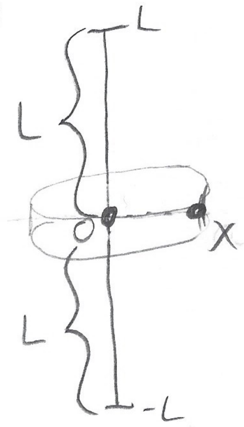
DAVID HATCH

1.3

D



charge density λ_0

$$\rho_L l = Q = \oint_S D \cdot dS = D_\rho \oint dS$$
$$= D_\rho 2\pi \rho l$$

$$D = \frac{\lambda_0}{2\pi x}$$

Exact Answer

$$E = \frac{2Lk\lambda_0}{x\sqrt{x^2+L^2}} \qquad D = \frac{2L\lambda_0}{4\pi x\sqrt{x^2+L^2}}$$

Compare $\quad D_{approx} = \frac{\lambda_0}{2\pi x} \qquad D_{exact} = \frac{2L\lambda_0}{4\pi x\sqrt{x^2+L^2}}$

$$\frac{1}{x} \qquad \frac{L}{x\sqrt{x^2+L^2}} \approx \frac{L}{x\sqrt{L^2}} = \frac{1}{x}$$

choose x s.t. $x^2 \ll L^2$

for $x \ll L$ $\quad \Rightarrow \frac{\lambda_0}{2\pi x} \approx \frac{2L\lambda_0}{4\pi x\sqrt{x^2+L^2}}$

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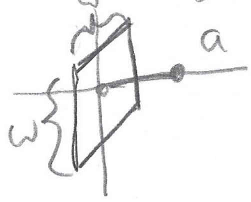
(1.3) Cont.

2) charge density $= \sigma_0$



$$D = \frac{\sigma_0}{2}$$

Exact Answer

$$E_z(z) = \frac{\sigma_0}{\pi \varepsilon_0} \tan^{-1}\left[\frac{\omega^2}{4z} \cdot \frac{1}{\sqrt{z^2 + \frac{\omega^2}{2}}}\right]$$

$$D = \frac{\sigma}{\pi} \tan^{-1}\left[\frac{\omega^2}{4z} \cdot \frac{1}{\sqrt{z^2 + \frac{\omega^2}{2}}}\right]$$

w/ $\omega = 10$

$z = 0.01$

$$= \frac{\sigma}{\pi}[1.56797]$$

$$\approx \sigma_0 \cdot 0.4991$$

$$\approx \sigma_0 \cdot 0.5 = \frac{\sigma_0}{2}$$