

MIDTERM ADVANCED DYNAMICS — PHY-4241/5227

March 17, 2010, 9:05-9:55 am, HCB 317

PROBLEM 1 (20 points)

1. Write down the Euler-Lagrange equations and the definition of the generalized momentum.
2. Write down the Lagrangian of the 1D harmonic oscillator and continue with this system.
3. Find the momentum p from the Lagrangian.
4. Write down the Hamiltonian $H(p, x)$.
5. Write down Hamilton's equations.
6. Show that Hamilton's equations give Newton's force law.

PROBLEM 2 (20 points)

1. Use spherical coordinates (θ, ϕ, r) to write down the Lagrangian for a particle of mass m moving in the presence of a spherically symmetric potential $V(r)$, $r = |\vec{r}|$, θ polar and ϕ azimuth angle.
2. Write down the Euler-Lagrange equations for the two angles.
3. Use the Lagrangian to identify two conserved quantities.
4. Find $\phi(t)$ for the solution with the initial condition $\dot{\phi}(0) = 0$ where ϕ is the azimuth angle.

PROBLEM 3 (10 points)

Use SI units and write down the four Maxwell equations (in vacuum) in the presence of a charge density ρ and a current density \vec{J} .