Answer on Question#55540 - Physics - Electromagnetism

For a single, isolated point charge carrying a charge of $q = 5.77 \times 10^{-11}\text{C}$, one equipotential surface consists of a sphere of radius $r = 0.0329\ \text{m}$ centered on the point charge as shown. What is the potential on this surface?

Answer in V=

You would like to draw an additional equipotential surface, which is separated by $\Delta\varphi = 4.90\ \text{V}$ from the previously mentioned surface. How far from the point charge should this surface be? This surface must also meet the condition of being farther from the point charge than the original equipotential surface.

Answer in m=

Solution:

The potential φ at distance r from the charge q is given by

$$\varphi = \frac{k_e q}{r},$$

where $k_e = 8.98755 \times 10^9\ \frac{\text{N}\cdot\text{m}^2}{\text{C}^2}$ – is Coulomb's constant. Therefore at distance $r = 0.0329\ \text{m}$ the potential is

$$\varphi_1 = \frac{8.98755 \times 10^9\ \frac{\text{N}\cdot\text{m}^2}{\text{C}^2} \cdot 5.77 \times 10^{-11}\text{C}}{0.0329\ \text{m}} = 15.76\text{V}$$

The potential difference between φ_1 and φ_2 (the potential of the equipotential surface whose radius r_2 we want to find) is given by

$$\Delta\varphi = \varphi_1 - \varphi_2 = \varphi_1 - \frac{k_e q}{r_2}$$

Therefore the radius r_2 is

$$r_2 = \frac{k_e q}{\varphi_1 - \Delta\varphi} = \frac{8.98755 \times 10^9\ \frac{\text{N}\cdot\text{m}^2}{\text{C}^2} \cdot 5.77 \times 10^{-11}\text{C}}{15.76\text{V} - 4.90\text{V}} = 0.0478\text{m}$$

Answer: $15.76\text{V}, 0.0478\text{m}$.