Final Examination for PHYS 6220/7220, Fall 2012

1. A particle of mass m moves on the interior of a surface defined in cylindrical coordinates (r, θ, z) by $r = (bz)^{1/2}$, where $z > 0$ and b is a positive constant. Magnitude of the acceleration due to gravity is g and it acts along the negative z direction. Define your frame of reference and generalized coordinates clearly.
(a) Using the method of Lagrange's undetermined multipliers find the magnitude and direction of the constraint force acting on the particle as a function of generalized coordinates. (**8 points**)

2. A particle of mass m, with impact parameter b, approaches a central potential with a speed v_0, far away from the origin. The potential has the form $V(r) = (g/r) + (h/r^2)$ where g and h are positive constants.
(a) Find the scattering angle α as a function of b and the given constants. (**6 points**)

3. A thin flat rectangular plate of mass M and sides of length b and 2b rotates with constant angular speed ω about an axis that passes through the diagonal of the plate. Define all frames clearly with one or more figures and in words.
(a) Find the principal moments of inertia of the plate through a body-fixed frame located at its center of mass. (**1 point**)
(b) Find the torque on the plate in a fixed inertial frame located at the same origin. (**5 points**)