

N1.L3.4 | Application of Newton's 2nd Law | Challenge Homework

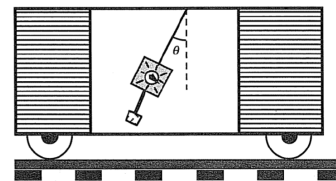
Submit a digital copy (PDF, jpg, etc.) to gradescope.com. Every page should be labeled on the top left with the question code (e.g. GR.L1.4-01). If there are more than one question, they should be in order. If a solution takes more than one page, be sure to label that it is a continuation of the previous 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**.

N1.L3.4-01

A spring scale, which measures forces, is loosely fastened, (i.e. it can swing back and forth) to the ceiling of a railway car. When a 1.0-kg block is hung from the scale and the car maintains a constant acceleration, the scale reads 12 N and is oriented at an angle of 6° as shown in the figure. All of the following questions refer to the time while the car is accelerating and the block is maintaining a constant angle with respect to the vertical.



- What must the direction of the acceleration of the car be? Explain.
- What is the direction of the velocity? Explain.
- Find the acceleration of the railway car.
- Use the *Proportionality* sense-making technique to check your expression for the acceleration in part (c). Does the acceleration increase or decrease as the angle increases? Is this the behavior you would expect? Explain.