Computational Physics / PHYS-UA 210 / Problem Set #8
Due November 10, 2017

You *must* label all axes of all plots, including giving the *units*!!

1. Implement Brent's method for minimization of a one-dimensional function. Test it on a fourth-order function. Compare your performance to the `scipy` implementation.

2. Write a routine that integrates the equations for projectile motion:

$$\frac{\mathrm{d}^2\vec{x}}{\mathrm{d}t^2} = -g\hat{x}_1 - \alpha\dot{\vec{x}}^2 \tag{1}$$

   These are appropriate for, say, a golf ball. The initial conditions should be that the object is launched at some angle θ from the horizontal at some initial speed in the x_0-x_1 plane. Integrate until the object hits the ground again. Implement Euler's method, and also use a Runge-Kutta method from `scipy`. Compare their convergence with time steps.

3. Use Brent's method (either yours or `scipy`'s) to optimize the angle θ to get the longest distance.

4. Now consider that you are aiming for a specific point along the $\hat{x}_0$ axis, and that there is some wind in the $\hat{x}_2$ direction, so the drag term becomes:

$$-\alpha(\dot{\vec{x}} - w\hat{x}_2)^2 \tag{2}$$

   Allow yourself the freedom to hit the golf ball in any direction θ from the horizontal, any angle *phi* from the x_0 axis in the x_0-x_2 plane, and at any speed. You should be able to hit any given spot D along the x_0 axis. Use the `scipy` implementation of `bfgs` to perform this optimization.