In Class Activity Plan

Week 7: Practicing with Energy and Defining Work

Note: We schedule the first exam during this week, and thus leave additional time for a question-answer session and possible review.

10 min **Whiteboard - Energy Problems for Practice (Word, Pdf)**

PURPOSE: To synthesize using pie charts, system schema and energy equations in coherent way

Note: Problem 2 generally yields a useful discussion, so you may want to have everyone put this one on their whiteboards. Otherwise break the class up so that different groups are working on different problems.

20 min **Board Meeting**

PURPOSE: To present coordinated use of pie charts, system schema and energy equations

- Include all objects in system schemas
- Pie charts should account for all of the energy in the system
- Use the pie charts to write the energy conservation equation!!

Note: Problem 2 works through all of these particularly well. Often students will try to make two pie charts, one for each of the masses. Forcing them to put all the energy in the energy into a single pie chart is critical to writing the equation correctly.
Further Note: Problem 3 is written for a Miami rooftop restaurant, you may choose a different restaurant. This is an easy problem if you allow it to be, but then can discuss the efficiency of the human body.

45 min **Energy Transferred Across the System Boundary (Word, Pdf)**

PURPOSE: To introduce work and integrate work into the use of energy tools to model phenomena.

Technical note: This worksheet is designed to introduce the concept of work. We recognize that work is a topic with multiple definitions and implementations, however. As a result, we choose a single definition of work for this class and that is the "energy transferred across the system boundary by mechanical means."

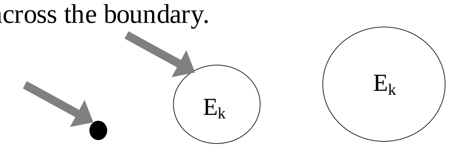
Logistic Notes:
- While this is a worksheet, it introduces a new concept to the students. Leave plenty of time for thinking and arguing while completing this worksheet.
- Situation 1(a) is intended to be a situation the students can work through using the system schema and energy pie charts as they have been doing up until this point. Make sure they include "person energy" or something like this in their pie charts.

- Situation 1(b) introduces what happens if we do not include all objects in the system schema, and represents Superman doing work on the system (the train). This means the pie charts will be getting bigger over time because the system (the train) is gaining energy.
- Situation 2 considers the reverse situation where the train is doing work on Superman. This means the pie charts will be getting smaller over time because energy is being transferred out of the system (the train).
- There are several ideas that need to be seeded, see below.

SEED:

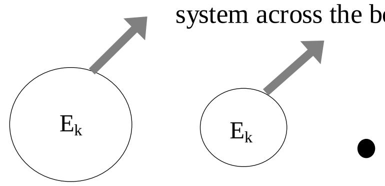
- The train is getting energy from somewhere. How do we indicate that? Introduce arrows transferring energy *into* the system.

Arrows represent energy being transferred across into the system across the boundary.



- In Situation 2 the train's energy is going somewhere. How do we indicate that? Introduce arrows transferring energy *out of* the system.

Arrows represent energy being transferred across out of the system across the boundary.



- We need a notation for this energy transfer. Physicists say that Superman is doing Work on the train, so we'll call this energy transfer "work."

$$E^{W}_{Superman->Train}$$

- Energy conservation now includes the work. So:

$$E_{pie1} + E^{W}_{Superman->Train} = E_{pie2}$$

and

$$E^{W}_{Superman->Train} = E_{pie2} - E_{pie1}$$

10 min **Whiteboard - Energy Transferred Across the System Boundary**
PURPOSE: Compare how choice of system influences the specific model
Split the three situations up among the class

30 min **Board Meeting**
PURPOSE: To build consensus about the meaning of work, and how it integrates into the models that students are capable of building.

- Definition for work as the transfer of energy across the boundary of the system by mechanical means – contact interactions.
- The new representational tools:
    - Arrows
    - Labeling mechanism
- Conservation of energy using work
    - Note: One of the issues that may come up is comparing the initial time frame to the final time frame. Note that you need to include the energy in the pie charts from the two time frames you are considering, but the work arrows from all of the time frames in between. For example in Situation 1, the work found from the expression below is equal to the sum of the two work arrows, not any single arrow.

      $$E^{W}_{Superman->train} = E_{pie3} - E_{pie1}$$

- Notice that in Situation 1(b) the work calculated is equal to the change in person energy from Situation 1(a).
- Definition of Work is change in energy in the system, regardless of whether the energy is transferred *into* the system, or *out of* the system.

Review for Exam

- Often we request that students bring questions to class, write them on the board, and then divide up groups to whiteboard the problems they want to see. At the end of an hour they put all board up at the front to share.

Exam I