1 Braking Disk

A disk with mass m and radius R is spinning with angular velocity ω_0.

(a) How much friction force would you need to apply to the rim in order to bring a disk to a halt in time T_0?

(b) *Sensemaking: Check Dimensions* First, indicate the dimensions you think your answer should have. Then, check that you answer has the expected dimensions.

(c) *Sensemaking: Evaluate the Functional Behavior* First, indicate how you expect the friction force to vary if you varied the initial angular velocity and the stopping time. Then, check that your answer has the expected functional behavior.

2 Linear Air Drag Power Series

For a projectile with linear drag, the vertical component of the position looks like:

$$y(t) = \frac{m}{b}\left(v_{y,0} + \frac{mg}{b}\right)\left(1 - e^{-bt/m}\right) - \left(\frac{mg}{b}\right)t + y_0$$

(a) ***Approximate with a Power Series:*** Do a power series expansion of the vertical component of the position to third order with respect to the constant b.

(b) ***Consider a Special Case:*** Show that if the air drag goes to zero, your expansion gives you the equation for the vertical component of the position if there is no air drag.

3 Cycle Racer

(*modified from Taylor 2.25*)
Consider a cyclist moving in a straight line and coasting to a stop under the influence of a quadratic air resistance $\vec{F}_{drag} = -cv^2\hat{v}$.

(a) ***Anticipate the functional behavior:*** Before doing any calculation, sketch (by hand) what you expect the velocity vs time and the position vs. time graph to look like. Label interesting regions or points.

(b) Calculate: Starting with Newton's 2nd Law, find the velocity and position of the cyclist as a function of time.

(c) *Dimensions:* Check the dimensions of the answers.

(d) *Examine the Behavior of Functions:* Plot the velocity and position as functions of time. Do your plots make conceptual sense? Compare your plots to the your hand-sketches and comment on similarities and differences.

4 Quadratic Drag with Gravity

(*modified from Taylor 2.35*)

Consider an object dropped near the surface of Earth and subject to a quadratic drag force from the air.

(a) ***Anticipate the functional behavior:*** Before doing any calculation, sketch (by hand) what you expect the velocity vs time and the position vs. time graph to look like. Label interesting regions or points.

(b) Calculate: Find the velocity as a function of time (the equation is in the textbook but I want to see the details of the calculations). Be sure to do any integrals involved.

(c) *Examine the Behavior of Functions:* Plot the velocity and explain the features of this plot. Compare your plot to your hand-sketch and comment on similarities and differences.

(d) Calculate: Find the position as a function of time (again, the equation is in the textbook but I want to see the details of the calculation). Be sure to do any integrals involved.

(e) *Examine the Behavior of Functions:* Plot the position and explain the features of this plot. Compare your plot to your hand-sketch and comment on similarities and differences.