

## SECOND MIDTERM

Name (print) Condella Name (signed) \_\_\_\_\_

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Discussion Section # \_\_\_\_\_

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

A charged, nonconducting sphere has a charge density given by  $\rho = \rho_0(1 - AR^2)$ , where  $\rho_0$  and  $A$  are constants, the total charge on the sphere is  $3.30 \times 10^{-6}$  C, the radius is 4.00 cm and the charge density goes to zero at its surface.

- (a) Calculate the numerical values, with proper units, for  $\rho_0$  and  $A$ .  
 (b) Find the electric potential at the surface of the sphere (numerical value).  
 (c) What is the electric field at a point 3.00 cm from the center of the sphere (numerical value)?

$$a) \text{ at } r = 0.04 \text{ m } \rho = 0 \Rightarrow 1 - AR^2 = 0 \Rightarrow A = \frac{1}{(0.04 \text{ m})^2} = 9.76 \times 10^6 \text{ 1/m}^2$$

$$Q_{\text{tot}} = 3.30 \times 10^{-6} \text{ C} = \int_0^{0.04} \rho dv \Rightarrow$$

$$Q_{\text{tot}} = \int_0^{0.04} \rho_0(1 - AR^2) 4\pi r^2 dr \Rightarrow \rho_0 = \frac{Q}{4\pi} \left( \frac{1}{\frac{r^3}{3} - A r^5/5} \right) \Big|_{\text{at } r=0.04}$$

Potential at surface  $r = 0.04 \text{ m}$ 

$$b) V = k \frac{Q_{\text{tot}}}{r} = 7.42 \times 10^5 \text{ V}$$

$$\rho_0 = 1.97 \times 10^{12} \text{ C/m}^3$$

$$c) E = ? \text{ at } r = 0.03 \text{ m}$$

$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{\text{in}}}{\epsilon_0} \Rightarrow E = \frac{q_{\text{in}}}{4\pi r^2 \epsilon_0} = \frac{\rho_0}{\epsilon_0} \left( \frac{r^3}{3} - A \frac{r^5}{5} \right)$$

$$q_{\text{in}} = \rho_0 \int_0^{0.03} (1 - AR^2) 4\pi r^2 dr$$

$$q_{\text{in}} = 4\pi \rho_0 \left( \frac{r^3}{3} - A \frac{r^5}{5} \right)$$

Gradinga)  $A = ?$  5 pts. $\rho_0 = ?$  5 ptsb)  $V = ?$  5 pts

c) Gauss law 3 pts

 $q_{\text{in}} = ?$  5 pts

putting it together 2 pts