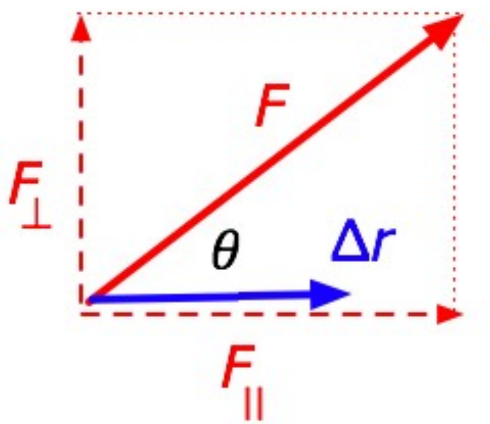
Foothold ideas: Kinetic Energy and Work

- So how do we relate this idea of work back to forces? $W_F = \vec{F} \bullet \vec{\Delta r}$
- The dot product here tells us that direction matters; which we know.
- Work done by a force $W_F = \vec{F} \bullet \vec{\Delta r}$ or $F_{||}\Delta r$

(part of force || to displacement)

Work in another direction: The dot product

- Suppose we are moving along a line, but the force we are interested in in pointed in another direction? (How can this happen?)
- Only the part of the force in the direction of the motion counts to change the speed (energy).



$$\text{Work} = F_{\parallel}\,\Delta r = F\cos\theta\,\Delta r \equiv \vec{F}\cdot\Delta\vec{r}$$

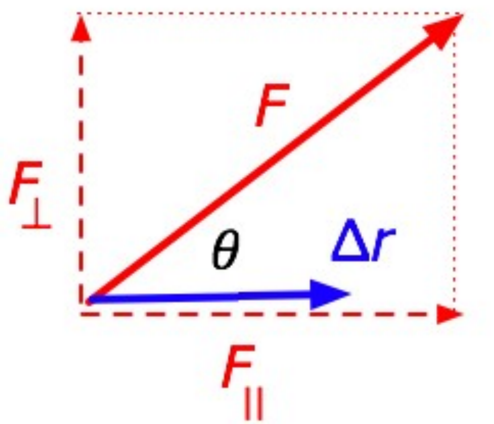
Dot products in general

$$F_{\parallel}\,\Delta r \equiv \vec{F}\cdot\Delta\vec{r} \qquad \vec{F}\cdot\Delta\vec{r} = F\cos\theta\,\Delta r$$

In general, for any two vectors that have an angle θ between them, the dot product is defined to be

$$\vec{a}\cdot\vec{b} = ab\cos\theta$$

$$\vec{a}\cdot\vec{b} = a_x b_x + a_y b_y$$



The dot product is a scalar.
Its value does not depend on the coordinate system we select.

Each row in the following table pairs a force vector with a corresponding displacement resulting in work *W* being done. In which of these rows is the work done zero?

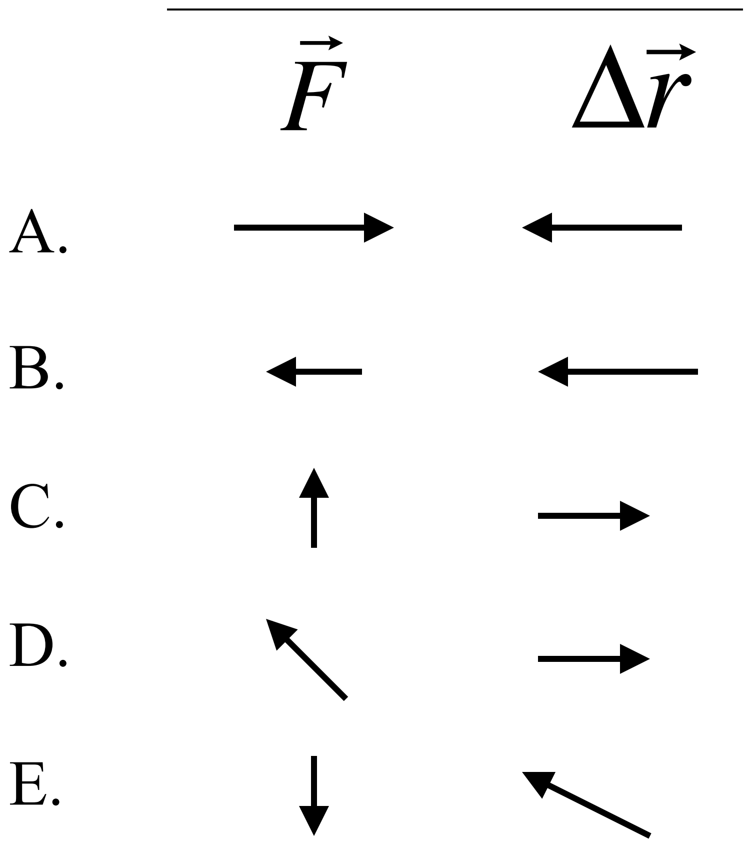
	$\vec{F}$	$\Delta\vec{r}$
A.	→	←
B.	←	←
C.	↑	→
D.	↖	→
E.	↓	↖

Each row in the following table pairs a force vector with a corresponding displacement resulting in work W being done. In which of these rows is the work done zero?

	$\vec{F}$	$\Delta\vec{r}$
A.	→	←
B.	←	←
C.	↑	→
D.	↖	→
E.	↓	↖

The force and the direction of the displacement vector are perpendicular so the work done is 0.

Each row in the following table pairs a force vector with a corresponding displacement resulting in work *W* being done. In which of these rows is the work done positive?



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	$\vec{F}$	$\Delta\vec{r}$
A.	→	←
B.	←	←
C.	↑	→
D.	↖	→
E.	↓	↖

The force and the direction of the displacement vector are in the same direction – so the work is positive.

Starting from rest, two identical boxes are pushed through the same distance. Box A experiences a force F, while box B experience a force 2F. What is true about their final speeds?

A. The final speed of box A is equal to that of box B
B. The final speed of box A is half that of box B
C. The final speed of box A is twice that of box B
D. Something else

Starting from rest, two identical boxes are pushed through the same distance. Box A experiences a force F, while box B experience a force 2F. What is true about their final speeds?

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Since the force on Box B is 2x the force on box A, but all else is the same, the change in the kinetic energy of A is ½ the kinetic energy of B. But the kinetic energy is related to the speed by squaring the speed. So the final speed of box B is √2 the final speed of box A.

The diagram depicts two pucks on a frictionless table. Puck II is four times as massive as puck I. Starting from rest, the pucks are pushed across the table by two equal forces.

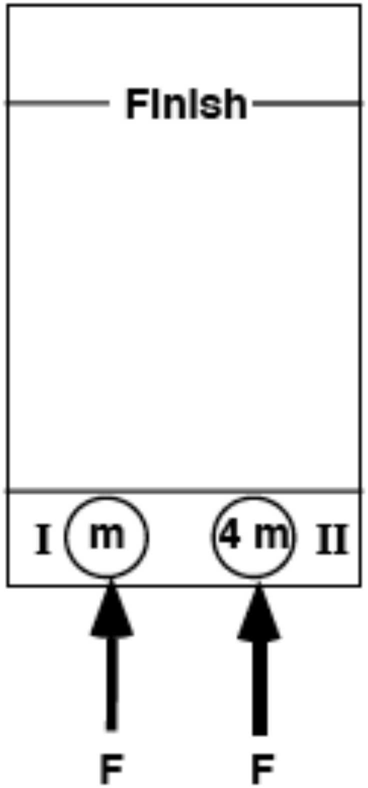
Which puck will have the greater momentum upon reaching the finish line?

A. Puck I

B. Puck II

C. Both will have the same.

D. There is not enough information to decide.



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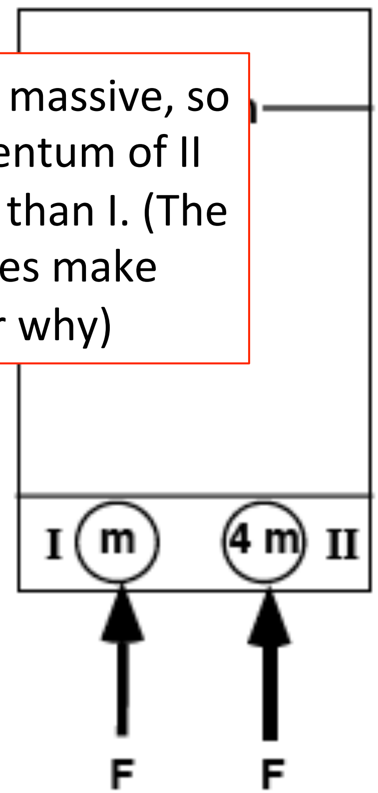
Puck II is more massive, so the final momentum of II will be greater than I. (The next set of slides make this more clear why)



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Which puck reach the finish line first?

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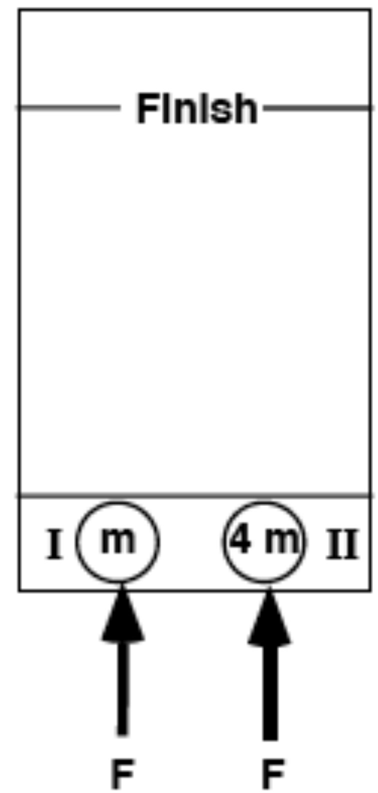

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Which puck reach the finish line first?

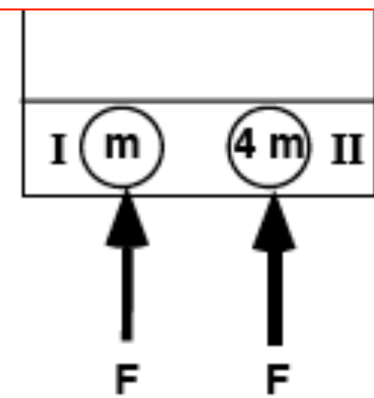
A. Puck I

B. Puck II

C. Both will have the same.

D. There is not enough information to decide.

Since the force is the same, the acceleration of puck I is greater than the acceleration of puck II, which means it will cover the same distance in a shorter amount of time.



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C. Both will have the same.

D. There is not enough information to decide.