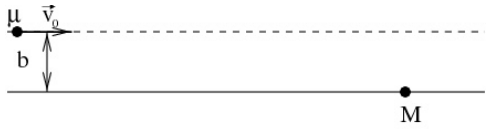
1 Scattering

Consider a very light particle of mass μ scattering from a very heavy, stationary particle of mass M. The **force** between the two particles is a **repulsive** Coulomb force $\frac{k}{r^2}$ (neglect the gravitational force). 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 μ is $\vec{v}_0$.

Answer the following questions about this situation in terms of k, M, μ, $\vec{v}_0$, and b. (It is not necessarily wise to answer these questions in order.)



(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 $r_{\min}$ **with** the interaction?

(d) Sketch the effective potential.

(e) What is the angular momentum at $r_{\min}$?

(f) What is the total energy of the system at $r_{\min}$?

(g) What is the radial component of the velocity at $r_{\min}$?

(h) What is the tangential component of the velocity at $r_{\min}$?

(i) What is the value of the effective potential at $r_{\min}$?

(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.