In Class Activity Plan
Week Nine: Investigating Forces Part II

So it turns out that the plan from week 8 was a little more than a single week could hold, so we're still doing some of that stuff.

20 min **Practice with Force Diagrams (Word, Pdf)**
PURPOSE: Practice making, using, and interpreting force diagrams in conjunction with system schema.
Notes:
- Have them draw two different system schema for each of the similar situations, particularly for the ball leaving the hand problem
- This is a reasonable worksheet to give as a homework as well

10 min **Board Meeting**
PURPOSE: Build consensus on the practice of making, using and interpreting force diagrams in conjunction with system schema.
Video Examples: (Discussion1, Discussion2)
- System schemas should have an arrow for every interaction
  - So the case where the ball is no longer in the hand, there is no interaction between the ball and hand and thus there can't be any force
  - Watch for students trying to put 2 labels on a single arrow!
- System schema and Force Diagrams should be consistent with each other
  - F_{net} is the direction of the acceleration
  - Directions are important

20 min **Whiteboard – Scales in an Elevator (Word, Pdf)**
PURPOSE: Gain experience reasoning conceptually with force diagrams.
Video Examples: (Boarding1, Boarding2, Boarding3)
Note: Probably want to whiteboard this, watch for same things as above. Emphasis on the direction of the acceleration matching the direction of the F_{net}

20 min **Board Meeting**
PURPOSE: Gain experience reasoning conceptually with force diagrams.
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15 min **Whiteboard - Newton's Second Law Variations on a Theme problem #1 (Word, Pdf)**
PURPOSE: Practice modeling phenomena with new law, N2, and new representational tools.

Notes: They will try *very* hard to just answer the question without making a model

10 min **Board Meeting**
PURPOSE: Build consensus about modeling phenomena with new law, N2, and new representational tools.

15 min **Whiteboard - Newton's Second Law Variations on a Theme problems #2 & 3 (Word, Pdf)**
PURPOSE: Practice modeling phenomena with new law, N2, and new representational tools.
Notes: Split up #2 & #3, have half of the class do one and the other half do the other.
Individual Problem notes:
- #1 - #3: All the same situation
  - Why bother? – Different quantities are given so we can find certain other quantities
  - It's always the same system schema and force diagram

10 min **Board Meeting**
PURPOSE: Build consensus about modeling phenomena with new law, N2, and new representational tools.
Video Examples: (Discussion)

25 min **Whiteboard - Newton's Second Law Variations on a Theme problems #4 or 5 (Word, Pdf)**
PURPOSE: Practice modeling phenomena with new law, N2, and new representational tools.
Notes: Split up #4 & #5, have half of the class do one and the other half do the other.

20 min **Board Meeting**
PURPOSE: Build consensus about modeling phenomena with new law, N2, and new representational tools.
Video Examples: (Discussion1, Discussion2)
Notes on each problem
#4 They don't like the force from the rope on the child, and will try to put the force of the child on the rope in their force diagrams
#5: Using energy to get the velocities is a lot simpler. There are two parts to this problem (the way up and the way down)

Homework: **Box on Box Problem (Word, Pdf)**
Note: You will come back to this homework at the end of the upcoming lab. So it's important that it is assigned before finishing the Newton's 3rd Law Lab.

60 min **Newton's 3rd Law Lab: Investigating Forces Part Two (Word, Pdf)**

PURPOSE: Introduce Newton's third law to models
Technical Notes:

- Have the students open the file for Newton's Third Law in Logger Pro
  - Logger Pro → Experiments → Physics with Vernier → 11 Newtons Third Law.cmbl
  - (This automatically has one of the force sensors with direction reversed so that you get positive values for one and negative for the other)
- Remember to calibrate the force sensors upon plugging them into the LabPro
  - Go to: Experiment → Calibrate → Calibrate Now →
    - (1) Enter 0N into the box when nothing is on the hook of the force sensor → Press KEEP
    - (2) Enter 9.8N into the box with a 1kg mass hanging from the force sensor → Press KEEP
- The force probes on the carts need to have the wide stoppers on them so that when they collide together, they actually push evenly on the stopper.
- The sampling rate should be increased to at least 500 samples/sec
  - Go to Experiment → Data Collection… →Sampling Rate

20 min **Whiteboard**

PURPOSE: Describe results of Newton's 3rd Law Lab
Video Examples: (Boarding1, Boarding2)

- What did you learn?
- What rules can you make?
- What would you say to your friend about the SUV argument?

45 min **Board Meeting**

PURPOSE: Synthesize results of Newton's 3rd Law Lab; introduce N3 to as law that models must obey.
Video Examples: (Discussion)
Goals:

- System schema for each different set-up
  - The force sensors measure the contact interaction in the schema
  - Each sensor reads one force, but it is the same interaction (2 forces for each interaction)
- Newton's 3rd Law: "For each interaction, there are two forces one on each object, the forces are equal in magnitude and opposite in direction."
- Rethink your box on box problem, carefully label each force, what is the same?
- Define Newton 3rd Law pairs as: the two forces that describe the same interaction

25 min **Whiteboard - Identifying Newton's 3rd Law Pairs (Word, Pdf)**
PURPOSE: Integrate N3 into use of force diagram representational tool.

20 min **Board Meeting**
PURPOSE: Build consensus about integration of N3 into use of force diagram representational tool

60 min **Whiteboard - Practice with doing Force Problems**
PURPOSE: Build consensus about modeling phenomena with Newton's laws, new representational tools, integrating force with other approaches to modeling phenomena.