Week 10 Challenge Homework

Conservation of Energy and Collisions

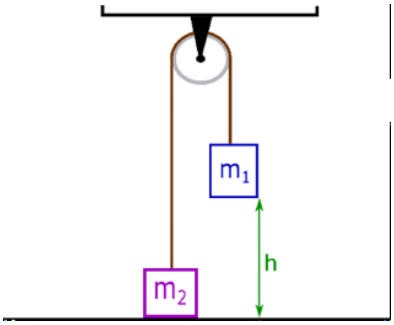
Submit a digital copy (PDF, jpg, etc.) to gradescope.com. Please use the Gradescope interface to associate each page of your submission with the corresponding question number! It makes grading much easier.

Every page should be labeled on the top left with the question number and there should be only be one solution per page. If a solution takes more than one page, be sure to label that it is a continuation of the previous page's solution. If data is needed to complete a problem, be sure to cite the source you've acquired your data from. See the course website for further details.

You will be asked to apply sense-making in some problems. Use the list below as a reference to the different sense-making techniques. More information about sense-making can be found on the BoxSand menu under Math Tools => Sense-making.

- *Sign:* Check the **sign** of each quantity makes sense.
- *Dimensionality:* Check the **dimensionality** and units of each quantity makes sense.
- *Order of Magnitude:* Check the **order of magnitude** of the final answer and other important quantities is within a a factor of 10 of what you think it should be.
- *Graphical Analysis:* Use a **graph** to see if the behavior of a solution makes sense.
- *Proportionality:* Using a symbolic solution, check the behavior of the answer when you change a given quantity on which it is dependent. Does the answer vary **proportionally** to what you expect?
- *Special Cases:* Check the behavior of a derived equation in limiting (**special**) cases makes sense, e.g. as x goes to 90 degrees in sin(x).
- *Self-consistency:* Check derived equations, functions, or values, are **self-consistent**, e.g. check that the slope of a derived position plot matches the values of the given velocity plot
- *Known Values:* Compare given or derived quantities with common well **known values**.
- *Related Quantities:* Compare the relative magnitude of two **related quantities**.

Question 1:



Two masses are connected by a light string passing over a light frictionless pulley. The 5.00 kg mass is released from rest at a height of h = 4.00 m above the horizontal floor below.

(a) Using the law of conservation of energy, determine the speed of the 3.00 kg mass just as the 5.00 kg mass hits the ground.

(b) Use one of the sense-making techniques to analyze your solution to part (a). Clearly state which technique you're using and why it is relevant.

(c) Find the maximum height to which the 3.00 kg mass rises after the 5.00 kg mass hits the ground. The image is not drawn to scale, assume that the 3.00 kg box does not hit the ceiling.

(d) Use a different sense-making technique than you used in part (b) to analyze your solution to part (c). Clearly state which technique you're using and why it is relevant.