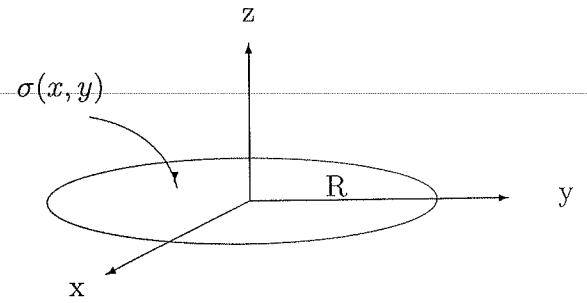


Poorly written, field not symmetric about axis

1. Consider a thin nonconducting disk of radius R centered on the origin of a coordinate system, lying in the x-y plane, and carrying a surface charge density given by

$$\sigma = \sigma_o \frac{yR}{x^2 + y^2}.$$

   (a) {6 pts} Determine the electric field at a location $\vec{r} = z\hat{k}$.

   (b) {3 pts} Give an approximation to your answer to part (a) that is valid for the $z >> R$.

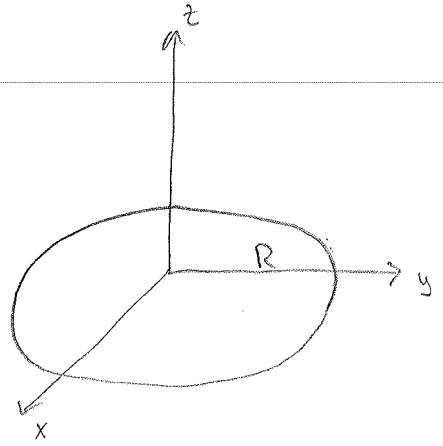
   (c) {1 pts} Find the force on a charge q located at a position $\vec{r} = z\hat{k}$.

Jan 2010

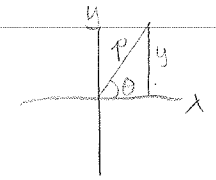
E+M #1

Gaussian

a)



$$\sigma = \sigma_0 \frac{yR}{x^2+y^2}$$



$$\sigma = \sigma_0 \frac{yR}{\rho^2}$$

$$= \sigma_0 \frac{\rho \sin\theta R}{\rho^2}$$

$$= \sigma_0 \frac{\sin\theta R}{\rho}$$

$$\int \nabla \cdot E = \int 4\pi\rho$$

$$\int \vec{E} \cdot d\vec{a} = 4\pi \int \sigma(r)\,\delta(z)\,\rho\,d\rho\,d\theta\,dz$$

$$E \cdot 2\pi\rho^2 = 4\pi \int \sigma_0 \sin\theta R\,\delta(z)\,\rho\,d\rho\,d\theta\,dz$$

$$= 4\pi\sigma_0 R \int \sin\theta\,\rho\,d\rho\,d\theta$$

$$= 2\pi\sigma_0\rho \int \sin\theta\,d\theta$$

$$= -\pi\sigma_0\rho \cos\theta \Big|_0^{2\pi}$$

$$= 0$$