

Name (print)

Tsiper

Name (signed)

Discussion Instructor (circle): Gramoda

Hansen

Li

Zhuikov

Discussion Section # _____

SHOW ALL WORK!!!!**REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!****Use the conversion constants and data given on the front page.**

Consider a long cylindrical non-conductor. The outside radius of the cylinder is R_0 , and the charge distribution inside the cylinder is modeled by $\rho = AR^2$, where A is a constant and $R \leq R_0$ (artificial, but it keeps the math simple).

- (a) Calculate the electric field at any interior point at a distance R from the center of the cylinder.
 (b) Using $V(R) = 0$ at $R = 0$, find the value of the potential at a point R where $R \leq R_0$. The sign of V must be clearly stated for the case where the charge density is positive.
 (c) Obtain a formula for A if the cylinder has a linear charge density of λ C/m. What are the units of A ?

(a) by Gauss' Theorem:

$$|E| \cdot (2\pi R) \cdot \ell = \frac{1}{\epsilon_0} \int_0^R Ar^2 \cdot (2\pi r) \cdot \ell \cdot dr$$

$$|E| = \frac{A}{\epsilon_0 R} \cdot \frac{R^4}{4} = \frac{AR^3}{4\epsilon_0}$$

\vec{E} directed outside.

(b)

$$|V(R)| = \left| \int_0^R E(r) dr \right| = \frac{AR^4}{16\epsilon_0};$$



Sign = '-', since V is max at $R=0$

$$(c) \lambda \ell = \int_0^{R_0} Ar^2 \cdot 2\pi r \ell \cdot dr = \frac{\pi}{2} AR_0^4$$

$$A = \frac{2\lambda}{\pi R_0^4} \quad \therefore [A] = \frac{C/m}{m^4} = C/m^5$$