ADVANCED DYNAMICS — PHY 4241/5227

HOME AND CLASS WORK – SET 1

(January 6, 2010)

(1) Consider light passing from medium 1 into medium 2. Use Fermat's principle to derive a relationship between the velocities of light in the media, v_1 and v_2, and the angles of refraction, θ_1 and θ_2 (a figure will be given in class). Due January 6 in class (10 points).

(2) Write down your expectations for this course. What are the main objectives? Due January 11 before class (up to 8 points).

(3) Read the Handout, the first nine pages of "The Principle of Least Action" from Chapter 19 of *"The Feynman Lectures on Physics", Vol. II.* Due January 8 before class.

Assignments 4 to 7 are motivated by Feynman's text:

(4) Show that "the mean square of something that deviates around an average ... is always greater that the square of the mean" (4 points).

(5) What is a 3D conservative force? Write down two definitions (2 points).

(6) Derive the Euler-Lagrange equations from

$$\delta \int_{t_1}^{t_2} dt\, L = 0\,, \qquad L = L(q_i, \dot{q}_i, t)\,, \qquad i = 1, \ldots, n_f\,.$$

Due January 11 in class (8 points).

(7) Write down and solve the Euler-Lagrange equation for a free particle, $T = m\dot{x}^2/2$, $U = 0$. Due January 11 in class (2 points).

(8) Draw 2D projections when possible.

1. Write x, y, z in cylindrical coordinates ρ, ϕ, z (1 point).
2. Write cylindrical coordinates in spherical coordinates (1 point).
3. Write x, y, z in spherical coordinates r, θ, ϕ (1 point).
4. Express unit vectors $\hat{\rho}$, $\hat{\phi}$ for cylindrical and $\hat{r}$, $\hat{\theta}$, $\hat{\phi}$ for spherical coordinates in terms of the cartesian unit vectors $\hat{x}$, $\hat{y}$, $\hat{z}$ (3 points).
5. Make a table of the nine dot products between spherical and Cartesian unit vectors (3 points).
6. Express $\vec{v}$ in spherical coordinates using also spherical unit vectors (3 points).
7. Express $\vec{v}^{\,2}$ in spherical coordinates (2 points).

Due January 22 before class.