UNIVERSITY OF LEIPZIG
INSTITUTE FOR THEORETICAL PHYSICS
Department: Theory of Elementary Particles

TP2 2017

Lecturer: PD Dr. A. Schiller

List of problems 3

6. Each of three charged spheres of radius a, one conducting, one having a uniform charge density within its volume, and one having a spherically symmetric charge density that varies radially as r^n ($n > -3$), has a total charge Q. Use Gauss's theorem to obtain the vector of the electric fields both inside and outside each sphere.
   Sketch the behavior of the fields as a function of the radius for the first two spheres, and for the third with $n = -2, +2$.
   Hint: Inside a conductor the electric field is zero.

7. Check by explicit calculation the Gauss's law (integral form) for a point charge inside/outside a sphere. The sphere has a diameter R, the point charge is located at a distance a away from the center of the sphere.
   Hint: Use spherical coordinates and locate the point charge on the z axis.

8. The time-averaged potential of a neutral hydrogen atom is given by

$$\Phi = \frac{e}{4\pi\epsilon_0}\frac{1}{r}\exp(-\alpha r)\left(1+\frac{\alpha r}{2}\right)$$

   where e is the magnitude of the electronic charge, and $\alpha^{-1} = a_0/2$, a_0 being the Bohr radius.
   Calculate the vector of the electric field $\mathbf{E}$.
   Find the distribution of charge (both continuous and discrete) that will give this potential.
   Sketch the charge density.
   Check that the total charge vanishes.