GAUSS'S LAW

Each group will be given one of the charge distributions given below: (α and k are constants with dimensions appropriate for the specific example.)

- Spherical Symmetry
  1. A positively charged (dielectric) spherical shell of inner radius a and outer radius b with a spherically symmetric internal charge density $\rho(\vec{r}) = \alpha\, r^3$.
  2. A positively charged (dielectric) spherical shell of inner radius a and outer radius b with a spherically symmetric internal charge density $\rho(\vec{r}) = \alpha\, e^{(kr)^3}$.
  3. A positively charged (dielectric) spherical shell of inner radius a and outer radius b with a spherically symmetric internal charge density $\rho(\vec{r}) = \alpha\, \frac{1}{r^2}\, e^{kr}$.
- Cylindrical Symmetry
  1. An infinite positively charged (dielectric) cylindrical shell of inner radius a and outer radius b with a cylindrically symmetric internal charge density $\rho(\vec{r}) = \alpha\, s^3$.
  2. An infinite positively charged (dielectric) cylindrical shell of inner radius a and outer radius b with a cylindrically symmetric internal charge density $\rho(\vec{r}) = \alpha\, e^{(ks)^2}$.
  3. An infinite positively charged (dielectric) cylindrical shell of inner radius a and outer radius b with a cylindrically symmetric internal charge density $\rho(\vec{r}) = \alpha\, \frac{1}{s}\, e^{ks}$.

For your group's case, answer each of the following questions:

1. Use Gauss's Law and symmetry arguments to find the electric field at each of the three radii below: (Use r for spherical symmetry and s for cylindrical symmetry.)
   a) $r_1 > b$ or $s_1 > b$
   b) $a < r_2 < b$ or $a < s_2 < b$
   c) $r_3 < a$ or $s_3 < a$
2. What dimensions do α and k have?
3. For $\alpha = 1$, $k = 1$, sketch the magnitude of the electric field as a function of r or s.