1. An infinite coaxial cable carries a uniform volume charge density $\rho$ in the inner cylinder of radius $a$ and a uniform surface charge density $\sigma$ on the outer cylindrical shell of radius $b$. This surface density $\sigma$ is negative and is of just the right magnitude that the cable as a whole is electrically neutral.
   (a) Which is the value of $\sigma$ in terms of $\rho$?
   (b) Find the electric field everywhere.

2. Find the electric field inside a sphere that carries a charge density proportional to the distance from the origin $\rho = kr$, where $k$ is a constant.

3. In its ground state, the electron of a hydrogen atom is described by the wavefunction $\psi = e^{-r/a}/\sqrt{\pi a^3}$, so the associated charge density can be written as $\rho = -e|\psi|^2$, being $e$ the electron charge and $a = 0.053$ nm the Bohr radius. Find the total charge of the distribution $\rho$, and the electric field everywhere.

4. Two spheres, each of radius $R$ and carrying uniform volume charge densities $+\rho$ and $-\rho$, respectively, are placed so that they partially overlap. Call the vector from the positive center to the negative center $\vec{d}$. Show that the field in the region of overlap is constant, and find its value.

5. One of the following vector functions cannot represent an electrostatic field. Which one?
   
   \[ \vec{E} = k[xy \hat{x} + 2yz \hat{y} + 3xz \hat{z}] \]
   \[ \vec{E} = k[y^2 \hat{x} + (2xy + z^2) \hat{y} + 2yz \hat{z}] \]