Week 9 Challenge Homework

Conservation of Energy

Submission Details | Submit a digital copy (PDF, jpg, etc.) to Canvas. Include solutions to the metacognitive exercise and each question. Please use the interface to associate each page of your submission with the assignment. It makes grading much easier. Please clearly indicate which question is being solved. If data is needed to complete a problem, be sure to cite the source you've acquired your data from. Typed work will not receive credit. See the course website for further details.

Group Submissions | You may submit a group collaboration to Canvas. Add each group member to the submission. Each group member should contribute to the work. Clearly indicate which part of the submission is written by each member (color or labels are preferable).

Sensemaking | You will be asked to apply sensemaking in some problems. More information about sense-making can be found on the BoxSand Sensemaking page, which is linked on the Canvas homepage.

Metacognitive Exercise

Each week will feature a metacognitive exercise, followed by one or two challenge problems to solve. The metacognitive exercise will usually ask you to reflect on your solution to the previous week's challenge problems.

Review your solution to the Week 8 Challenge Homework. If you do not have a copy of it anymore, you can find it on Canvas or Gradescope, under the Week 8 Challenge Homework assignment. Also, review the solution which has been posted to the BoxSand solutions archive (click here for a link) a few days after the assignment is due.

(a) What questions do you have about the general sensemaking process? How about the proportionality / covariation sensemaking technique, like you were asked to complete in question 2 from the week 8 challenge homework? Where could you find answers to your questions?

(b) How have these metacognitive exercises benefited you this term? Were there specific prompts or types of prompts that you felt were more helpful? Less helpful? (You don't need to write what you think we want to hear!)

(c) What has your process been for completing challenge homework assignments this term? Have you worked in a consistent group? Rotating group of classmates? By yourself? If you plan to take PH 202 next term, what changes to this routine will you make in the Winter term?

Question 1:

Old naval ships fired cannon balls with mass $\mathbf{m_1 = 10\ kg}$ from a cannon of mass $\mathbf{m_2 = 200\ kg}$. It was very important to stop the recoil of the cannon, since otherwise the heavy cannon would go careening across the deck of the ship. In one design, a large spring with spring constant $\mathbf{k = 20{,}000\ N/m}$ was placed behind the cannon. The other end of the spring braced against a post that was firmly anchored to the ship's frame. When the cannon fired, the spring compressed a distance $\mathbf{\Delta x = 50\ cm}$.

(a) Use *Units* or *Dimensionality* sensemaking to make a clear prediction for the units or dimensions of your answer to part (b). (hint: read parts (b) and (c) before your start any part of this solution!)

(b) Find a symbolic expression for the speed, $\mathbf{v}$, at which the cannon balls exit this cannon. Your solution should include only the symbols $\mathbf{m_1}$, $\mathbf{m_2}$, $\mathbf{k}$, and $\mathbf{\Delta x}$ (and of course the symbol $\mathbf{v}$ on the opposite side of the equality). It should also be algebraically simplified when possible (i.e. $\mathbf{m_1 * m_2 / m_1}$ should just be written as $\mathbf{m_2}$). Note: symbolic solutions sometimes include coefficients like 2 or ½ in addition to the given quantities.

(c) Complete your *Units* or *Dimensionality* sensemaking process by comparing your prediction from part (a) with your found units or dimensions from part (b). Hint: a good way to show the units / dimensions match your prediction is to show that the units / dimensions of your symbolic solution simplify to the units of the expected quantity (the velocity, in this question).

(d) Plug in the values we were provided to find a numerical answer for the speed at which cannon balls exit the cannon.