

September 21, 2011

Physics 131

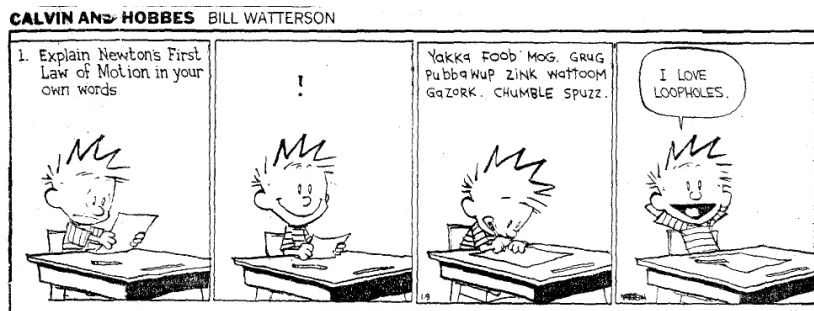
Prof. E. F. Redish

■ Theme Music: Movin' Out

Billy Joel

■ Cartoon: Bill Watterson

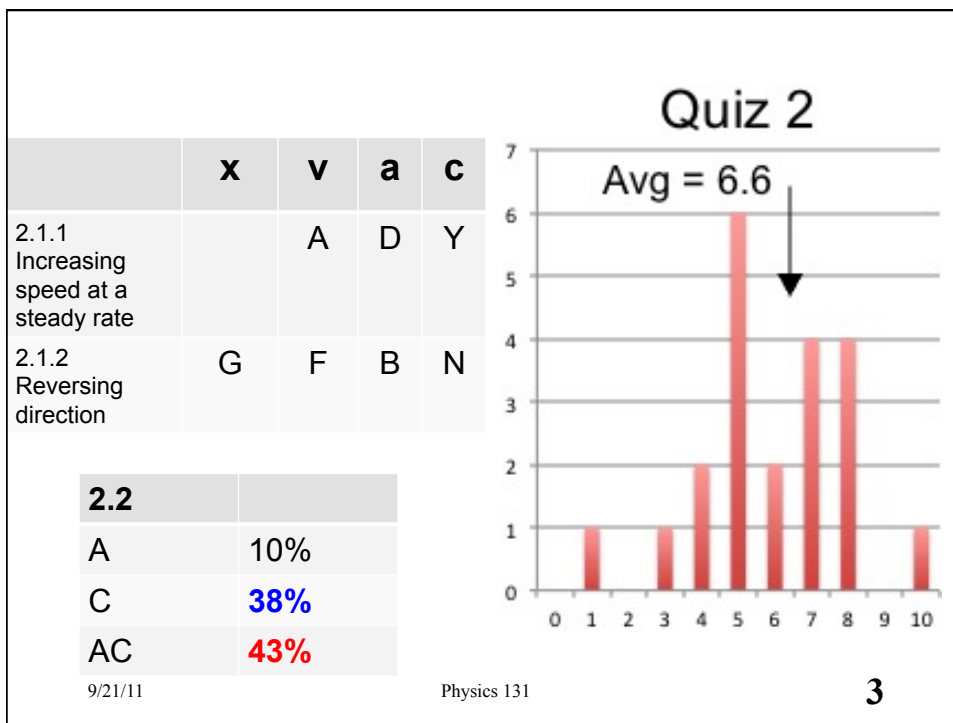
Calvin & Hobbes



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A Question: Why did I do that?

- “What does it mean to write an equation such as $\Delta x = \Delta v$ and then $\Delta v = \Delta x$. Should we then conclude that $\Delta x = \Delta v$? Do you mean we should pick one of these to test and then if we can prove it wrong, we should pick the other one? It seems impossible that both could be correct.”

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Conceptual ideas underlying Newton's Laws 1-3

1. Objects respond only to influences acting upon them at the instant that those influences act.
(Object egotism)
2. All outside effects on an object being equal, the object maintains its velocity (including direction). The velocity could be zero, which would mean the object is at rest. (Inertia)
3. Every change in velocity an object experiences is caused by the object interacting with some other object – **forces**. (Interactions)

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Conceptual ideas underlying Newton's Laws 4-6

4. If there are a lot of different objects that are interacting with the object we are considering, the overall result is the same as if we add up all the forces as vectors and produce a single effective force -- the **net force**. (Superposition)
5. When one object exerts a force on another, that force is shared over all parts of the structure of the object. (Mass)
6. Whenever two objects interact, they exert forces on each other. (Reciprocity)

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Making it quantitative: Some additional ideas

- When an object feels multiple forces they add like vectors and it's the resultant that determines the object's acceleration.
- Forces in one direction only affect the motion in that direction (so x-forces affect x-acceleration, y-forces affect y-acceleration).

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

$$\vec{F}_A^{net} = \vec{F}_{B \rightarrow A} + \vec{F}_{C \rightarrow A} + \vec{F}_{D \rightarrow A} + \dots$$

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Foothold Ideas

Newton's Laws: Version 0.8



- Newton 0:
 - Objects only feel forces when some other object interacts with them. An object responds to the forces it feels at the time that 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 $\vec{a} = \vec{F}^{net} / m$

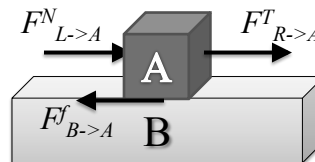
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Kinds of forces

- Touching:
 - Normal (N)
 - Tension (T)
 - Resistive (f)
- Non-touching (action at a distance)
 - Weight (W)
 - Electric (E)
 - Magnetic (M)



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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 we label it as N
 - Tension pForce we label it as T
 - Friction pForce we label it as f
 - Weight pForce we label it as W
- We put subscripts on each force telling *who* is acting on *whom*.

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

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