PHYS-330 - Classical Mechanics - Fall 2017

Homework 1

Due: 7th Sept 2017 by the start of class. Anything later will be considered late.

Instructions: Complete all of the questions below. You are encouraged to use Jupyter Notebooks to complete any numerical work and written. While the use of python is encouraged, you can use any programming language you want. You can either email me your assignment or provide me with a hard copy in class.

1. Prove the vector triple product

$$\mathbf{A} \times (\mathbf{B} \times \mathbf{C}) = \mathbf{B}\,(\mathbf{A} \cdot \mathbf{C}) - \mathbf{C}\,(\mathbf{A} \cdot \mathbf{B})$$

2. Problem 1.40 from Taylor.
3. Problem 1.32 from Taylor.
4. A sphere of radius R and density ρ falls from an altitude of H. The atmospheric density varies with height x (where $x = 0$ is sea level) as

$$\rho_a = \rho_0 e^{-x/X}.$$

We assume there is quadratic drag of $F_d = 0.2\pi\rho_a R^2 v^2$ where v is the velocity of the sphere and $v = 0$ at $t = 0$. Obtain numerical solutions (i.e. plots) for velocity $v(t)$ and height $x(t)$ for (a) $H = 5$ km (b) $H = 10$ km (c) $H = 15$ km and (d) $H = 20$ km. You may take \$ R = 2.0\$ cm, $\rho = 5.00 \times 10^3$ kg·m^{-3}, $\rho_0 = 1.29$ kg·m^{-3}, $X = 7.46 \times 10^3$ m, Earth's Radius $R_e = 6.37 \times 10^6$ m and at sea level $g_0 = 9.80$ m·s^{-2}.

5. Problems 1.50 and 1.51 from Taylor.