

FIRST MIDTERM

3

Name: _____

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Discussion Section # _____

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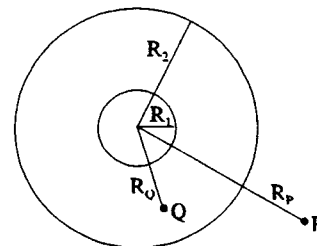
SHOW ALL WORK!!!!

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!

Use the conversion constants and data given on the front page.

A thick, hollow sphere is constructed out of non-conducting material. The inner radius is R_1 and the outer radius is R_2 . The charge density between R_1 and R_2 can be expressed as $\rho = A/R^2$, where A is a constant. [R is the variable.]

- (a) Determine the electric field at point P, where $R_p > R_2$.
(b) Find the electric field at point Q, where $R_2 > R_Q > R_1$.



a) Use Gauss's law

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0}$$
$$E_p 4\pi R_p^2 = \frac{1}{\epsilon_0} \int_{R_1}^{R_2} \rho dV = \frac{1}{\epsilon_0} \int_{R_1}^{R_2} \frac{A}{R^2} 4\pi R^2 dR$$
$$= \frac{1}{\epsilon_0} 4\pi A R \Big|_{R_1}^{R_2} = \frac{4\pi A}{\epsilon_0} (R_2 - R_1)$$

$$So \vec{E}_p = \frac{4\pi A}{4\pi R_p^2 \epsilon_0} (R_2 - R_1) \hat{R} = \frac{A}{\epsilon_0 R_p^2} (R_2 - R_1) \hat{R}$$

b) Use Gauss's law

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0}$$
$$E_Q 4\pi R_Q^2 = \frac{1}{\epsilon_0} \int_{R_1}^{R_Q} \rho dV = \frac{1}{\epsilon_0} \int_{R_1}^{R_Q} \frac{A}{R^2} 4\pi R^2 dR$$
$$= \frac{1}{\epsilon_0} 4\pi A R \Big|_{R_1}^{R_Q} = \frac{4\pi A}{\epsilon_0} (R_Q - R_1)$$

$$So \vec{E}_Q = \frac{4\pi A (R_Q - R_1)}{4\pi R_Q^2 \epsilon_0} \hat{R} = \frac{A}{\epsilon_0 R_Q^2} (R_Q - R_1) \hat{R}$$