November 23, 2015        Physics 131        Prof. E. F. Redish

■ Theme Music: Cannonball Adderly
   Work Song

■ Cartoon: Mike Peters
   Mother Goose & Grimm

11/23/15        Physics 131        1
Mechanical energy conservation

\[ \Delta \left( \frac{1}{2}mv^2 + U \right) = 0 \]
# Quiz 9

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Avg. = 5.0
Basic principle

Starting with an equation is often the right way to solve a qualitative question and remind yourself about basic principles.

\[ A_1 v_1 = A_2 v_2 \]

\[ \Delta p = \left( \frac{8 \mu L}{\pi R^4} \right) Q \]

\[ \vec{F}^{\text{net}} \cdot \Delta \vec{r} = \Delta \left( \frac{1}{2} mv^2 \right) \]
Foothold ideas: Potential Energy

■ For some forces work only depends on the change in position. Then the work done can be written

\[ \vec{F} \cdot \Delta \vec{r} = -\Delta U \]

\( U \) is called a potential energy.

■ For gravity,

\[ U_{\text{gravity}} = mgh \]

For a spring,

\[ U_{\text{spring}} = \frac{1}{2} kx^2 \]

For electric force,

\[ U_{\text{electric}} = k \frac{Q_1 Q_2}{r_{12}} \]
Using Mechanical Energy Conservation

■ If resistive forces can be ignored, mechanical energy is conserved (exchanges with hidden internal energy such as thermal or chemical can be ignored)

\[ KE_i + PE_i = KE_f + PE_f \]

■ \( KE \) may refer to one or more objects

■ \( PE \) may refer to one or more interactions.

■ If only one object’s KE is important and only one interaction matters, this can make things really easy.
Which Energies add to give Total Mechanical Energy?

YES
Potential Energies (Conservative Interactions)

NO
Work done by Interactions that cross System Boundary

YES
Kinetic Energy (in general, all objects)
Foothold ideas:
Energies between charge clusters

■ Atoms and molecules are made up of charges.
■ The potential energy between two charges is

\[ U_{12}^{\text{elec}} = \frac{k_C Q_1 Q_2}{r_{12}} \]

■ The potential energy between many charges is

\[ U_{12\ldots N}^{\text{elec}} = \sum_{i<j=1}^{N} \frac{k_C Q_i Q_j}{r_{ij}} \]