HW #7

1. Calculate the first post-Newtonian corrections to the perihelion, $r_<$, and aphelion, $r_>$, in a Schwarzshild metric.

   Under what condition(s) is the orbit circular in Newtonian approximation? Does it remain circular when the general-relativistic corrections are made?

2. A scalar particle's quantum-mechanical equation of motion in flat space is

   $$\left[\partial^\mu \partial_\mu + \left(mc/\hbar\right)^2\right]\Phi = 0 ;$$

   convert this to a general-relativistic equation of motion, taking the background metric to be the Schwarzschild metric of a massive static point source.

3. From the solution of problem #2 above, take the nonrelativistic limit and identify the gravitational potential acting on the particle, through the first post-Newtonian correction.

4. Again, from the solution of problem #2 above, use the eikonal approximation to calculate the gravitational deflection of a particle of large 3-momentum as it passes close to the Sun. How does this compare with the classical result? (The eikonal approximation for scattering can be found in the book *Collision Theory* by M.L. Goldberger and K.M. Watson.)