Physics 2220
Spring 2002
George A. Williams

Yong Han Solution

FIRST MIDTERM

4

Name:______________________

Discussion Instructor (circle): Andrade El-Gendy Mimoto Owen

Discussion Section # ____________ Student ID #:____________________

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

A long non-conducting cylinder of radius R_o has a volume charge density given by $\rho = Br^4$, where B is a constant. $\rho = 0$ for $r > R_o$ (outside the cylinder).

(a) Calculate the total charge in a length L of this cylinder.
(b) Calculate the electric field a distance R_1 away from the axis of the cylinder if $R_1 > R_o$.
(c) Calculate the electric field a distance R_2 away from the axis of the cylinder if $R_2 < R_o$.

$$\rho(r) = \begin{cases} Br^4, & r \le R_0 \\ 0, & r > R_0 \end{cases}$$

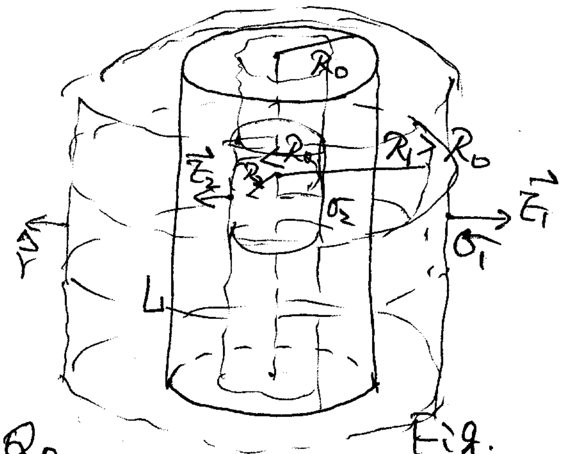

Fig.

(10) (a) $Q_0 = \int \rho\, dV \qquad dV = 2\pi r L\, dr$

$$= \int_0^{R_0} \rho(r) \cdot 2\pi r L\, dr$$

$$= \int_0^{R_0} Br^4 \cdot 2\pi r L\, dr = \frac{1}{3}\pi B L R_0^6$$

(5) (b) From Gauss's law, $\int \vec{E}_1 \cdot d\vec{\sigma} = \frac{Q_0}{\varepsilon_0}$ and

$\int \vec{E}_1 \cdot d\vec{\sigma}_1 = E_1 \cdot 2\pi R_1 L$, we get

$\vec{E}_1 = \frac{BR_0^6}{6\varepsilon_0 R_1}\hat{r}$, $\hat{r}$ is the unit vector.

(10) (c) From Gauss's law, $\int \vec{E}_2 \cdot d\vec{\sigma}_2 = \frac{Q_1}{\varepsilon_0}$ and

$\int \vec{E}_2 \cdot d\vec{\sigma}_2 = E_2 \cdot 2\pi R_2 L$, we get

$\vec{E}_2 = \frac{BR_2^5}{6\varepsilon_0}\hat{r}$, $\hat{r}$ is the unit vector.

σ_1 and σ_2 are the Gauss's surface as shown in Fig.