1. Find the electric field a distant $z$ above the center of a square loop.

2. In some region, the electric field is found to be $\vec{E} = kr^3 \hat{r}$ in spherical coordinates ($k$ is a constant).
   
   (a) Find the charge density $\rho(\vec{r})$.

   (b) Find the total charge contained in a sphere of radius $R$, centered at the origin (Do it in two different ways).

3. A thick spherical shell carries charge density $\rho(\vec{r}) = \frac{A}{r^3} (r_1 \leq r \leq r_2)$.

   Find the electric field in the three regions (1) $r < r_1$ (2) $r_1 < r < r_2$ and (3) $r > r_2$.

4. Find the potential a distance $s$ from an infinitely long straight wire that carries a uniform line charge $\lambda$. Compute the gradient of the potential and check that it yields the correct $\vec{E}$ field, sketch the potential.

5. Find the energy stored in a uniformly charged solid sphere of radius $R$ and charge $Q$. Do it three different ways. (i.e. use Eqs. 2.43, 2.45, and 2.44)

7. Find the capacitance per unit length of two coaxial metal cylindrical tubes, of radius \( R_1 \) and \( R_2 \) \((R_2 > R_1)\).

8. The electric field of some configuration is given by the expression,

\[
V(\vec{r}) = A \frac{e^{-\lambda r}}{r},
\]

where \( \lambda \) and \( A \) are constants. Find the electric field and charge density.

9. A spherical charge distribution is given by:

\[
\rho = \rho_o \left(1 - \frac{r^2}{a^2}\right) \quad r \leq a
\]

\[
\rho = 0 \quad \quad r > a
\]

(a) Calculate the total charge \( Q \) on the sphere.
(b) Find the electric field and potential for \( r > a \).
(c) Find the electric field and potential for \( r \leq a \).
(d) For what value of \( r \) is \( E \) maximized?