Classical Mechanics, PHYB54
Problem Set 1

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Due: Monday, January 16th 2017, 4pm

Note: Assignments can be hand-written, but illegible answers will not be marked. Clearly indicate your final answers.

Problem 1.1

A ball is launched with velocity v_0 at angle θ from the top of a hill. The hill is inclined by angle ϕ below the horizontal. How far down the hill does the ball land (i.e. if a piece of string connects the launch and land points, how long is the string)?
Hint: Choose your axes such that $\hat{x}$ and $\hat{y}$ are parallel and normal to the hill, respectively.

Problem 1.2

A bowling ball of mass M and radius R is shot vertically up into the air with velocity v_0. The bowling ball is subject to quadratic air resistance $f_{quad} = cv^2$, where $c = 4\gamma R^2$, γ is a constant and R is the radius of the object.
a) Write down the equation of motion for the trajectory of the bowling ball.
b) Derive the time required for the bowling ball to reach the top of the trajectory.
c) At the same time as the bowling ball, a volleyball of mass $M/50$ and radius R is shot vertically up into the air, also with velocity v_0. If $\gamma = 0.25\text{Ns}^2/\text{m}^4$, $v_0 = 10\text{m/s}$, $M = 7.2\text{kg}$ and $R = 0.11\text{m}$, which object reaches the top of its trajectory first?

Problem 1.3

A particle of positive charge q and mass m enters two plates containing a uniform magnetic field $\mathbf{B}$ pointing into the page as shown in the figure below. The initial position of the particle upon entering the magnetic field is $x = 0$, $y = 0.5D$, with an initial velocity of $\mathbf{v} = v_0\hat{x}$.
a) What direction is the particle directed once it enters the magnetic field?
b) What is the total velocity $\mathbf{v}$ of the particle if it strikes the end of the plate (at $x = L$ and $y = \pm D$)? Express your answer in terms of the variables provided (q, m, L, D, $\mathbf{B}$).