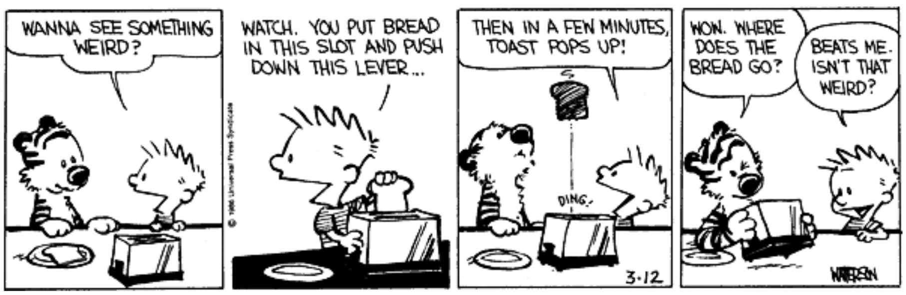
November 21, 2013 Physics 131 Prof. E. F. Redish

- **Theme Music: Cannonball Adderly**

  Work Song

- **Cartoon: Bill Watterson**

  Calvin & Hobbes



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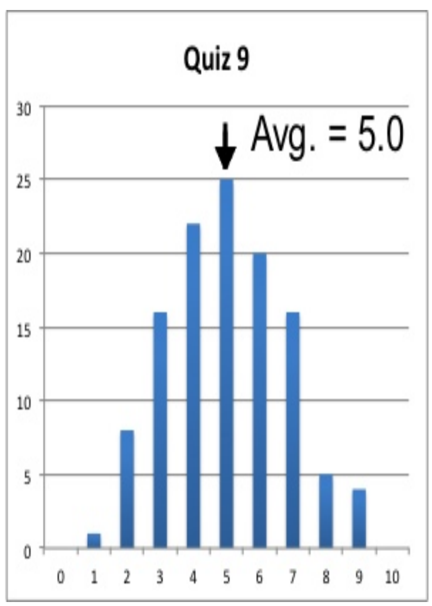
Quiz 9

	1.1	1.2		2	3
A>B>C>D	27%	1%	A	40%	55%
D>C>B>A	12%	96%	B	33%	4%
A=B=C=D	32%	2%	C	10%	21%
B=C=D>A	16%	1%	D	11%	17%
A>B=C=D	3%	0%	E	4%	2%
D>B=C>A	3%	1%			



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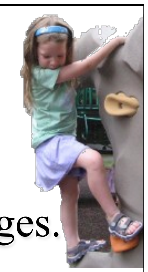
Foothold ideas: Kinetic Energy and Work



- 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 done by a force = $\vec{F}\cdot\Delta\vec{r}$ or $F_{||}\Delta r$ (part of force || to displacement)
- Work-energy theorem: $\Delta(\frac{1}{2}mv^2) = F_{||}^{net}\Delta r$

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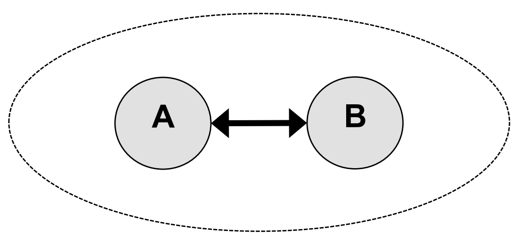
Simplest example:

Consider the motion of two objects during a short time interval while they exert forces on each other.

Momentum change?
Impulse-momentum theorem!

$$\Delta\vec{p}_A = \vec{F}_{B\to A}\Delta t$$

$$\Delta\vec{p}_B = \vec{F}_{A\to B}\Delta t$$



Add and use N3!

$$\Delta\vec{p}_A + \Delta\vec{p}_B = \vec{F}_{B\to A}\Delta t + \vec{F}_{A\to B}\Delta t = (\vec{F}_{B\to A} + \vec{F}_{A\to B})\Delta t = 0$$

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Momentum Conservation!

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Simplest example:

Consider the motion of two objects during a short time interval while they exert forces on each other.

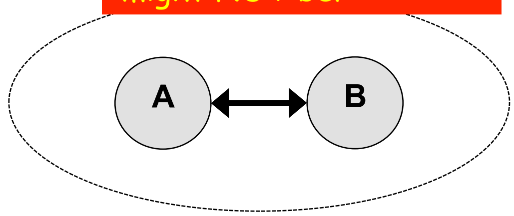
KE change?

Work-energy theorem!

They may each be moving so although the times are the same,the distances might NOT be!

$$\Delta KE_A = \vec{F}_{B\to A} \cdot \Delta\vec{r}_A$$

$$\Delta KE_B = \vec{F}_{A\to B} \cdot \Delta\vec{r}_B$$



Add and use N3!

$$\Delta KE_A + \Delta KE_B = \vec{F}_{B\to A} \cdot \Delta\vec{r}_A + \vec{F}_{A\to B} \cdot \Delta\vec{r}_B$$

$$= \vec{F}_{B\to A} \cdot \left(\Delta\vec{r}_A - \Delta\vec{r}_B\right) \neq 0$$

??!

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Foothold ideas: Potential Energy

- For some forces between objects (gravity, electricity, springs) the work only depends of the change in relative position of the objects. Such forces are called *conservative*.
- For these forces the work done by them can be written $$\vec{F} \cdot \Delta\vec{r}_{rel} = -\Delta U$$
- *U* is called a *potential energy* and can be considered an *energy of place belonging to the two objects that can be exchanged with KE.*

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