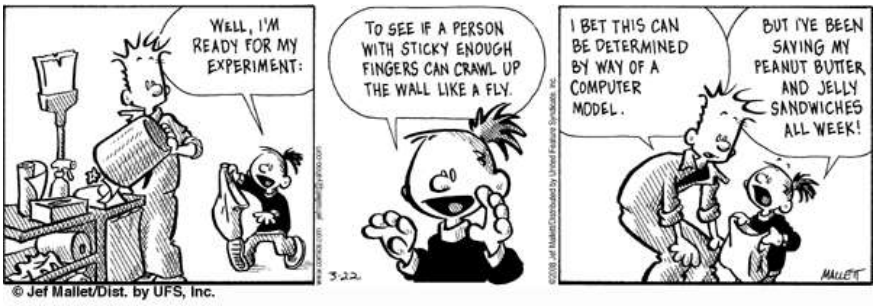
September 26, 2011 Physics 131 Prof. E. F. Redish

■ Theme Music: The Grateful Dead

When Push Comes to Shove

■ Cartoon: Jef Mallet

Frazz



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Outline

- Quiz 3
- Recap of Newton's laws
- Examples
- Springs
- Normal forces
- Examples

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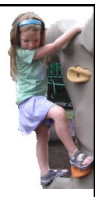
Newton's Laws: Version 1.0



- 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 $\vec{a}_A = \vec{F}_A^{net} / m_A$
- Newton 3:
  - When two objects interact the forces they exert on each other are equal and opposite. $\vec{F}^{type}_{A\to B} = -\vec{F}^{type}_{B\to A}$

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Kinds of pForces

- 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
- Notation convention.

$\vec{F}$ type of force
(object causing force)→(object feeling force)

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Question on the reading

- When gravity is acting in an object at rest (such as the object sitting on the table), is the normal force always the same size as the force of gravity to balance it out?

Question on the reading

- When you said "But what is really important is that the Newton's law equations for a mass being pulled by a spring described an oscillation" are you also including Hooke's law? Or are you saying Hooke's law is derived from Newton's laws? Because if not, it seems kind of random to mention it if it doesn't directly tie in.

Question

- I guess I'm still in the line of thinking in which 'forces balancing' means they cancel each other out and there is no movement. I still see it as movement being a consequence of the magnitude of force in one direction being greater than the force in the direction opposing it (me pushing harder on the block on the table than friction and the block on me).

The Newtonian Framework helps us learn to see “hidden” pForces

- Contact forces are often hard to measure directly.
- We infer them from the Newtonian principles.
- Consistency is a good test as to whether our model of invisible forces is good (and sometimes we can actually measure them)

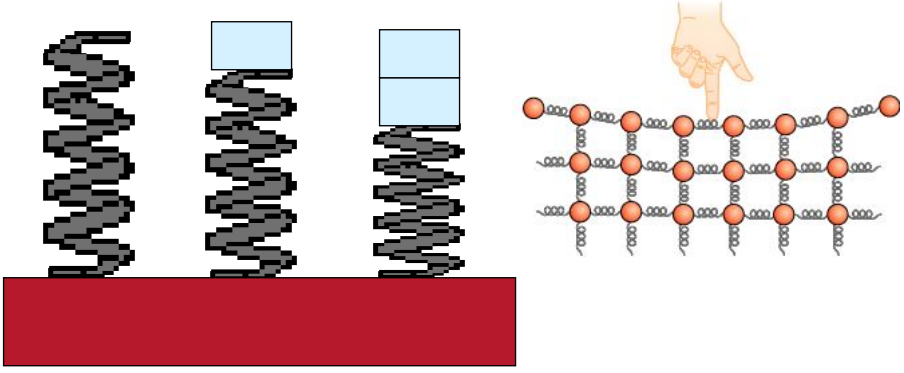
Springs

- If you pull on a spring from both sides it changes its length.

$$T = k\Delta L$$

("ΔL" = stretch or squeeze)

Normal Force works like a very stiff spring



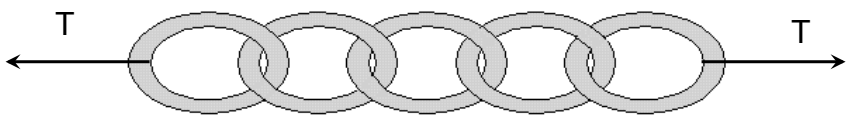
Tension: The Spring

- Recall what we have learned about a spring.
- A spring changes its length in response to pulls (or pushes) from opposite directions.

$$T = k\,\Delta l$$

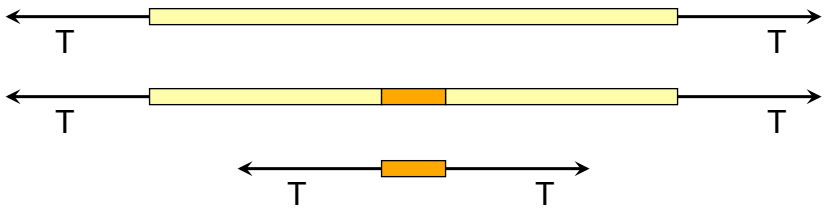
Tension: The Chain

- Consider a series of links of chain being pulled from opposite directions. What are the forces on each link?



Tension: The String

- A string is like a thin chain, but without easily identifiable links.
- We can imagine the string in parts and consider how each part acts on the others.



Tension: Scalar vs. Vector

- Note we are using the word "tension" in two distinct ways!
- The "tension" in a spring, chain, or string has no direction (or rather, both directions at once). It is a tension scalar.
- When tension appears at the end of a spring, chain, or string, the choice of end gives us a direction and lets us create a tension force.