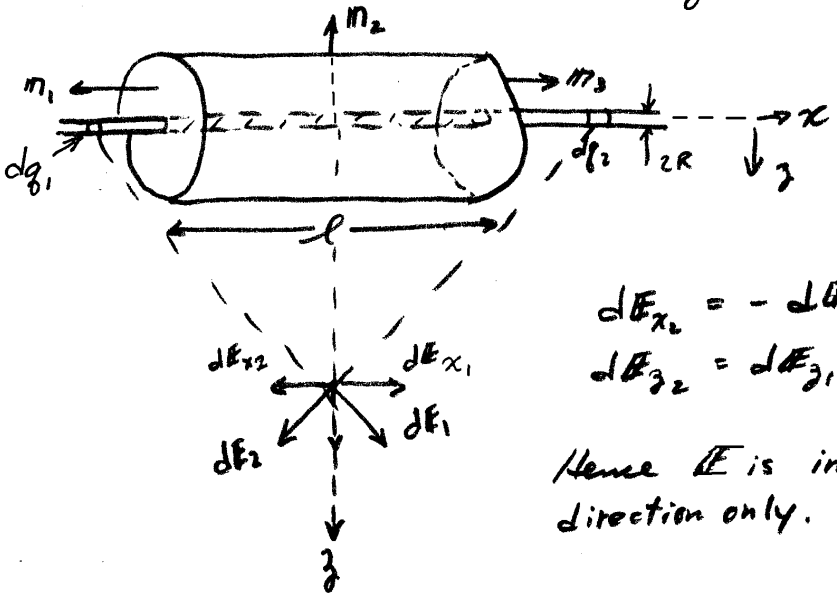
RJP-685

Find $\mathbf{E}$ for an infinitely long cylinder with charge density ρ = const. and radius R
consider a section of the cylinder of length ℓ.



$dE_{x_2} = -dE_{x_1}$

$dE_{z_2} = dE_{z_1}$

Hence $\mathbf{E}$ is in z direction only. -5

Div Theorem & Gauss's Law: $\int \nabla \cdot \mathbf{D}\, d\tau = \int \rho\, d\tau = \int \mathbf{D} \cdot \mathbf{n}\, d\sigma$

$$q = \int \rho\, d\tau = \rho \int_{cyl} d\tau = \rho(\pi R^2 \ell)$$

$$\int \mathbf{D} \cdot \mathbf{n}\, d\sigma = \int_{\neq 0} \mathbf{D} \cdot \mathbf{n}_1 d\sigma_1 + \int \mathbf{D} \cdot \mathbf{n}_2 d\sigma_2 + \int_{=0} \mathbf{D} \cdot \mathbf{n}_3 d\sigma_3$$

$$= \int \mathbf{D} \cdot \mathbf{n}_2 d\sigma_2 = D_z \int d\sigma_2 = D_z (2\pi r \ell)$$

Hence $\rho(\pi R^2 \ell) = D_z\, 2\pi r \ell$

$$D_z = \frac{\rho R^2}{2r} = \epsilon E_z$$

$$E_z = \frac{\rho R^2}{2\epsilon r}$$