University of California, Berkeley
Physics 105 Fall 2006 Section 2 (*Strovink*)

ASSIGNMENT 3

Reading:
SCCM 4.1-4.6
Taylor 6.1-6.4, 7.1-7.4

1. Taylor Problem 7.38.

2. Taylor Problem 7.40.

3. In plane polar coordinates a particle has potential energy $U(r,\theta)$. By taking the gradient in polar coordinates, show that the radial and tangential components of the force on the particle are

$$F_r = -\frac{\partial U}{\partial r}$$
$$F_\theta = -\frac{\partial U}{r\,\partial\theta}\ .$$

Write the Lagrangian of the particle in plane polar coordinates. Using the Euler-Lagrange equations, prove that the particle's acceleration is

$$\vec{a} = \hat{r}(\ddot{r} - r\dot{\theta}^2) + \hat{\theta}(r\ddot{\theta} + 2\dot{r}\dot{\theta})\ .$$

4. A Lagrangian $\mathcal{L}(q,\dot{q},t)$ satisfies the Euler-Lagrange equation. Prove that if any arbitrary function $dF(q,t)/dt$ is added to $\mathcal{L}$, the resulting Lagrangian $\mathcal{L}'(q,\dot{q},t)$ also satisfies the Euler-Lagrange equation (note that F is not a function of $\dot{q}$). This shows that the Lagrangian is not unique – not even within an arbitrary constant.

5. Taylor Problem 6.10.

6. Taylor Problem 6.17.

7. Taylor Problem 6.24.