

Week 6 Challenge Homework

Inclined Planes, Friction, and Uniform Circular Motion

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.

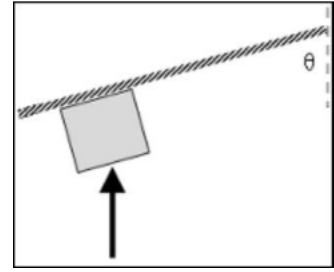
Every page should be labeled on the top left with the question number and there should be only be one solution per page. If a solution takes more than one page, be sure to label that it is a continuation of the previous page's solution. If data is needed to complete a problem, be sure to cite the source 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 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:

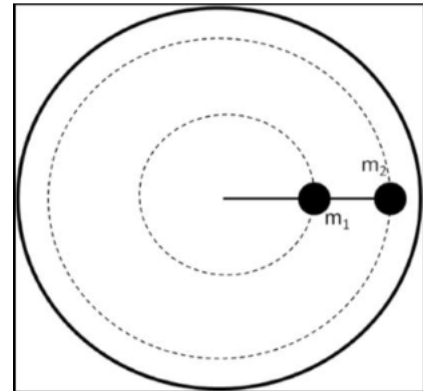
A 2-kg-block is pushed upward from underneath by a constant 50-N vertical force. The block is sliding on the bottom side of an inclined plane that makes an angle of 70° with respect to the vertical. The coefficient of kinetic friction between the block and the plane is 0.2.



- Determine if the net force points up or down the incline?
- If after traveling a total distance of 4 m the block is traveling at a speed of 4.443 m/s up the incline, what was the initial speed of the block?
- Use the *Sign* sense-making technique, along with your answer to part (a), to check whether your answer to part (b) seems reasonable.

Question 2:

A mass of 3.0 kg is tied via a light string to the center of a table. A second mass of 5.0 kg is tied, also via a light string, to the first mass. Both masses are made to undergo uniform circular motion in the horizontal plane at a rate of 10 revolutions per second. The first mass is 1.2 m from the center of the table and the second mass is 2.0 m from the center of the table.



- What is the tension in both strings?
- Use *Related Quantities* along with *Proportionality* sense-making technique to check your answer to part (a) behaves the way you'd expect. Should the tension increase if the speed increases? Which tension do you expect to be greater?