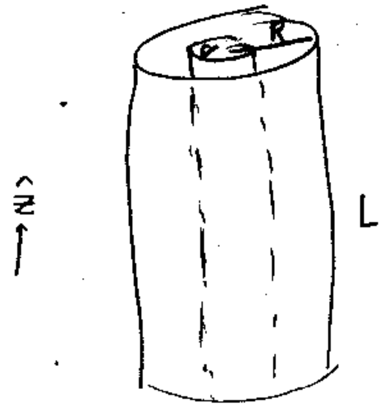
Spring 2003 # 8



Lets put a charge Q on inner cylinder

$$\int E\cdot da = 2\pi s L E = \frac{Q}{\varepsilon_0}$$

$$E = \frac{Q}{2\pi s L \varepsilon_0}\,\hat{s}$$

$$V = -\int_r^R E\cdot dl = \frac{-Q}{2\pi L\varepsilon_0}\int_r^R \frac{1}{s}\,ds = \frac{-Q}{2\pi L\varepsilon_0}\ln\left(\frac{R}{r}\right) = V(b) - V(a)$$

But $V(b) < V(a) \Rightarrow V(a) - V(b) = \frac{Q}{2\pi L\varepsilon_0}\ln\left(\frac{R}{r}\right)$

a) $$C = \frac{Q}{V} = \frac{2\pi\varepsilon_0 L}{\ln\left(\frac{R}{r}\right)}$$

b). Now half of gap is filled with a dielectric and have a potential difference V.

Empty part $V = \frac{\lambda}{2\pi\varepsilon_0}\cdot\ln\left(\frac{R}{r}\right)$

Filled part $D = \frac{\lambda'}{2\pi s} \Rightarrow E = \frac{\lambda'}{2\pi\varepsilon s} \Rightarrow V = \frac{\lambda'}{2\pi\varepsilon}\ln\left(\frac{R}{r}\right)$

holding charge constant $\rightarrow \frac{\lambda}{\varepsilon_0} = \frac{\lambda'}{\varepsilon}$ $\quad \lambda' = \frac{\varepsilon}{\varepsilon_0}\lambda = \varepsilon_r\lambda$

$$Q = \lambda'(h) + \lambda(L-h) = \varepsilon_r\lambda h - \lambda h + \lambda L = \lambda[\underbrace{(\varepsilon_r - 1)}_{\chi_e}h + L]$$

$$C = \frac{Q}{V} = \frac{\lambda(\chi_e h + L)}{2\lambda\ln(R/r)}\cdot 4\pi\varepsilon_0 = 2\pi\varepsilon_0\frac{(\chi_e h + L)}{\ln(b/a)}$$

$$F = \frac{1}{2}V^2 \frac{dC}{dh} = \frac{1}{2}V^2 \frac{2\pi\epsilon_0 \chi_e}{\ln(R/r)} \hat{z}$$