

23.90. A hollow, thin-walled insulating cylinder of radius R and length L (like the cardboard tube in a roll of toilet paper) has charge Q uniformly distributed over its surface. (a) Calculate the electric potential at all points along the axis of the tube. Take the origin to be at the center of the tube, and take the potential to be zero at infinity. (b) Show that if $L \ll R$, the result of part (a) reduces to the potential on the axis of a ring of charge of radius R (See Example 23.11 in Section 23.3). (c) Use the result of part (a) to find the electric field at all points along the axis of the tube.

$$V(x)_{RING} = \frac{k_e Q}{(R^2 + x^2)^{1/2}}.$$