November 16, 2012   Physics 131   Prof. E. F. Redish

■ **Theme Music:** **Bruce Springsteen**

   Working on a Dream

■ **Cartoon:** **Pat Brady**

   Rose is Rose

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Energy

■ N2 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.

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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 = $F_x \Delta x$ or $F_{||}\Delta r$ (part of force || to displacement)

■ Work-energy theorem: $\Delta(\frac{1}{2}mv^2) = F_{||}^{net}\Delta r$

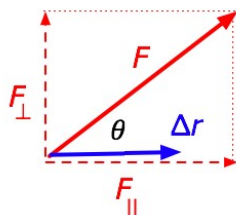11/16/12   Physics 131   **6**

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).

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

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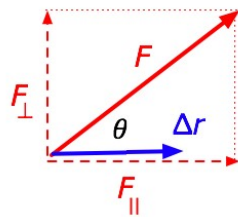
Dot products in general

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

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.

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