Computerphysik

SoSe 2016

Problem Set 1

Deadline: April 21, 2016 – 16:15

Problem 1: Projectile range – Theory and graphics

We consider the motion of a projectile experiencing air resistance. For simplicity we assume a point-like projectile of mass m and a net force

$$\vec{F} = -k\dot{\vec{r}} - mg\vec{e}_y$$

where k/m is the drag coefficient.

1. Show that the trajectory is given by

$$y(x) = \left[\tan\alpha + \frac{mg}{kv\cos\alpha}\right] x + g\left(\frac{m}{k}\right)^2 \ln\left(1 - \frac{kx}{mv\cos\alpha}\right)$$

   where $\vec{v}$ is the initial velocity and α is the initial angle between $\vec{v}$ and the horizontal axis $\vec{e}_x$.

2. Plot the trajectory $y(x)$ for $k = 0, 0.1, 0.62$, and 1.62 kg/s assuming $v = 100$ m/s, $m = 1$ kg and $\alpha = \pi/4$.

Problem 2: Projectile range – Finding roots

1. Explain why the projectile range R lies within the interval

$$0 < R < \min\left(\frac{v^2}{g}\sin 2\alpha, \frac{mv\cos\alpha}{k}\right).$$

2. Calculate and plot the projectile range R as a function of the initial angle α for the values of k, m, and v given above.

Problem 3: Projectile range – Finding extrema

In the previous problem you have calculated the range $R(\alpha)$ of a projectile as a function of the initial angle α between its velocity and the horizontal axis. Determine the angles yielding the maximal range for the parameters given in problem 1, part 2.