Cauchy problems

1. Solve the initial values problem

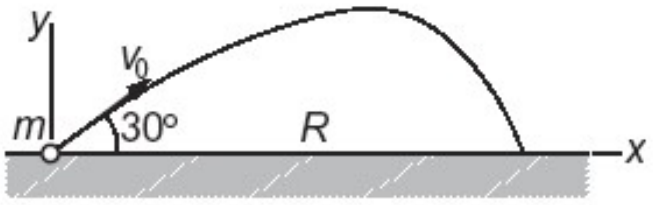
$$y' = \frac{1}{t^2} - \frac{y}{t} - y^2,\ 1 \le t \le 2,\ \ y(1) = -1$$

by using Euler method and Runge-Kutta standard method. Compare the results with the exact solution $y(t) = -\frac{1}{t}$.

2. Solve the pundulum problem using ode45 from Matlab:

$$\frac{d^2\theta}{dt^2} + \frac{g}{L}\sin\theta = 0\,,\ \theta(0) = 0,\ \frac{d\theta}{dt}(0) = 0.1$$

3. (optional)



A ball of mass $m = 0.25$ kg is launched with the velocity $v_0 = 50$ m/s in the direction shown. Assuming that the aerodynamic drag force acting on the ball is $F_D = C_D v^{3/2}$, the differential equations describing the motion are

$$\ddot{x} = -\frac{C_D}{m}\dot{x}v^{1/2} \qquad \ddot{y} = -\frac{C_D}{m}\dot{y}v^{1/2} - g$$

where $v = \sqrt{\dot{x}^2 + \dot{y}^2}$. Determine the time of flight and the range R. Use $C_D = 0.03$ kg/(m·s)$^{1/2}$ and $g = 9.80665$ m/s^2.