In Class Activity Plan
Week 13: Investigating Spring Forces & Circular Motion

90 min

Investigating Spring Forces (Word, Pdf)
PURPOSE: Investigate situation that can't be modeled with constant acceleration, introduce Hooke's Law; introduce relationship between forces and energy.
Video Example: (Predictions)
Technical Notes:

- The force sensors need to have their direction reversed so that both the motion sensor and the force sensor see the same direction as positive
- We probably want each group to have a different spring
- They're going to be coming back to energy at the end of this lab using the force versus displacement graph and the energy stored in the spring

SEED:

- Consider the situation of a person just constantly stretching the spring
    - Draw pie charts for this situation
    - Where does the energy from the person go?

10 min

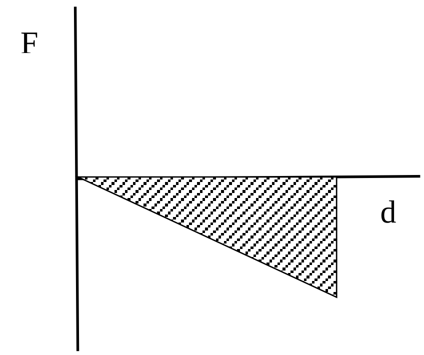
Whiteboard Investigating Spring Forces
PURPOSE: Summarize results of investigation
Video Examples: (Boarding1, Boarding2)

1) What did you learn?
2) What rules can you make?
3) What questions do you still have?

45 min

Whiteboard Discussion
PURPOSE: Investigate situation that can't be modeled with constant acceleration, introduce Hooke's Law; introduce relationship between forces and energy.
Video Example: (Discussion)
Goals:

- Hooke's Law
    - $\vec{F} = -k\vec{d}$
    - The slope of the F vs d graph is the spring constant
- Energy stored in the spring
    - Consider the units of the area under the F vs d curve (get to energy stored in the spring)
    - Need to point out this is negative (and makes sense b/c the integral is negative)



20 min **Whiteboard - Spring problems (2): Compression Spring (Word, Pdf) & Crates from a spring (Word, Pdf)**
PURPOSE: Practice modeling situations using Hooke's law, integrating non constant acceleration situations into existing models.
Note: Do one in class and assign the other for homework

25 min **Board Meeting**
PURPOSE: Build consensus around modeling situations using Hooke's law, integrating non- constant acceleration situations into existing models.
Video Examples: (Boarding1, Boarding2, Boarding3)

40 min **Instructor led discussion - Thinking about circular motion**
PURPOSE: Introducing circular motion, special type of constant a modeling.
Video Example: (Four perspectives)
Using bowling balls and rubber mallets:

- Ask the students, how would you have to hit the ball in order to get it to move in a circle? Try it.
- Should find that they need to hit the balls toward the center of the circle (or perpendicular to the motion or something similar).
- Confirm with video from Rutgers: http://paer.rutgers.edu/pt3/experiment.php?topicid=5&exptid=56
- Have the students make a motion map for the ball
- Divide the class in quarters, and have each of them find the direction of the acceleration for each ¼ of the motion map on their whiteboard
  - They already know about impulse, so it might be useful for them to be thinking about the force that is changing the momentum in this case

30 min **Whiteboard Discussion**
PURPOSE: Use motion maps to determine uniform circular motion as a special case of a constant acceleration model.

- Looking at each sections acceleration and force diagrams, what can we say about the direction of the acceleration? The net force?

- Either show the geometric derivation of the centripetal acceleration or give the handout to get to $a_{centripetal} = \frac{v^2}{r}$
    - Handout: Centripetal Acceleration Derivation (Word, Pdf)