1. Consider a particle of mass $m$ which is constrained to move on the surface of a sphere of radius $R$. There are no external forces of any kind on the particle.
   a) Derive the Hamiltonian of the particle. Is it conserved? [15 points]
   b) Using the Hamiltonian equations of motion, prove that the motion of the particle is along a great circle of the sphere. [15 points]
   NB: A great circle on a sphere is a circle on the sphere’s surface whose center is the same as the center of the sphere.

2. *Goldstein*, Problem 10.5. [30 points]

3. A tennis ball of mass $m$ is bouncing off the floor. The total energy of the ball is $E$. The ball is moving strictly along the vertical. The collision between the ball and the floor is perfectly elastic.
   a. Derive the action-angle variables for the tennis ball and determine the period of motion. [30 points]
   b. Suppose that the tennis ball is a quantum-mechanical object. Using the results of part [a], surmise the dependence of the quantized energy levels on the level number. [10 points]