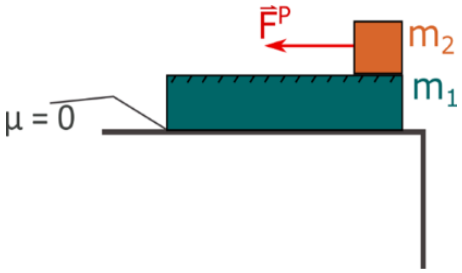
N3.L1.4 | Coupled Systems and Pulleys | Challenge Homework

Submit a digital copy (PDF, jpg, etc.) to gradescope.com. Every page should be labeled on the top left with the question code (e.g. GR.L1.4-01). If there are more than one question, they should be in order. If a solution takes more than one page, be sure to label that it is a continuation of the previous page's solution (e.g. GR.L1.4-01 continued). Challenge homework for a given week are due the following week by Tuesday at midnight. 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 most 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**.

N3.L1.4-01



A block (4.00 kg) is at rest on the right edge of a large 11.0-kg slab. There is no friction between the slab and the horizontal surface it is on, but there is friction between the block and the slab. The coefficient of kinetic friction between the two is 0.25. The slab is 3.00 meters wide and a constant horizontal force is applied to the left of the block. The block starts on the right side of the slab and it takes 2.00 s for the block to reach the other side of the slab.

(a) What is the magnitude of the force applied to the block?
(b) How far does the bottom block travel? (Hint: use a non-moving/non-accelerating reference frame, i.e. static origin on the right side of the table for both blocks.)
(c) What is the final velocity of the top and bottom block?
(d) Use the *Related Quantities* in conjunction with an *Order of Magnitude* sense-making analysis to check if your answers to part (c) are reasonable.