August 31, 2012 Physics 131 Prof. E. F. Redish

- **Theme Music:** **Paul Simon**
  When numbers get serious
- **Cartoon:** **Bill Waterson**
  Calvin & Hobbes

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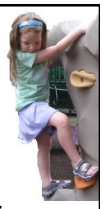
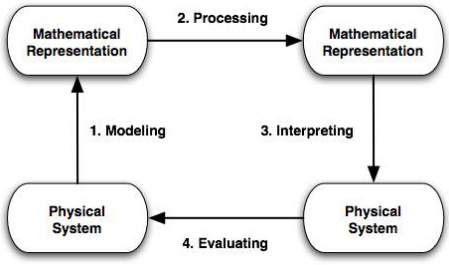
Foothold ideas: Modeling the world with math



- We use math to model relationships and properties.
- From the math we inherit ways to process and solve for results we couldn't necessarily see right away.
- Sometimes, mathematical models are amazingly good representations of the world. Sometimes, they are only fair. It is very important to develop a sense of when the math works and how good it is.
- Mostly, the math we use differs in important ways from the math taught in math classes.



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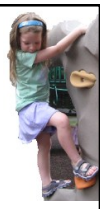
Dimensions and units

- We assign numbers to physical quantities by measurement.
- Each kind involves an arbitrary choice of scale.
  - Different types ↔ **dimensions**
    - Distance, time, mass, …
  - Equations that represent physical relationships must maintain their equality even when we change our arbitrary choice.
- The quantity we create by adding a unit is NOT just a number but a blend.

Foothold ideas: Dimensional and unit analysis



- We label the kinds of measurement that go into assigning a number to a quantity like this:

[x] = L	means “x is a length”
[t] = T	means “t is a time”
[m] = M	means “m is a mass”
[v] = L/T	means “you get v by dividing a length by a time

- Units specify which particular arbitrary measurement we have chosen.
  - Units should be manipulated like algebraic quantities.
  - Units can be changed by multiplying by appropriate forms of “1” e.g. 1 = (1 inch)/(2.54 cm)

Foothold ideas: Dimensional analysis

- In physics we have different kinds of quantities depending on how measurements were combined to get them. These quantities may change in different ways when you change your measuring units.
- Only quantities of the same type may be equated (or added) otherwise an equality for one person would not hold for another. Equating quantities of different dimensions yields nonsense.
- Dimensional analysis tells us *how* something changes when we either
  - Change our arbitrary scale (passive change)
  - Change the scale of the object itself (active change)

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Foothold Ideas: Estimation – Quantifying experience

- **Measure your body parts**
- **Don't** look up data online or get it from friends!
- **Don't** use your calculator! Use 1-digit arithmetic
- **Do** figure out your estimations by starting with something you can plausibly know and scale up or down
- **Do** check your answer to see if it's reasonable
- **Do** learn a small number of Useful numbers

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My personal scales

	inches	centimeters
First digit of thumb		
Open handspan		
Forearm (cubit)		
Full height