George Williams

Third Midterm

4

Name (print)_____ Name (signed)_____

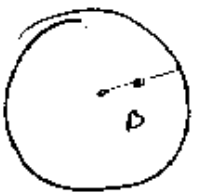
Discussion Instructor (circle): Brown Chakhbazian Condella Portnoi Zhukov

Discussion Section # _____

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

A sphere of non-conductor has a volume charge density give by $\rho = A/R^2$, for $R < R_o$, where R_o is the radius of the sphere.

(a) Calculate the electric field at a point $R = R_A$, where $R_A < R_o$ (inside the sphere).
(b) Calculate the magnitude of the electric potential difference between the surface of the sphere and an arbitrary point in the interior that is a distance R_B from the center.
(c) Evaluate the constant A in terms of the total charge on the sphere.



$$\oint E\,dA = \frac{Q_{in}}{\epsilon_0} = \frac{1}{\epsilon_0}\int_0^R \frac{A}{R^2}\,dV = \frac{1}{\epsilon_0}\int_0^{R_A} \frac{A}{R^2}\,4\pi R^2 dR$$

$$E \cdot 4\pi R^2 = \frac{1}{\epsilon_0} A \cdot 4\pi R$$

+10

$$E = \frac{A}{\epsilon_0 R}$$

$$V_A - V_B = -\int_B^A E(r)\,dr = -\int_B^A \frac{A}{\epsilon_0 R}\,dR = -\frac{A}{\epsilon_0}\ln R = -\frac{A}{\epsilon_0}\ln\frac{R_A}{R_B}$$

+10

$V_A < V_B$

$$\Rightarrow \frac{A}{\epsilon_0}\ln\frac{R_A}{R_B} > 0$$

$$Q = \int_0^{R_o} \frac{A}{R^2}\,dV = \int_0^{R_o} \frac{A}{R^2}\,4\pi R^2 dR = 4\pi A R_o$$

+5

$$A = \frac{Q}{4\pi R_o}$$