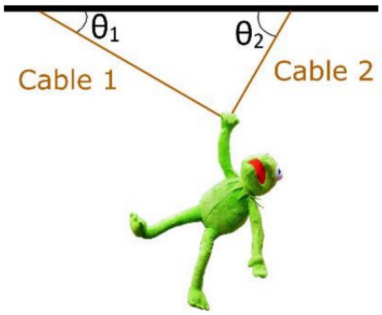
N1.L2.4 | FBD and Newton's 2nd Law | Challenge Homework

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.L2.4-01



A chandelier with mass m is attached to the ceiling of a large concert hall by two cables. Cable 1 has tension T_1 and makes an angle of θ_1 with the ceiling. Cable 2 has tension T_2 and makes an angle of θ_2 with the ceiling.

(a) Find an expression for T_1, the tension in cable 1, that does not depend on T_2. Express your answer in terms of some, or all of the variables m, θ_1, θ_2, and the magnitude of the acceleration due to gravity g.

(b) Use the *Special Cases* sense-making technique to check your expression in part (a). Specifically how does the tension change as m, θ_1, θ_2, and **g** change to extreme values?