Chapter 22 - Gauss's Law

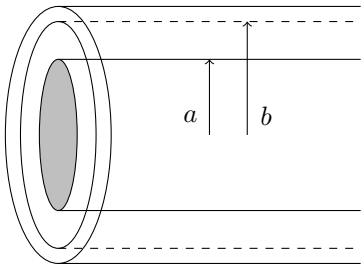
Physics 207

1a. Opposite corners of a rectangle are at positions $(x, y, z) = (2, 3, 1)$ and $(x, y, z) = (5, 3, 6)$. There is an electric field $\vec{E} = (3x^2 + 4)\hat{y}$. What is the electric flux through this rectangle due to this electric field?
1b. Find the electric flux through a thin disc of radius R, due to a point charge q. Let the point charge be a distance x_0 from the center of the disc and along its axis.

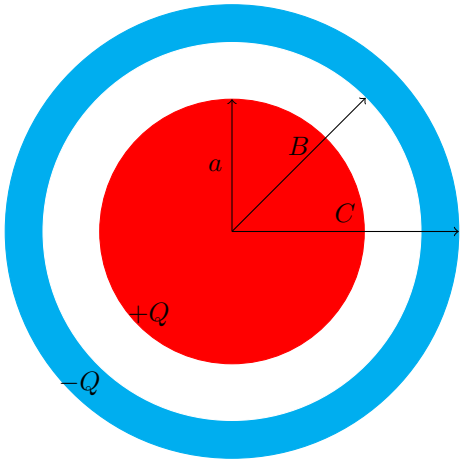
2. A very long, insulating cylinder with radius a and the formula for charge density as a function of radius given below. This cylinder is placed inside a long, conducting, cylindrical shell which has an inner radius b and a thickness t.

$$\rho(r) = \frac{\rho_0 r^3}{a^3}$$

a) Find the electric field for $r < a$.
b) Find the electric field for $a < r < b$.
c) Find the electric field for $b < r < b + t$.
d) Find the electric field for $b + t < r$.
e) Plot $E(r)$.
f) Suppose the inner cylinder is known to have a **total** linear charge density, λ. Find the constant, ρ_0, in terms of λ and the radius of the cylinder.



3. An insulating sphere of uniform charge $+Q$ and a radius a is placed inside an insulating shell of uniform charge $-Q$ with inner radius B and outer radius C.
a) Find the electric field for $r < a$.
b) Find the electric field for $a < r < B$.
c) Find the electric field for $B < r < C$.
d) Find the electric field for $C < r$.
e) Plot the electric field lines in all regions and $E(r)$.



4. An insulating hollow sphere has an inner radius a and an outer radius b. Within the insulating material, the volume charge density is given below where γ is a positive constant.

$$\rho(r) = \frac{\gamma}{r}$$

a) Find the electric field for $r < a$.
b) Find the electric field for $a < r < b$.
c) Find the electric field for $b < r$.
d) Plot $E(r)$
e) A point charge q is placed at the exact center of the hollow space. In terms of γ and a, what value must q have (sign and magnitude) in order for the electric field to be constant in the region $a < r < b$? What is the value of the electric field if this is the case?
f) Suppose the hollow sphere is known to have a **total** charge Q. Find γ in terms of Q, a and b.