1. Suppose the electric field in some region of space is found to be $E = \frac{E_0}{R^n} r^n \hat{r}$, where $E_0$ is a quantity with dimensions of electric field, $R$ is a length and $n > 1$ is a positive integer.

   (a) Determine the charge density.
   (b) Determine the total charge in a sphere of radius $R$, centered at $r = 0$.
   (c) Determine the electric potential $V(r)$.

2. A thin rod of length $L$ has its left end at $x = -L/2$ and its right end at $x = L/2$. The rod carries a line charge density given by $\lambda = \lambda_0 \frac{x^2}{L^2}$.

   (a) Determine the electric field at the origin.
   (b) Determine the electric potential $V$ at all points in space. You can express your answer in terms of a well-defined one-dimensional integral.

3. Consider an infinitely long cylinder of radius $a$, with a uniform (constant) charge density, $\rho$. Determine the electric field (per unit length) for positions inside and outside the cylinder.

4. Let us consider the structure of an electron by assuming that it is a uniformly charged, spherical particle of radius $R$.

   (a) Compute the electrostatic energy of this system.
   (b) Assume further that the rest energy, $mc^2$ (where $m$ is the mass of the electron, and $c$ is the velocity of light), is electrostatic in origin. Look up the values of the relevant numbers ($m, c, e_0$) and determine the so-called classical radius of the electron $R$ in units of meters.