

**GAUSS'S LAW**

Each group will be given one of the charge distributions given below: ( $\alpha$  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  $\alpha$  and  $k$  have?
3. For  $\alpha = 1$ ,  $k = 1$ , sketch the magnitude of the electric field as a function of  $r$  or  $s$ .