- Last Lecture
  - Combining momentum and energy
- Today
  - 2D collisions
- Important Concepts
  - Momentum is a vector, energy is not.
  - Think carefully about internal versus external forces.
  - Energy changes due to forces along the motion, momentum changes due to external forces acting over a period of time.

Important Reminders

- Pset #7 due Today.
  - Leave it here now or drop it at my office before 6:30pm.
- MasteringPhysics due next Monday.
- Experiment #5 next Tuesday.
- Pset # 8 due next Friday.
- No class tomorrow.

Problem-Solving Strategy 4-steps

- Don't try to see your way to the final answer
  - Focus on the physical situation, not the specific question
- Think through the techniques to see which one (or ones) apply to all or part of the situation
  - Focus on the conditions under which techniques work
- Think carefully about the geometry
  - Here is the one place where lots of practice can help
- Make sure you are efficient in applying techniques
  - Here is one place where memorization can help

Techniques you should know

- Kinematics
  - Position+velocity+acceleration+time
  - Useful for constant acceleration or formulas for x vs t
- F=ma
  - Frequently needed along with other techniques
- Work & Energy
  - Speed at points A & B, PE, known forces along motion
- Momentum
  - Collisions, objects come together or fly apart

Helpful Hints

- Don't memorize special cases (N=mg, for example).
- Think about why things you write are true
  - For example, never write $f=\mu N$ without thinking (or preferably writing down) why that is true
- Draw a careful picture.
- Think about special cases ($\theta=0$, for example) to check that you have the geometry correct.
- Watch out for missing minus signs.

Momentum

- Very simple formula: $\vec{p}_{Tot} = \Sigma\left(m_i \vec{v}_i\right)$
  - Note the vector addition! $\Delta\vec{p}_{Tot} = \int \vec{F} dt$
- Momentum of a system is conserved only if:
  - No net external forces acting on the system.
  - Or, study the system only over a very short time span.
- Collisions in 2 dimensions add another equation for the second component but otherwise are not new.
  - Momentum can be used to find 1 unknown per spatial dimension. Work&Energy can be solved for 1 unknown.