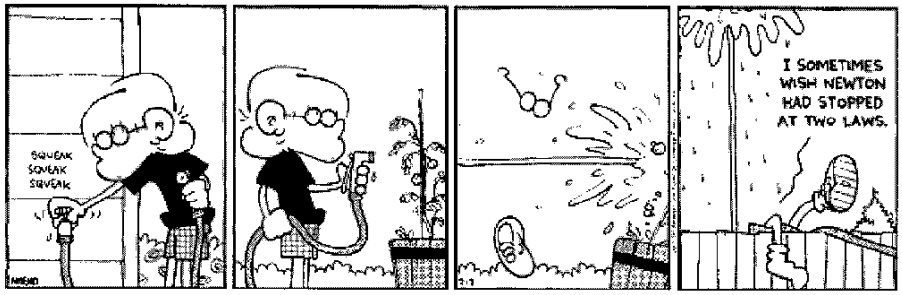
September 23, 2011 Physics 131 Prof. E. F. Redish

- **Theme Music: Runnin' Wild**
  Benny Goodman
- **Cartoon: Bill Amend**
  FoxTrot



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Note for the HW

- Example of estimation using dimensional analysis.
- Consider a ball of mass m being thrown upward with a speed v_0. Can we estimate how long it will be in the air without doing a calculation?
- Parameters: $[m] = M$, $[v_0] = L/T$, $[g] = L/T^2$…? Can you construct a time from these parameters?

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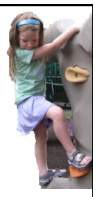
Newton's Laws: Version 0.8



- Newton 0:
  - An object responds to the forces it feels when it feels them.
- Newton 1:
  - An object that feels a net force of 0 keeps moving with the same velocity (which may = 0).
- Newton 2:
  - An object that is acted upon by other objects changes its velocity according to the rule

$$\vec{a}_A = \vec{F}_A^{net} / m_A$$

pForce-labeling convention

- According to our foothold idea, pForces are what objects do to each other when they touch.
- If a pForce is a
  - Normal pForce N
  - Tension pForce T
  - Friction pForce f
  - Weight pForce W
  - Electric pForce F^E
  - Magnetic pForce F^M
- We put subscripts on each force telling *who* is acting on *whom*.

$$\vec{F}_{\text{(object causing force)}\rightarrow\text{(object feeling force)}}$$

We can learn a lot about our forces from our principles –

without knowing a lot about our forces!

Free-Body Diagrams: Procedure

- This allows us to keep careful track of both N0 and N2.
- For each object in the system being considered, we
  - draw a dot representing the object
  - find all the objects touching it
  - draw arrows starting at the dot in the direction of the forces, with lengths indicating the approximate relative size of the forces
  - label each force according to our convention

Newton's 3rd Law

- When two objects touch each other, each exerts a force on the other.
- pForces are interactions between objects.
- In order for our analysis to be consistent, when two objects interact, the pForces they exert on each must be equal and opposite.
- This must be tested experimentally.
- Strangely enough, it works!

$$\vec{F}_{A\to B} = -\vec{F}_{B\to A}$$

Does N3 always hold?

- You will be checking N3 for some cases of normal forces in tutorial next week and it will always work.
- For tension and friction forces we could also do the experiment and see that it works.

*It will work for **every** case until we get into systems where more than two-bodies interact at the same time- for example when radiation (e.g., light) is emitted.*