

33-331 Physical Mechanics I. Fall Semester, 2009
Assignment No. 11
DO NOT TURN IN

ANNOUNCEMENT: There will be an hour exam on Monday, Nov. 18 at 6:30 pm in WEH 7500. It will be closed book and closed notes and no calculators. Bring a pencil or equivalent.

The exam will cover material from Sec. 7.5 through Sec. 7.12 in Ch. 7 of Thornton and Marion (we did not take up Sec. 7.13), and all of Ch. 8 with the exception of Sec. 8.9. The corresponding problem assignments are 7, 8, 9, and 10. Of course you are expected to know the material from earlier parts of the course, but it will not be the main focus.

PRACTICE EXERCISES. NOT TO BE TURNED IN.

1. Thornton and Marion 7-26. Are there conserved quantities?
2. Thornton and Marion 7-35.
3. Two masses m_1 and m_2 are placed on a smooth, frictionless table and connected with a spring in such a way that the potential energy is

$$U(r) = \frac{1}{2}k(r - r_0)^2,$$

where r is the distance between them (assume they are point particles), and $r_0 > 0$ is some constant.

a) What is the Lagrangian and what is the Hamiltonian in Cartesian coordinates x, y ? Use the Hamiltonian formulation to derive equations for the accelerations. Indicate what you are doing.

b) Introduce generalized coordinates which make it obvious that certain quantities are conserved, and explain how the conservation laws are related to the Lagrangian and/or Hamiltonian expressed in these coordinates. [Hint. There are 4 conserved quantities.]

c) What are the conditions for circular orbits? Consider both $r > r_0$ and $r < r_0$. Are they stable? What do the circles look like in x, y space in a coordinate system with the center of mass located at the origin? Make some sort of sketch.

4. Thornton and Marion 8-14.
5. Thornton and Marion 8-37.