Physics 172 Winter Quarter 1982

(25 PTS)

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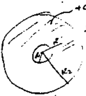
BE SURE TO SHOW ALL WORK!

A) (10 PTS)



$+Q$ total

$\rho = 0$ $R_1 > r > R_2$

$\rho = \frac{A}{r^3}$ $R_1 < r < R_2$

full credit

r - specifies general radial dependence.

$Q = \int \rho(r)\,dV$

$dV = 4\pi r^2 dr$

$\rho(r) = \frac{A}{r^3}$

$Q = 4\pi \int_{R_1}^{R_2} \frac{A}{r^3} r^2 dr$

$= 4\pi A \int_{R_1}^{R_2} \frac{dr}{r}$

$Q = 4\pi A \ln \frac{R_2}{R_1}$

$$A = \frac{Q}{4\pi \ln \frac{R_2}{R_1}}$$

Errors:

$\int_{R_1}^{R_2} \frac{A}{r^3} dr$, -5 ; $\int \frac{A}{r^3}\left(\frac{4}{3}\pi r^3\right) dr$, -4

$Q = \rho\,\text{Vol} = \frac{A}{r^3}\left[\frac{4}{3}\pi\left(R_2^3 - R_1^3\right)\right]$

This type of stuff -10

Algebraic errors -1 to -3

B) (15 PTS)

$\oint \vec{E} \cdot d\vec{s} = \frac{q_{enclosed}}{\varepsilon_0}$

$E = \frac{q_{enc}}{4\pi R^2 \varepsilon_0}$

$q_{enc} = \int_V \rho(r)\,dV$

$= \int_{R_1}^{R} \rho(r)\,4\pi r^2 dr$

$= 4\pi A \int_{R_1}^{R} \frac{dr}{r}$

$q_{in} = 4\pi A \ln \frac{R}{R_1}$

$$E = \frac{A \ln \frac{R}{R_1}}{\varepsilon_0 R^2} = \frac{Q}{4\pi\varepsilon_0 R^2} \cdot \frac{\ln \frac{R}{R_1}}{\ln \frac{R_2}{R_1}}$$

full credit

ERRORS:

$E = \frac{q_{enc}}{4\pi\varepsilon_0 r^2}$ } generally +5 if some $q_{enc} = q_{enc}(r)$ is given

again, $q_{enc} = \int_{R_1}^{R} \frac{A}{r^3} dr$ -5

$q_{enc} = \rho \int_{R_1}^{R} dr$ -4

$q_{enc} = \rho\left(\frac{4}{3}\pi\left(R^3 - R_1^3\right)\right)$ -10

Algebraic errors -1 to -3

4. A spherically symmetric charge distribution of total charge +Q can be described by the relation:

$$\rho(\text{charge density}) = \frac{A}{r^3} \quad \text{for } R_1 < r < R_2 ,$$

$\rho = 0$ everywhere else.

(a) Find the value of the constant A.
(b) Find the value of the electric field at any value of r between R_1 and R_2.