Physics 4810 / 7810 Week 5 - Learnin!

Day 10: Fa2008:
Knowledge in Pieces

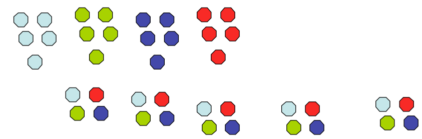
Application to Newton, Dynamics and N3

PER@C

Jigsaw Approach

(i) Form groups of disciplinary expertise

(ii) Jigsaw / regroup into distributed expertise in order to solve broader problem



Redish Jigsaw

1) What are our goals for physics instruction?

2) What is social learning? Does it include lecture? Does technology affect it?

3) How can we teach students "how to use multiple representations and pick out the significant pieces of information from a problem?"

4) How do these theories of memory apply to teaching and learning?

5) What's better, bridging or cognitive conflict? What are their advantages/disadvantages? How would we implement bridging in tutorials?

Broad Question (from Redish)

Broad Question 1: We've seen evidence that *Tutorials* are very effective at teaching physics concepts. Why?

b) Is it because they're "well-written"? Is it because they encourage social learning? Is it the extra time spent?

a) Should we scrap lectures and focus on tutorials? Is it too expensive? Will it just be the "blind leading the blind", and therefore produce improper learning? What about un-social students?

diSesssa Jigsaw

1) Can you think of possible p-prims you have used or encountered? Have you ever had your p-prims challenged by instruction and learned as a result?
2) Is physics simply a way of reorganizing, clarifying, and expressing p-prims?
3) DiSessa notes a number of differences between p-prims and logic. Do you agree with his contrasts between the two? Are p-prims not logical?
4) How does the second section of the paper (on dinosaur cartoons) relate to the first? Why are these two sections in the same chapter?
5) Has anyone experienced one of diSessa's "rare events" that sparked your interest in physics in particular and science in general? Has anyone not experienced one of these events? If not, what got you interested in math and science?

Broad Question (from diSessa)

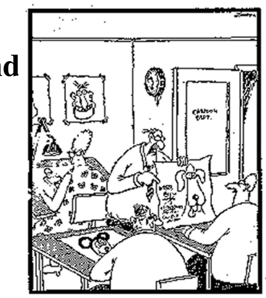
Broad Question 2: How do you make use of *p-prims* and *rare events* in the classroom?

DiSessa

- What is the relationship between a p-prim and a conception? Is conception some sort of higher-level knowledge than a p-prim (i.e. is it made out of them?)? I would like to learn more about these p-prims and look into regorous studies on their properties and how we develop them.

September 10, 2001 Physics 121 Prof. E. F. Redish

- **<u>Theme Music:</u>** **David Hildebrand** ***The Motion Detector Rag***
- **<u>Cartoon:</u>** **Gary Larson** ***The Far Side***



"Hey! What's this, Higgins? Physics equations?... Do you enjoy your job here as a cartoonist, Higgins?"

Doing Science: Tools for Building Knowledge

- Science is a process that studies the world by:
  - Limiting the focus to a specific topic (***making a choice***)
  - Observing (***making a measurement***)
  - Refining Intuitions (***making sense***)
  - Extending (***seeking implications***)
  - Demanding consistency (***making it fit***)
  - Community evaluation and critique

Making a choice

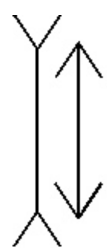
- Chosing a chanel on cat television
- Relates to the questions we are asking

Making a Measurement (and sense)

- We think we see the world around us, but ...
- How do we know we see things the same? (reliable)
- How do we know that we see things correctly? (valid)
- Our own VR:
  - We gather info through our senses
  - Our brains interpret these stimulae
  - But don't necessarily get them right

Making a measurement

- Do these line segments look the same?
- Are they?



Making Sense

- What is this?
- Hint: it's an animal
- Hint][: it's not oriented correctly

Hmmmm….

- Does this help?

Making sense of physics

- Does this look like dots
- Or deep relations of electric forces

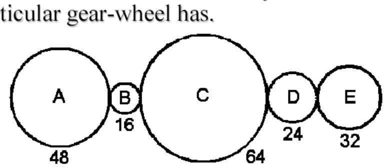
$$\vec{F}_0 = \frac{1}{4\pi\varepsilon_0} \sum_{i=1}^{N} \frac{q_0 q_i}{\left|\vec{r}_i - \vec{r}_0\right|^3} (\vec{r}_i - \vec{r}_0)$$

Seeking Implications

- Elaboration -- when we assume one thing it is bound to have implications beyond the exact case we are considering.
- Figuring out what something implies is a good way to examine the thing itself
- And develop MODELS which are applicable beyond our immediate case

Elaboration

- The drawing shows a chain of five gear-wheels, identified as **A** to **E**, each one meshing properly with its immediate neighbour(s). The number under each one show how many teeth that particular gear-wheel has.



- When **A** is turned clockwise ten full turns, **in which direction does E turn, and how many times?**

Seeking consistency / Making a Fit

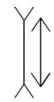
- Science seeks consistency in patterns
- Want our principles to be as broad as possible
- Breadth depends upon the state of what we know
- Physics has been around for quite some time and hence, developed a high degree of consistency.

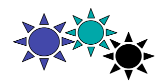
The puzzle analogy

- Seek consistency
- Patterns fit
- Lack of consistency leads to frustration
- The same is true in physics

Next steps… summary cues

- Making a choice
- Making a measurement
- Making sense
- Elaboration
- Coherence

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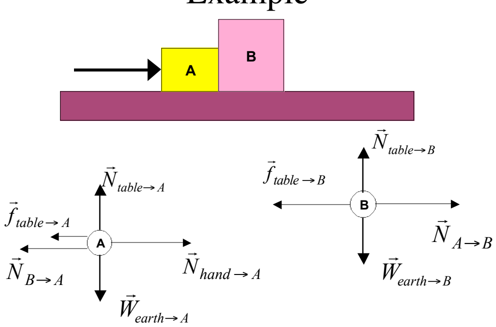
- **<u>Theme Music:</u> Indigo Girls** ***Galileo***
- **<u>Cartoon:</u> Pat Brady** ***Rose is Rose***

Outline

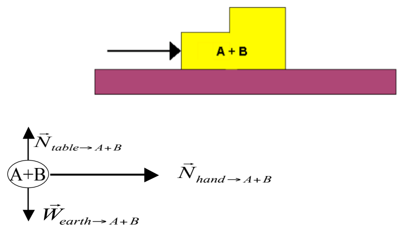
- Recap of Free-Body Diagrams
- Working out the implications
- Newton's 3rd Law
- Reviewing Newton's Laws

Example



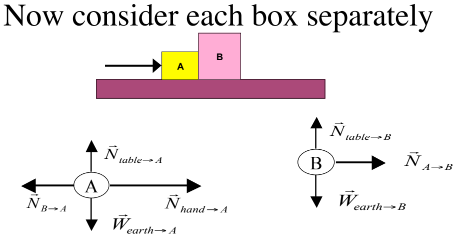
Implications!
"If that's true, then…"

- Consider the example above. If we assume no friction, how does the pair of blocks speed up?
- Consider them first as a single system. The problem is much simpler then.
- Afterwards, lets consider it as two separate blocks. What does the result of treating it as a single system tell us?



$$m_{A+B}\vec{a}_{A+B} = \vec{N}_{hand\to A+B}$$

Now consider each box separately



$$m_A\vec{a}_A = \vec{N}_{hand\to A} + \vec{N}_{B\to A}$$

$$m_B\vec{a}_B = \vec{N}_{A\to B}$$

Compare the equations!

- All the accelerations must be the same.

$$(m_A + m_B)\vec{a} = \vec{N}_{hand\to A}$$

$$m_A\vec{a} = \vec{N}_{hand\to A} + \vec{N}_{B\to A}$$

$$m_B\vec{a} = \vec{N}_{A\to B}$$

$$(m_A + m_B)\vec{a} = \vec{N}_{hand\to A} + \vec{N}_{B\to A} + \vec{N}_{A\to B}$$

A serious implication

- In order for our treatment of the two objects as a system and as separate parts to be the same we must conclude:

$$\vec{N}_{B\to A} + \vec{N}_{A\to B} = 0$$

or

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

Newton's 3rd Law

- When two objects touch each other, each exerts a force on the other.
- Forces are <u>interactions between objects</u>.
- In order for our analysis to be consistent, when two objects interact, the forces 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?

- We were able to check N3 for a lot of cases of normal forces in tutorial last week and it always worked.
- Test it!
- For tension and friction forces we could also do the experiment and see that it works.
- For gravity (and electricity and magnetism) things are a bit more subtle.
  - We can't really measure the effect of small objects pulling up on the earth (but they could be there).