# Lab 4: Bicycle Racing

The purpose of this lab is to use the Euler method to solve a simple model for the motion of a bicycle.

Download the code `Bike_racing_skeleton.py` and rename it something that makes sense (i.e. it won't be a skeleton code when you are done). In today's lab, you will use the Euler method to solve for the motion of the bicycle. Recall that, in lecture, I showed that

$$\frac{dv}{dt} = \frac{F_{\text{total}}}{m} \tag{1}$$

can be transformed into

$$v_{i+1} = v_i + \frac{F_i}{m}\Delta t \tag{2}$$

where $F_i = P/mv_i + F_{\text{drag},i}$. Here $F_{\text{drag},i} = -\frac{1}{2}C\rho A v_i^2$.

The goal of this lab is to make a figure showing the speed of the bicycle as a function of time. The figure must include a caption that explains what the reader is supposed to take away from the figure, and gives enough information that the reader could reproduce the figure.

Here are some things to think about:

- Comments should be useful, but also not longer than they need to be. A 2nd-year physics student should be able to read your code and understand what it does, and what all the variable names mean.
- Variable names should be meaningful, but not long or complicated. You are trying to make your code readable.
- Make sure that your code runs after you `%reset` it.
- You will need to think carefully about how to set up your loop. Check **by hand** what your loop does on the first iteration and on the last iteration. Take a simple case with, for example, only 5 time steps and work through the loop to make sure it is behaving as expected.
- Avoid complicated equations in your loop, as these are hard to debug. Break complicated calculations into small pieces, and check each of these pieces separately. Combinations of constants (such as $\frac{1}{2}C\rho A/m$) can be calculated once, outside of the loop.
- When you go to make your figure, remember the guidelines I gave you in Lab 01.
- If you have time, calculate the terminal speed of the bike by hand from the original differential equation. This can be compared to the value you get from numerics. Note that, at the terminal speed, $dv/dt = 0$.