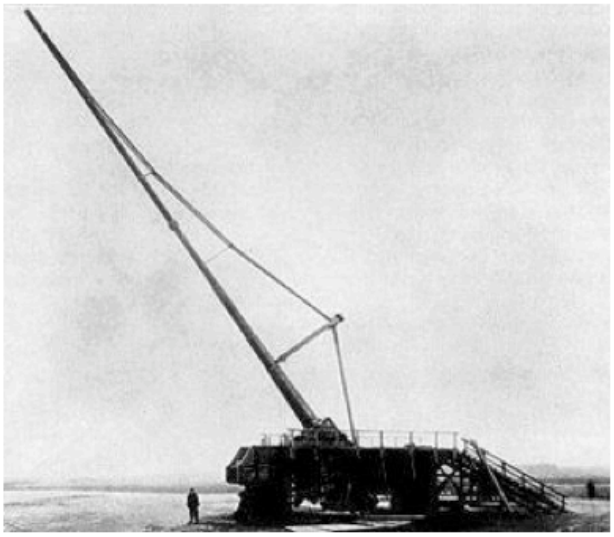
Project 2: Projectile motion with air resistance

Write a program that simulates the projectile motion with allowing for air resistance, varying air density and wind. The amplitude of air resistance force on an object moving with speed v can be approximated by $F_{drag}=-0.5C\rho_0 Av^2$, where ρ_0 stands for air density ($\rho_0=1.25$ kg/m^3 at sea level), and A is the cross section. The drag coefficient C depends on an object shape and for many objects it can be approximated by a value within 0.05 - 0.5. Use Runge-Kutta method as a primary method for solving a system of differential equations.

Application: Study the trajectory of shells of one of the largest cannons "Pariskanone" used during the First World War. Calculate effects of air resistance, varying air density and wind on the range, time of flight and max altitude of shells. Determine the angle (between 0 and 90 degrees) that gives the maximum range for such cannon. The range and time of flight have to be calculated numerically (using interpolation) by the program.



Some initial information: The shell mass - 94 kg., initial speed - 1600m/s, caliber - 210 mm, and the C coefficient is about 0.12. Approximate the density of the atmosphere as $\rho = \rho_0 * \exp(-y/y_0)$, where y is the current altitude, $y_0 = 1.0*10^4$m, and ρ_0 is air density at sea level (y=0).