CLASSICAL ELECTRODYNAMICS I
Homework Set 7
November 8, 2017

1. Two point charges q and $-q$ are located on the z axis at $z = a$ and $z = -a$, respectively.

    (a) Find the electrostatic potential as an expansion in spherical harmonics and powers of r for both $r > a$ and $r < a$.

    (b) Next find the potential for $r \neq 0$ by keeping the product $p = 2aq$ constant and then taking the limit $a \to 0$. This limit corresponds to a point dipole along the z axis.

    (c) Give the charge density ρ of the two charges in part (a) in terms of Dirac delta functions expressed in spherical coordinates.

    (d) Suppose now that the two charges in part (a) are surrounded by a grounded conducting spherical shell of negligible thickness and radius b. The shell is concentric with the origin. Use the spherical Green function expansion to determine the electrostatic potential as an expansion in spherical harmonics and powers of r. As in part (b), also find the potential for $r \neq 0$ by keeping the product $p = 2aq$ constant and then taking the limit $a \to 0$.

    (e) Use your final result from part (d) to find the surface charge density $\sigma(\theta)$ induced on the sphere that surrounds the dipole.