- Last Lecture
  - Newton's Three Laws
- Today
  - More discussion
  - Lots of examples
- Important Concepts
  - Think carefully about what object each force acts on
  - Think carefully about which forces have well defined values and which one you need to calculate from F=ma
  - Think carefully about the acceleration

Important Reminders

- Pset # 3 due Friday at 10am.
- Exam #1 average = 64.
- Final class grade will be on a curve.
- We don't give letter grade equivalents on individual exams. General guidance is:
  - >80 is good, <60 is not good, <45 is poor
- If you want to discuss your exam or general class performance, contact me or your recitation instructor during office hours or by appointment.

Newton's Three Laws

1) If $\vec{v}$ is constant, then $\Sigma\vec{F}$ must be zero and if $\Sigma\vec{F}=0$, then $\vec{v}$ must be constant.

2) $\sum \vec{F} = m\vec{a}$

3) Force due to object A on object B is always exactly equal in magnitude and always exactly opposite in direction to the force due to object B on object A.

Some Advice

- Your instincts are often wrong. Be careful!
- $\sum \vec{F} = m\vec{a}$ is your friend. Trust what it tells you.

Inertial Reference Frames

- These principles only apply for observers who are not accelerating, a so-called "inertial" frame
- There are philosophical objections to this concept since it's hard to precisely define an inertial frame except as one where Newton's Laws are valid
- Alternative formulations are beyond the scope of this course, you don't need to worry about it

Forces you know about (so far)

- Gravity near Earth's surface: |F|=Mg, points "down"
- String tension: Can be given explicitly or implicitly or found from $\sum \vec{F} = m\vec{a}$
  - One example: "String breaks if tension is larger than XX."
- External forces: Can be given explicitly or found from $\sum \vec{F} = m\vec{a}$
- Normal force: Almost always found from $\sum \vec{F} = m\vec{a}$

- Problem Solving Tool:(Revised)Free-Body Checklist
  - Draw a clear diagram of (each) object
  - Think carefully about all of the forces on (each) object
  - Think carefully about the angles of the forces
  - Chose an axis, put it on your drawing
  - Think carefully about the acceleration and put what you know on your drawing
  - Calculate components: $\sum F_x = ma_x$ $\sum F_y = ma_y$ ...
  - Solve…

An Old Friend: Component Checklist

- Loop through vectors, is there a component?
- Is there an angle factor
- Is it sine or cosine?
- Is it positive or negative?

Summary

- $\sum \vec{F} = m\vec{a}$ $\sum \vec{F} = m\vec{a}$ $\sum \vec{F} = m\vec{a}$
- Action-reaction pairs are an important concept in solving problems but need to be considered very carefully, especially the fact that the two forces in the pair act on different objects
- Think carefully about which forces can almost always only be determined using $\sum \vec{F} = m\vec{a}$
  - Typical examples are the normal force and string tension