Quiz 3, Physics 9C, Winter 2016

**General Instructions:** This quiz is closed book. Only a calculator is allowed. Please show all your work, and give units for all answers and on all graphs. Credit will only be given for complete solutions. The constant $k$ in Coulomb’s law is $k = 9 \cdot 10^9 \text{Nm}^2/\text{C}^2$.

Charge $Q = +8.0 \mu \text{C}$ is distributed uniformly over the volume of an insulating sphere that has radius $R = 7.0 \text{ cm}$. What is the potential difference between the center of the sphere and the surface of the sphere? **Important:** A complete solution to this problem will provide the following steps:

(a) Write down Gauss’ Law.
(b) Apply Gauss’ Law to get the electric field inside the sphere ($r < R$). Explain clearly how you get the charge enclosed that you use in your equation.
(c) Write the equation which tells you how to get $V$ from $E$.

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\begin{align*}
a) & \quad \Phi_E = 4\pi k Q_{\text{enclosed}} \\
b) & \quad 4\pi r^2 E \\
& \quad \text{(because } E \text{ same everywhere on surface and } E \parallel \hat{n}) \\
\Rightarrow & \quad E = \frac{kQr}{R^3} \\
c) & \quad V_o = -\int_a^b E \, dr \\
& \quad V_R = -\int_R^0 \frac{kQr}{R^3} \, dr + \int_0^R \frac{kQr}{R^3} \, dr \\
& \quad = \frac{kQ}{R^3} \left[ \frac{1}{2} r^2 \right]_0^R = \frac{kQ}{2R}.
\end{align*}
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**Numerical value**

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V_R = \frac{(9\cdot10^9)(8\cdot10^{-6})}{2(1.07)} = 514000 \text{ Volts}
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