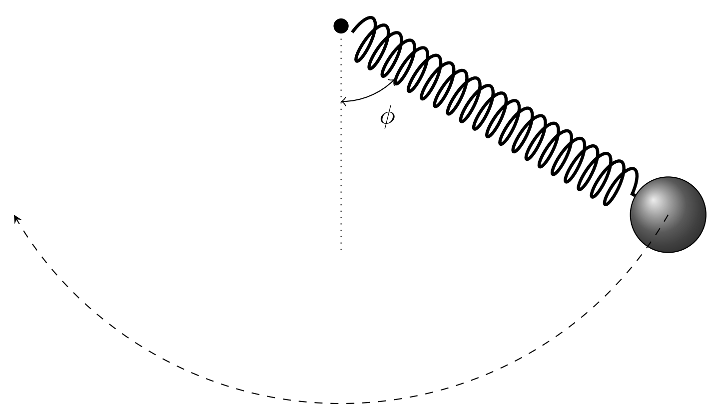
All numbered questions from Taylor, Chapter 1. Please show all your work on your own paper, each problem starting on a new page, and write legibly and clearly for full credit. If you get stuck or have any questions, please don't hesitate to ask! For problems done on a computer, please save the Jupyter notebook as a pdf and combine it with your handwritten scanned pdf before submitting.

- **1.5** – Just some easy practice using vector operations
- **Circle Physics** – A particle moves in a circle (with center at the origin and radius R) with constant angular velocity ω in the counter-clockwise direction. The circle lies in the xy plane and the particle is on the x axis at $t = 0$.
  (a) Determine a vector expression for the particle's position at any point in time given the supplied constants. (This is asking what $\vec{\mathbf{r}}(t)$ is.)
  (b) Determine expressions for the particle's velocity and acceleration as functions of time.
  (c) What are the magnitude and direction of the acceleration? How do both of these values compare with what you may have learned about circular motion back in Intro Physics?
- **1.18** – There are easy and hard ways to do this. If your work is looking too ugly, you may want to check into a different approach.
- **1.47** – You can follow much of the same argument made for the 2D polar coordinates here, just with the slight added complication of another dimension.
- **Springy Pendulums** – Take an instance where you have a 2 kg mass attached to a central point by a spring with spring constant $k = 10\,\mathrm{N/m}$ and relaxed length of 1 m. The whole setup can rotate about the fixed point like a pendulum. The mass starts from rest 1 m from the pivot point and with $\phi_0 = 60°$.



  (a) Using the polar form of Newton's 2nd law, write out both second-order differential equations that model the system (commonly called the equations of motion).
  (b) These two equations are coupled and not easily solved analytically, but you can solve for answers computationally. (Feel free to either use the Euler-Cromer method you used in Intro or take advantage of Scipy's `odeint`.) Make a polar plot of the r vs ϕ results over the first 20 s of motion. Does your plot seem reasonable for what you'd expect?
  (c) If you were to increase the spring stiffness to a large value, say to 1×10^5, your solution should become basically the same as a normal rigid pendulum. Do this computationally and plot the resulting r vs ϕ. Add to your plot the motion an actual rigid pendulum would undergo. Do they seem to be in agreement?