Physics 172
Winter Quarter 1986
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George Williams

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SECOND MIDTERM

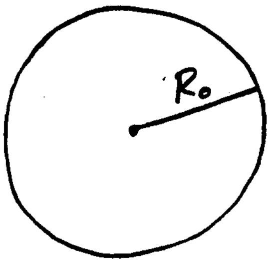
Name (Print) Bob Brown   Name (Signed) $\bar{x} = 15.8$

Discussion Instructor (Circle One): Brown   Chung   Pollard   Rothman

Discussion Section #:________   Schweizer   Soderberg   Vaseghi   Viohl

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

Consider a sphere of non-conductor, whose radius is R_o and $\kappa = 1.00$. It is positively charged, with a charge density given by $\rho = A/R$, where A is a constant, and R the distance from the center of the sphere. Calculate the energy stored in the electric field between $R = R_o/2$ and $R = R_o$.



Use Gauss's Law to find E-field

$$\int \vec{E}\cdot d\vec{A} = \frac{Q}{\cancel{K}\epsilon_0} \qquad Q = \int \rho\, dVol \Rightarrow \int \vec{E}\cdot d\vec{A} = \frac{1}{\cancel{K}\epsilon_0}\int \rho\, dVol$$

$$E(4\pi R^2) = \frac{A}{\cancel{K}\epsilon_0}\int \frac{1}{R}4\pi R^2 dR \Rightarrow E(\cancel{4\pi}R^2) = \frac{\cancel{4\pi}A}{\cancel{K}\epsilon_0}\int R\, dR$$

+10 $$E(R^2) = \frac{A}{2\cancel{K}\epsilon_0}R^2 \Rightarrow \boxed{E = \frac{A}{2\cancel{K}\epsilon_0}}$$ Constant E-field for $R < R_o$

$$u_E = \frac{1}{2}\epsilon_0 E^2 = \frac{1}{2}\epsilon_0\frac{A^2}{4\epsilon_0^2} = \frac{A^2}{8\epsilon_0} \qquad K = 1.00$$

$$U = \int u_E\, dVol = \frac{A^2}{8\epsilon_0}\int_{R_o/2}^{R_o} 4\pi R^2 dR = \frac{A^2\pi}{6\epsilon_0}\left[R^3\right]_{R_o/2}^{R_o}$$

$$U = \frac{A^2\pi}{6\epsilon_0}\left[R_o^3 - \frac{R_o^3}{8}\right] = \frac{A^2\pi}{6\epsilon_0}\left[\frac{7}{8}R_o^3\right]$$

+15 $$\boxed{U = \frac{7A^2\pi}{48\epsilon_0}R_o^3}$$

Dimensions: $[U] = \left(\frac{N\text{-}m^{\cancel{2}}}{\cancel{C^2}}\right)\left(\frac{\cancel{C^2}}{\cancel{m^4}}\right)(\cancel{m^3}) = \boxed{N\text{-}m}$ ☑