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$\rho_s = 2\mu C/m^2$ for $r = 1m$, $0 \le \phi \le 2\pi$, $0 \le \theta \le \pi$

find WE for $2 \le r \le 3$, $0 \le \phi \le 2\pi$, $0 \le \theta \le \pi$

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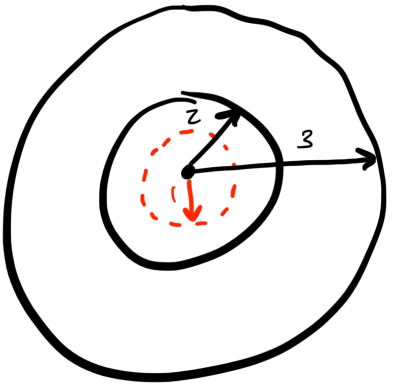
(1) Draw The Situation:



(2) Determine Q_{enc}...

$$Q_{enc} = \iint \rho_s \, ds = 2\times10^{-6} \int_0^{2\pi}\int_0^{\pi} r^2 \sin\theta \, d\theta \, d\phi$$

$$= 2\times10^{-6} \cdot (1)^2 \cdot \int_0^{2\pi} d\phi \cdot \int_0^{\pi} \sin\theta$$

$$= (2\times10^{-6})(1)^2(2\pi)(-\cos\theta\,|_0^{\pi})$$

$$= 8\pi\times10^{-6} C$$

(3) Determine $\tilde{D}$ in the enclosed region...

$$\oint\oint D \cdot ds = Q_{enc}$$

$$D_r \cdot 4\pi r^2 = 8\pi\times10^{-6} C$$

$$D_r = \frac{8\pi\times10^{-6}}{4\pi r^2} C/m^2 = \frac{2\times10^{-6}}{r^2} C/m$$

(4) Determine $\bar{E}$ in the enclosed region

$$D = \varepsilon E \Rightarrow \frac{D}{\varepsilon} = E \quad \text{or} \quad \bar{E} = \frac{2\times10^{-6}}{\varepsilon r^2}$$

(5) Determine W_E...

$$W_E = \frac{1}{2}\iiint \varepsilon \cdot |E|^2 \, dV = \frac{1}{2}\iiint D \cdot E \, dV$$

$$W_E = \frac{1}{2}\int_0^{2\pi}\int_0^{\pi}\int_2^3 \left(\frac{2\times10^{-6}}{r^2}\right)\left(\frac{2\times10^{-6}}{\varepsilon r^2}\right) \cdot r^2 \sin\theta \, dr\,d\theta\,d\phi$$

$$W_E = \frac{1}{2}\int_0^{2\pi}\int_0^{\pi}\int_2^3 \frac{4\times10^{-12}}{\varepsilon r^4} \cdot r^2 \sin\theta \, dr\,d\theta\,d\phi$$

$$W_E = \frac{1}{2\varepsilon} \cdot 4\times10^{-12} \cdot 2\pi \cdot 2 \cdot \int_2^3 \frac{1}{r^2}\, dr$$

$$W_E = \left(\frac{1}{2\varepsilon}\right)\left(4\times10^{-12}\right)(4\pi)\left(\frac{1}{6}\right)$$

$$W_E = 0.47\,\mu J$$