**Central Forces Homework 6**
*Due 5/16/17, 4 pm*

**REQUIRED:**

1. Consider a very light particle of mass $\mu$ scattering from a very heavy, stationary particle of mass $M$. The force between the two particles is a **repulsive** Coulomb force $\frac{k}{r^2}$. The impact parameter $b$ in a scattering problem is defined to be the distance which would be the closest approach if there were no interaction (See Figure). The initial velocity (far from the scattering event) of the mass $\mu$ is $\vec{v}_0$. Answer the following questions about this situation in terms of $k$, $M$, $\mu$, $\vec{v}_0$, and $b$. It is not necessarily wise to answer these questions in order.)


Initial Configuration for Problem 5

   (a) What is the initial angular momentum of the system?
   (b) What is the initial total energy of the system?
   (c) What is the distance of closest approach $r_{\text{min}}$ **with** the interaction)?
   (d) Sketch the effective potential.
   (e) What is the angular momentum at $r_{\text{min}}$?
   (f) What is the total energy of the system at $r_{\text{min}}$?
   (g) What is the radial component of the velocity at $r_{\text{min}}$?
   (h) What is the tangential component of the velocity at $r_{\text{min}}$?
   (i) What is the value of the effective potential at $r_{\text{min}}$?
   (j) For what values of the initial total energy are there bound orbits?
   (k) Using your results above, write a short essay describing this type of scattering problem, at a level appropriate to share with another Paradigm student.

2. Calculate to solid angle subtended by the moon and by the sun, both as seen from the earth.

3. Consider the case of "hard cone scattering," where the target particles are all shaped like identical cones, with their points oriented directly into the beam of incident particles. Describe the angular distribution of the scattered particles.

4. Write down Laplace's equation in two dimensions in polar coordinates. Use the separation of variables procedure to separate this partial differential equation into two ordinary differential equations.