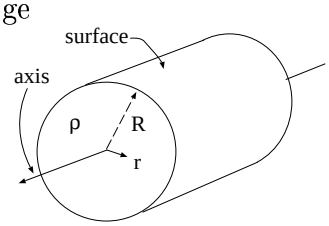
Physics 2220
Sept. 7–Sept. 13, 2000

Your name:_____ Group member:_____
Your Student ID#:_____ Group member:_____
Discussion Sec.:_____ Group member:_____

COLLAB #2
Gauss' law, cylindrical distributions of charge

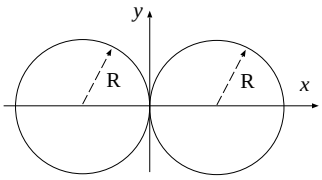
PART 1 *(5 points)*
An infinitely long rod has uniform charge density ρ, and has a circular cross section of radius R. What is λ, the charge per unit length, of the rod? (Note: ρ is the lower case Greek letter "rho," and λ is the lower case Greek letter "lambda.")



PART 2 *(5 points)*
What is the magnitude of the electric field at the surface of the rod described in PART 1?

PART 3 *(10 points)*
Let r be the distance from the axis. By symmetry it is clear that for the configuration of PART 1 the electric field is in the radial direction, i.e., it has only the component E^r. Sketch a graph of E^r vs. r from $r = 0$ to r equal to several times R.

PART 4 *(5 points)*
Two of the rods just described (infinitely long, radius R, uniform charge density ρ) are arranged adjacent to each other as shown in cross section in the figure, Their axes are in the xz plane parallel to, and at equal distances from, the z axis. What is the $\vec{\mathbf{E}}$ field at the origin?

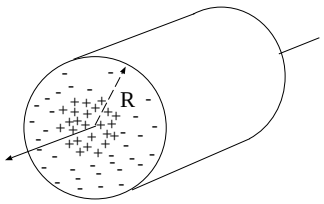


PART 5 *(10 points)*
For the two-rod configuration of PART 5, what is the $\vec{\mathbf{E}}$ field at $y = 0$, $x = 2R$?

PART 6 *(10 points)*
For the two-rod configuration of PART 5, sketch a plot of E^x, the x component of the $\vec{\mathbf{E}}$ field, along the x axis, as a function of x, from $x = -3R$, to $x = +3R$.

PART 7 *(15 points)*
For the two-rod configuration of PART 5, give an expression for E^y, the y component of the $\vec{\mathbf{E}}$ field, as a function of y, along the y axis.

PART 8 *(15 points)*



A single infinitely long rod with a circular cross section of radius R, has an electric charge density ρ that varies with r, the distance from its central axis, according to the formula

$$\rho = \rho_0(1 - 2r/R) \ .$$

The electric field for this source is zero at $r = 0$ and at $r = \infty$. At what other value of r is the electric field equal to zero?

PART 9 *(10 points)*

A single infinitely long charged cylinder, with a circular cross section of radius R, has a radial electric field that is given by

$$E^r = \alpha r^4 \qquad \text{for } r \leq R \ .$$

Consider an infinitely long cylinder of radius $r < R$ that is coaxial with the charged cylinder. What is λ, the charge per unit length, contained within this cylinder. Give the answer in terms of k, α, r.

PART 10 *(15 points)*

What is the charge density $\rho(r)$ for the cylinder of radius R described in PART 9?