1. The electric field in a region of space is given by
\[ \mathbf{E} = (3.0\mathbf{i} + 4.0\mathbf{k}) \text{ N/C} \]
What is the electric flux through a square which lies in the x-y plane which is of side 2 cm?

2. Consider an infinitely long rod of diameter \( a \) centered inside an infinitely long cylindrical shell of inner diameter \( b \) and outer diameter \( c \). The rod is uniformly charged and carries a charge per unit length \( \lambda \).
   a) What charge per unit length should be placed on the cylindrical shell, and how must it be distributed, so that the electric field is zero for all \( r > c \)?
   b) Now assume the shell is uniformly charged with charge per unit length \(-4\lambda\). If the electric field at \( r = b \) is \( E \), what is \( \lambda \)?

3. A thick spherical shell with a uniform volume charge density, \( \rho \), has inner radius \( a/2 \) and outer radius \( a \), as shown. Derive the electric field for -
   a) \( r < a/2 \)
   b) \( a/2 < r < a \)
   c) \( r > a \)

4. (Extra Credit) Consider a uniformly charged sphere of radius \( B \) with volume charge density \( \rho \) centered on the y-axis but where the sphere is above the x-axis as shown (A > B, the z-axis is out toward you). Show that for any point \( r \) which is inside the sphere, the x-component of the electric field is the same as the x-component for a uniformly charged sphere centered at the origin with charge density \( \rho \) and with radius \( R > A + B \). What implication does this have for the field within a spherical cavity within an otherwise uniformly charged sphere?