ADVANCED DYNAMICS — PHY 4241/5227

HOME AND CLASS WORK – SET 1

(January 5, 2011)

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

(2) Method of 2D projections for spherical coordinates. Each of the following tasks counts one point. Follow the instructions given in class (no other methods).

1. Write x, y in cylindrical coordinates ρ, ϕ.
2. Write $dx^2 + dy^2$ in cylindrical coordinates.
3. Write cylindrical coordinates ρ, z in spherical coordinates r, θ.
4. Write $d\rho^2 + dz^2$ in spherical coordinates.
5. Write $dx^2 + dy^2 + dz^2$ in spherical coordinates.
6. Write v^2, the velocity squared, in cartesian coordinates.
7. Write v^2, in ccylindrical coordinates.
8. Write v^2, in spherical coordinates.

Due January 12 before class (up to 8 points).

(3) Read Landau-Lifshitz up to page 10 and the Handout, the first nine pages of "The Principle of Least Action" from Chapter 19 of *"The Feynman Lectures on Physics", Vol. II.* Prepare questions about anything you do not understand. Due January 7 before class.

(4) Write down your expectations for this course. What are the main objectives? How do they relate to your present knowledge? Due January 10 before class. Be detailed (up to 8 points)!

(5) 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 10 before class (10 points).