PHY820 Homework Set 7

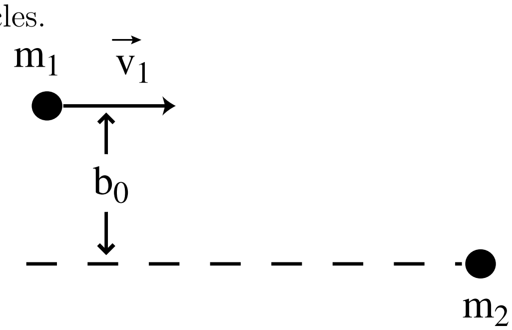
1. [5 pts] A smooth wire is bent into the shape of a helix, with cylindrical polar coordinates $\rho = R$ and $z = \lambda\phi$, where R and λ are constants and the z axis points vertically up (and gravity vertically down). Using z as your generalized coordinate, write down the Lagrangian for a bead of mass m threaded on the wire. Find the Lagrange equation and hence the bead's vertical acceleration $\ddot{z}$.

2. [10 pts] Goldstein, Problem 3.31.

3. [5 pts] A proton of energy 4 MeV scatters off a second proton at rest. One proton comes off at an angle of 30° in the lab system. What is its energy? What is the energy and scattering angle of the second proton?

4. [10 pts] From an exam: Two particles of masses m_1 and m_2 ($m_1 \neq m_2$) collide. The initial velocity velocity of particle 1 is $\vec{v}_1$, while the particle 2 is initially at rest. The initial impact parameter is b_0, as shown. The particles interact through a repulsive potential $V = V_0/|\vec{r}_1 - \vec{r}_2|^4$. (a) Find the magnitude of net angular momentum and the net energy in the *center of mass*, in terms of provided quantities. (b) Obtain an equation for the rate of change of the separation $r = |\vec{r}_1 - \vec{r}_2|$ in time. Find the distance of closest approach between the particles.

   (c) Consider a situation where b_0 is unknown, but the magnitude v_1^f of the final velocity of particle 1 has been measured in the laboratory frame. Find the angle β between the final laboratory velocities of particles 1 and 2, given v_1^f. (Use conservation laws whenever possible.)



5. [5 pts] Goldstein, Problem 4-6.

6. [5 pts] Goldstein, Problem 4-10.