

PHY 5246: Theoretical Dynamics, Fall 2015

September 16th, 2015

Assignment # 4

(Graded problems are due Wednesday September 23rd, 2015)

1 Graded problems

1. A spherical pendulum consists of a bob of mass m attached to a weightless, extensionless rod of length l . The end of the rod opposed to the bob pivots freely (in all directions) about some fixed point.
 - (1.a) Set up the Lagrangian function in spherical coordinates and derive the equations of motion. How can you interpret the equation for ϕ , the angle of rotation about the vertical axis?
 - (1.b) Discuss the limiting case $\phi = \phi_0$, i.e. $\phi = \text{constant}$.
 - (1.c) Discuss the case $\theta = \theta_0$, i.e. the case of a *conical pendulum* (θ is the angle with respect to the vertical). Which condition needs to be verified for the pendulum to move at $\theta = \theta_0$? Find the frequency of small oscillations about $\theta = \theta_0$.
2. A particle of mass m starts at rest on top of a smooth hemisphere of radius a . Find the force of constraint, and determine the angle at which the particle leaves the hemisphere.
3. A uniform hoop of mass m and radius r rolls without slipping on a fixed cylinder of radius R . The only external force is that of gravity. If the smaller cylinder (hoop) starts rolling from rest on top of the bigger cylinder, use the method of Lagrange multipliers to find the point at which the hoop falls off the cylinder.
4. Problem 2.21 of Goldstein's book.

2 Non-graded suggested problems

5. Problem 2.2 of Goldstein's book.
6. Problem 2.4 of Goldstein's book.