Euler's method is a numerical approach for finding velocities and positions when the acceleration is not constant. In this approach, very small time steps are made into the future (0.05 seconds) and new positions and velocities are calculated using the simple formulas:

$$v_f = v_i + a\Delta t \tag{0.1}$$

$$x_f = x_i + v\Delta t \tag{0.2}$$

(the $\frac{1}{2}at^2$ term is not neede because the velocity is assumed to be constant over such a small time interval)
The smaller the time steps taken, the better the accuracy (to a point)

1. A hailstone of mass 4.80×10^{-4} kg falls through the air and experiences a net force (gravity plus drag) given by:

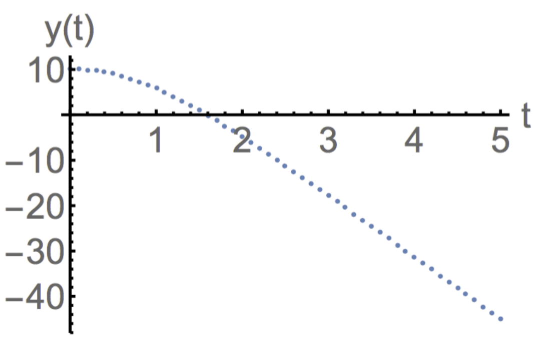
$$F = -mg + Cv^2 \tag{0.3}$$

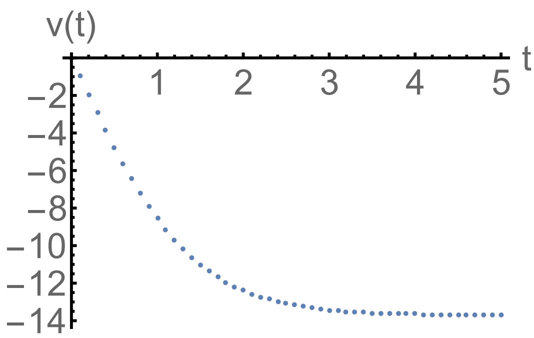
   where $C = 2.50 \times 10^{-5}$ kg/m.

   a) Calculate the terminal speed of the hailstone.

   b) Using Python, implement Euler's method to find the speed and position of the hailstone as a function of time. Take the initial speed to be zero and use 0.2 s time intervals. Continue the calculation until the hailstone reaches 99% of terminal speed.

   Your Python results should look like this (notice that the speed approaches a constant value equal to the number you found in part a):





2. A 0.142 kg baseball has a terminal speed of 43.5 m/s (95 mi/hr).

   a) If the baseball experiences a drag force equal to Cv^2, what is the value of the constant C.

b) Using Python, implement Euler's method to determine the speed and position of the baseball as a function of time. Take the initial speed to be 36.0 m/s and use 0.1 s time intervals. What maximum height does the ball reach? How long is it in the air? What is it's speed just before it hits the ground? (Hint: you'll need to think hard about the direction of the drag force. It doesn't always point in the same direction)

c) What if you could throw the baseball at 300 m/s. What would the answers to the previous question be?

Your Python results should look like the ones found below. You can read off velocities, times and max heights from the curve: