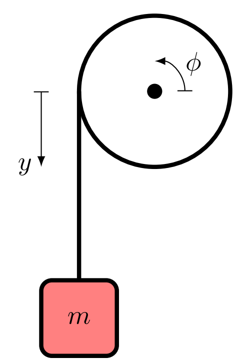
All questions from Taylor, Chapter 7. Please show all your work and write legibly for full credit! Due date is Monday, October 19 at midnight.

- **7.27**: Double Atwood Machine (*Inevitably, the largest source of confusion here has to do with signs. The book likes to call the downwards direction positive for these types of problems, but I find that tends to be more confusing than helpful (because of course, things CAN be moving upwards here). Either way, if you are consistent, things will work out. But this highlights the importance of not only clearly indicating what your chosen coordinates are, but in indicating what direction you are taking to be positive for each!*)
- **7.30**: Pendulum in an Accelerating Traincar (*When defining your β triangle as in 5.11, you should make sure that β is the angle with the vertical, so that it is defined with the same zero point as your angle ϕ*)
- **7.35**: Bead on Sideways Rotating Ring (*A trig identity will be helpful in simplifying things here. And read the question carefully and realize that you are looking at the ring in a top down view!*)
- **7.38**: Cone Physics (*When determining stability and frequency, you'll probably want to rewrite your function in terms of ϵ and then take a series approximation for when ϵ is small. Remember you aren't looking at the potential energy this time, but rather the acceleration, so keep that in mind when determining ω. Also, plug back in any constants so that your final expression for ω is just in terms of g, α and r_0.*)
- **My Problem**: Consider a mass m that hangs from a string, the other end of which is wound several times around a wheel (radius R, moment of inertial I) mounted on a frictionless horizontal axle. Suggested generalized coordinates for the system are shown in the image below, and you will want to use both as your goal here will be to use Lagrange multipliers to solve for the tension in the string as a function of time.



  (a) Write down the Lagrangian in terms of these two variables and write down your constraint equation as well. (*Make sure you write your constrain equation out initially so that it is equal to 0, which is probably differently from how you'd originally think of it.*)

  (b) Solve the Lagrange equations and solve them (together with the constraint equation) for $\ddot{y}$, $\ddot{\phi}$, and λ. This problem is fairly simple, so you should be able to solve them entirely independent of one another–that is, each equation is separable. And in fact, in this problem, each can be written purely in terms of constants. (Frequently this will **not** happen, at which point you'd have to potentially solve the system numerically)

  (c) You have a few differential equations that are easy to solve with integration, and then the Lagrange multiplier that is related to the tension by $\lambda\frac{\partial f}{\partial x}$. Consider the case where $I = mR^2$ and the mass is dropped from rest with both $y(0) = 0$ and $\phi(0) = 0$. Plot the resulting motion of $y(t)$ and the magnitude of the tension in the string over the first 5 seconds (Each has different units, so you could potentially use 2 different y-axes in your plot or just stack some subplots.)