- Last Lecture
  - More Work/Energy
  - Start of Potential Energy
- Today
  - More on Work/Energy including Potential Energy
- Important Concepts
  - Don't double count by including a force in both the Work and the Potential Energy.
  - Don't forget to include the Work term (it is only zero under special conditions).

Important Reminders

- Pset # 6 due tomorrow at 10am.
- Next Mastering Physics deadline is next Monday.
- Exam #2 is next Friday at 10 am.
  - Covers material through today's lecture, tomorrow's problem-solving and Pset, and Monday's MasteringPhysics assignment
- Experiment #4 will be done next Tuesday
- Info on exam and experiment will be posted soon

Checklist to use Work/Energy

- Clearly define what is "inside" your system.
- Clearly define the initial and final conditions, which include the location and speed of all object(s)
- Think carefully about all forces acting on all objects
- All forces must be considered in the Work term or in the Potential Energy term, but never in both.

$$W = \Delta E = E_{Final} - E_{Initial}$$
$$= (KE_{Final} + PE_{Final}) - (KE_{Initial} + PE_{Initial})$$

Potential Energy

- Only applies for a force with special properties (so-called conservative forces):
  - For your purposes, there are very few:
    1. Gravity (both near to and far from the Earth)
    2. Springs
    3. Problems where you don't know the force but are given the Potential Energy explicitly.
  - You are only responsible for knowing the PE for gravity near Earth (Mgh) and option (3) on Exam #2.

Calculating Potential Energy

- For simplicity, the Potential Energy itself (as opposed to the ***difference***) is always defined relative to some reference point where the potential energy is defined to be zero. The location of this point is totally arbitrary because only the change in potential energy is ever important.

$$\text{Define (arbitrarily)} \quad PE(\text{at point A}) = 0$$

$$\text{Then: } PE(\text{at point B}) = -\int_{\text{A}}^{\text{B}} \vec{F} \bullet d\vec{s}$$

Using Potential Energy to Calculate Force

- If: $PE(\text{B}) = -\int_{\text{A}}^{\text{B}} \vec{F} \bullet d\vec{s}$
- Then: $F_x = -\dfrac{d(PE)}{dx} \quad F_y = -\dfrac{d(PE)}{dy} \quad \ldots$
- Given $\boldsymbol{F}$, you can find $\boldsymbol{PE}$ and vice versa.

Potential Energy Diagrams

- PE as a function of position:

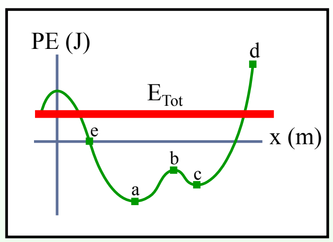

Figure by MIT OCW.

- If there are no other forces doing non-zero Work, then the total energy is a flat line on this plot.
- And the KE is the difference (see next slide).
  - $KE = E_{Tot} - PE$

Potential Energy Diagrams

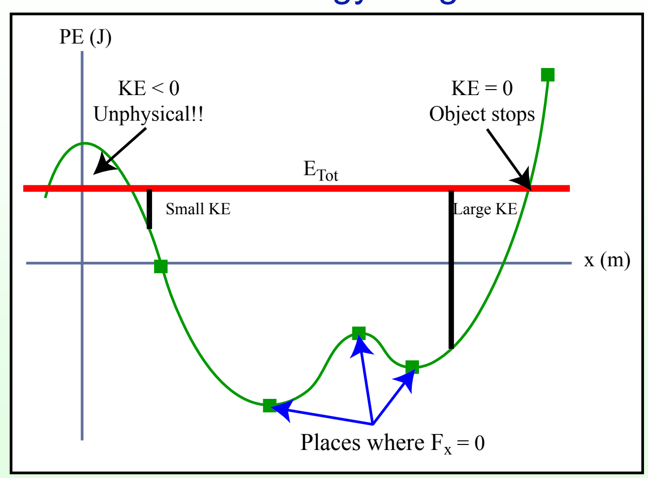

Figure by MIT OCW.