Classical Mechanics, Phys105A, Wim van Dam, UC Santa Barbara
Improved Exercises Week 3; due Monday February 5, 11:30 am

Question 1 (Charged particle in a magnetic field with linear drag, 5+5 points). Consider the trajectory of a particle with mass m and charge q in a constant magnetic field $\mathbf{B} = B\,\hat{e}_z$. Assume for the initial speed of the particle $\mathbf{v}(0) = v_0\,\hat{e}_x$ and that the drag is described by $\mathbf{f} = -b\mathbf{v}$.

▷ **(a)** Write down the appropriate differential equations for this system.

▷ **(b)** Solve these equations and describe the trajectory of the particle.

Question 2 (Hyperbolic functions, 2+2+2+2+2 points). Note that you can only get two points per question, so keep your answers short and to the point.

▷ **(a)** Taylor, Problem 2.34a.

▷ **(b)** Taylor, Problem 2.34b.

▷ **(c)** Taylor, Problem 2.34c.

▷ **(d)** Taylor, Problem 2.34d.

▷ **(e)** Taylor, Problem 2.34e.

Write the answers to the questions below on a separate set of pages.

Question 3 (Rockets, 10 points). For this question you probably want to have a look at Section 3.2 in the book.

▷ **(a)** Taylor, Problem 3.14.

Question 4 (Angular momentum for several particles, 5+5+5 points).

▷ **(a)** Taylor, Problem 3.30a.

▷ **(b)** Taylor, Problem 3.30b.

▷ **(c)** Taylor, Problem 3.30c.

Question 5 (Angular momentum and center of mass, 5+10 points). We will prove the very useful equality $\dot{\mathbf{L}}_{\text{CM}} = \Gamma^{\text{ext}}_{\text{CM}}$, which implies that the conservation of angular momentum also holds in the (noninertial) frame that at any given moment has the center of mass as its origin. Note that the book already gives the answer to Problem 3.37a.

▷ **(a)** Taylor, Problem 3.37b.

▷ **(b)** Taylor, Problem 3.37c.