

Physics 505 - Autumn 2010

HW VII

Due 11/17/10

Overview: Recall that solving physics problems is not (just) about solving differential equations. Use physical reasoning to help solve the following exercises and be certain to show your work. It is also important that you practice completely solving these exercises, checking for errors as you go along.

- 1) Fetter & Walecka – 5.3 (7 pts) We want to practice analyzing rigid body motion.
- 2) (5 pts) As another rigid body analysis (with clear application to your spare time pursuits) we want to work through the problem illustrated in Fig. 28.3 in Fetter & Walecka. A homogeneous billiard ball of mass M and radius a is struck impulsively with a horizontal force (*i.e.*, a cue stick), with the force applied a distance h above the center of the ball. The subsequent motion is determined by the force of friction that retards motion, with the frictional acceleration given in units of g (the gravitational acceleration),

$$\ddot{x} = -\mu g.$$

Here μ is assumed to be constant (independent of the ball's velocity). Let v_0 be the ball's initial velocity (after been struck). For h positive (as in Fig. 28.3), but otherwise arbitrary, determine the time and velocity at which the ball begins to roll without sliding. As noted in F&W, there are 3 distinct regimes in h to consider.

- 3) (5 pts) As practice with Euler consider the following system. A uniform right circular cone of height h , half angle α , and density ρ rolls on its side without slipping on a uniform horizontal plane in such a way that it returns to its original position in a time τ . Find expressions for the kinetic energy and the components of the angular momentum of the cone. (This is another exercise to be found on past Qual exams.)

- 4) Fetter & Walecka – 6.2 (5 pts) This exercise allows us to practice with Hamiltonian techniques.