

54. (a) The magnitude of the electric field is

$$E = \frac{\sigma}{\varepsilon_0} = \frac{q}{4\pi\varepsilon_0 R^2} = \frac{(3.0 \times 10^{-8} \text{ C}) \left(8.99 \times 10^9 \frac{\text{N}\cdot\text{m}^2}{\text{C}^2}\right)}{(0.15 \text{ m})^2} = 1.2 \times 10^4 \text{ N/C} .$$

(b)  $V = RE = (0.15 \text{ m})(1.2 \times 10^4 \text{ N/C}) = 1.8 \times 10^3 \text{ V} .$

- (c) Let the distance be  $x$ . Then

$$\Delta V = V(x) - V = \frac{q}{4\pi\varepsilon_0} \left( \frac{1}{R+x} - \frac{1}{R} \right) = -500 \text{ V} ,$$

which gives

$$x = \frac{R\Delta V}{-V - \Delta V} = \frac{(0.15 \text{ m})(-500 \text{ V})}{-1800 \text{ V} + 500 \text{ V}} = 5.8 \times 10^{-2} \text{ m} .$$