Physics 3344
Homework 12 — 15 Apr 2008
Due Tues, Apr 22

1. Read Marion 7.8 to 7.11 (Some Comments Regarding Dynamical Variables, etc). Also, read the last half of the Feynman lecture on Least Action (posted).

   True/False: I read this material.

2. Finish the discussion part of Marion Problem 7.11, using a pseudoforce. (See the comments on our web page.)

3. Marion Ch 7, Problems 15, 27(a)

   For problem 7.15, solve the resulting equations when the displacements for both angle θ and length ℓ from their equilibrium values are small. (Keep up to linear terms only in the equations of motion. You should find that the two motions decouple and become easily solvable.) Throughout this problem, assume that the spring can stretch but not bend.

   For problem 7.27, b is the equilibrium length of the spring at rest. Assume the two masses have the same value m. Note that the entire system is free to move.

   Emphasize the translational symmetry in the system by choosing as generalized coordinates the cartesian coordinates of the center of the spring, the angle θ about the center with respect to the (fixed) x-axis, and the length of the spring ℓ. When you derive T for the system, do so by first writing the velocities for each mass in terms of their x and y components (even though you could probably think of a simpler way to get T).
   Add the following parts to 7.27(a):

   (b) What are the generalized momenta associated with the four coordinates above? From the results of (a), which are conserved?

   (c) For a given value of the angular momentum, find an equation for the equilibrium length of the spring. (You don't need to solve it.) Why does the equilibrium length differ from b for a spinning spring?

   (d) Now rederive the Lagrangian, but using polar coordinates (r, ϕ) rather than cartesian coordinates for the position of the center of the spring, and define the angle θ with respect to ϕ rather than the x-axis; that is, treat θ as a relative angle. What conserved quantities can you identify from the Euler-Lagrange equations in this case? (Note that the Lagrangian should be very simple in both these systems, though the steps leading to them can be grungy.)