In Class Activity Plan
Week 11: Finishing Friction & Investigating Momentum

Homework: Full Model with Friction (Word, Pdf)
Note: You probably want to start this problem in class. They've got a lot of tools/representations to work with at this point, and probably could use some help coming up with them all. The goal in this problem is to represent the motion using every tool/representation we have thus far (e.g. energy pie charts, force diagrams, kinematic graphs)

30 min **Whiteboard - Pushing Boxes Static Friction (Word, Pdf)**
PURPOSE: Practice modeling situation with static friction.

15 min **Board Meeting**
PURPOSE: Build consensus on use of static friction in models.

15 min **Whiteboard - Box Held on Wall (Word, Pdf)**
PURPOSE: Practice modeling situation with static friction.
Video Example: (Boarding)

10 min **Board Meeting**
PURPOSE: Build consensus on use of static friction in models.

30 min **Whiteboard - Box on a Wall with Angle (Word, Pdf)**
PURPOSE: Practice modeling situation with static friction.
Video Examples: (Boarding1, Boarding2)

15 min **Board Meeting**
PURPOSE: Build consensus on use of static friction in models.
Video Example: (Discussion)

75 min **Investigating Collisions Lab (Word, Pdf)**
PURPOSE: Investigate momentum conservation
Video Examples: (Investigating1, Investigating2, Investigating3)
Notes:

- This lab should be quick because they've already done a similar lab with Newton's Third Law (Investigating Forces Part 2.doc)
- Note that there are two motion detectors in this lab set up on either end of the track. This is a case where using the bigger tracks can be useful.
- They will default to doing similar labs as to what they did with Newton's Third law, but you should encourage including the following experiments:
    - A thorough study of mass. Vary the proportions of mass on the carts.
    - A thorough study of velocity. Directions, speeds, etc.

- Magnets bouncing off magnets
- Velcro sticking to Velcro
- Cars at rest together, then pop the spring and fly apart

SEED:

- It looks like car 1 is transferring something to car 2, what is it?
  - They will suggest energy, have them check it (Velcro to Velcro is a great example)
  - Think about the ratios of masses and speeds
  - Lead them to mv = mv
  - Momentum vectors as a tool
- Sometimes kinetic energy is conserved, can we find out the conditions?
  - Elastic and inelastic collisions

15 min **Whiteboard - Investigating Collisions Lab**

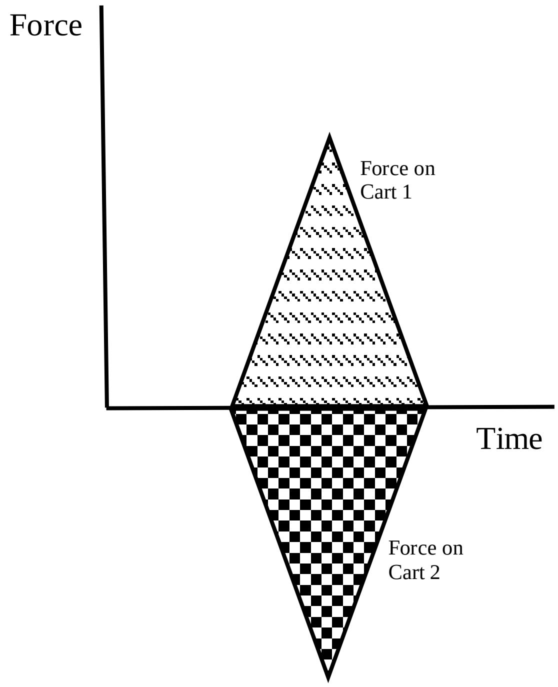
PURPOSE: Report results of investigations of momentum conservation
Video Examples: (Boarding1, Boarding2)

- What did you learn?
- What rules can you make?
- What questions do you still have?

60 min **Board Meeting**

PURPOSE: Introduce momentum conservation as a law that governs all models, introduce impulse and relate to Newton's 3rd law.
Video Example: (Discussion)
Goals:

- Something is being conserved, what is it?
  - Momentum is the same before the collision and after the collision.
  - $\vec{p} = m\vec{v}$
- New tool – momentum vectors
- Difference between elastic/inelastic collisions
- Impulse *Note: This discussion is led by the instructor, but can be done in the center of the discussion circle.*
  - We've already done this lab in the Newton's Third Law lab, what did the force graph look like during the collision?



    - *Note: Really are just recalling this, don't need to put them to put the force probe on the carts.*
    - Notice that the curves are curvy and the force car 1 reads is opposite of the force car 2 reads
- What is the area under each of these curves?
    - The same
    - What's the same in these collisions?
    - So the area must tell us something about momentum
        - So the change in momentum for each of the carts must be the same
    - What are the units of the area (N*t = kg m/s)
- Define Impulse
    - $\vec{I} = \Delta\vec{p}_{car1} = \int \vec{F}_{net\rightarrow car1}dt$
    - Notice the vectors
        - So having a negative impulse would meant that the change in momentum is in the negative direction