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 \( R < R_0 \). 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 \( \lambda \, \text{C/m} \). What are the units of \( A \)?

\( a \) by Gauss' Theorem:

\[
|E| = \frac{1}{\varepsilon_0} \int_0^R Ar^2 \, dR = \frac{A R^3}{4 \varepsilon_0}
\]

\( \vec{E} \) directed outside.

\( b \)

\[
|V(R)| = \left| \int_0^R E(r) \, dr \right| = \frac{AR^4}{16 \varepsilon_0}
\]

Sign = 

\( c \)

\[
\lambda \pi R_0^2 = \int_0^{R_0} Ar^2 \, 2\pi r \, dr = \frac{\pi}{2} AR_0^4
\]

\[
A = \frac{2\lambda}{\varepsilon_0 R_0^4}
\]

\[ [A] = \frac{\text{C/m}}{\text{m}^2} = \text{C/m}^5 \]