$\boxed{\text{Mathematica Homework \#1}}$

Email notebook to corbin@physics.ucla.edu
with a subject line: [Physics 105B]
Due on or about Friday , 22 Apr

- **Welcome back!** In the first cell, enter all the usual stuff: your **name**, **student ID**, **email address** and the **assignment identifier** (eg. "HW 1").
- 1) Let's warm our fingers up with something relatively easy. Suppose particle 1, of mass m_1, is moving through the lab (in three dimensions) with a velocity $\vec{v}_1$. Particle 2, of mass m_2 is also moving through the lab (in three dimensions) with a velocity relative to particle 1 given by $\vec{v}_{2,1}$
  - a) Find the velocity of each particle in the center-of-mass frame.
  - b) Show that the momentum of each particle, as well as the total energy of the system, as measured in the center-of-mass-frame, can be easily expressed in terms of the reduced mass of the system and the relative velocity $\vec{v}_{2,1}$. (This should not be as surprising as it might seem. How many parameters do you really need to describe what is going on?)
  - c) Suppose the particles collide elastically. Considering the results you obtained in the center-of-mass frame, discuss the three possible outcomes…
- 2) A couple of quick center-of-mass calculations
  - a) **Marion 9-2**
  - b) **Marion 9-8**
- 3) **Marion 9-46**
- 4) Derive the Rutherford differential scattering cross-section

$$\sigma(\theta) = \frac{k^2}{(4T_0')^2}\,\frac{1}{\sin^4(\theta/2)}$$

  from first principles, using Mathematica to do the dirty-work for you (You'll probably revisit this calculation in quantum and E/M).

- 5) **Marion 10.5** Before you start the problem proper, it might be cool to try to produce a series of plots like you see in Figure 10-4 (They will look cooler if you superpose the trajectory over a circle of appropriate radius).