ADVANCED DYNAMICS — PHY 4241/5227
HOME AND CLASS WORK – SET 1

(January 7, 2009)

(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 7 in class (10 points).

(2) 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 9 before class.

Assignments 3 and 4 are motivated by Feynman's text:

(3) Show that "the mean square of something that deviates around an average ... is always greater that the square of the mean". Due January 9 in class (4 points).

(4) What is a conservative force? Write down a definition. Due January 9 in class (1 point).

(5) Read Chapter 6.1 to 6.3 of M&T. Due January 12 before class.

(6) Write x, y, z in

1. Cylindrical coordinates ρ, ϕ, z.
2. Spherical coordinates r, θ, ϕ (define ϕ as before).
3. Write cylindrical coordinates in terms of spherical coordinates.

Due January 12 in class (3 points).

If you have nothing more to do: 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 $\hat{x}$, $\hat{y}$, $\hat{z}$.

(7) Consider a particle of mass $m = 1$, moving from $x_1 = 0$ at time $t_1 = 0$ to $x_2 = 1$ at time $t_2 = \pi/2$, under the influence of a one-dimensional harmonic potential of the form $V(x) = x^2/2$.

1. Using Newton's equations of motion, obtain the time-dependent motion of the system; *i.e.,* solve for $x(t)$. Compute the action for this exact path.
2. Using an approximate linear path of the form $x(t) = a + bt$, compute the action for this path and compare it with the value obtained before. Hint: Make sure that the path is consistent with the boundary conditions.
3. Assume that the action result of (2.) is in units $J \cdot s$ and express it in multiples of $\hbar = 1.05 \times 10^{-34}\, J \cdot s$.

Due January 14 before class (10 points).