Physics 2220
Spring 2004
George A. Williams

FIRST MIDTERM

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Name:_____

Discussion Instructor (circle): Billeter Blake Gillman Herring

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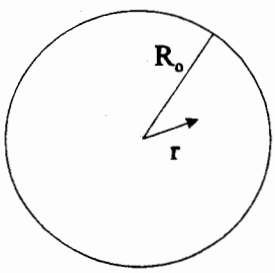
SHOW ALL WORK!!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

A disk of radius R_o is charged with a surface charge density given by $\sigma = \sigma_o r$. The units of σ are C/m^2.



(a) 10' Calculate the total charge on the disk.
(b) 15' Calculate the electric field on the axis of the disk a distance x away from the disk (out of the paper a distance x).

(a.) $Q = \int \sigma \, dA$ 1'

$= \int_0^{R_o} \sigma_o r \cdot 2\pi r \, dr$ 7'

$= 2\pi\sigma_o \times \frac{r^3}{3}\Big|_0^{R_o}$

$= \frac{2\pi}{3}\sigma_o R_o^3$ 2'

(b) $dq = 2\pi r \sigma_o r \, dr$ 4'

$\vec{E} = \int_0^{R_o} \frac{k\,dq}{r^2}\,\hat{r}$

$= \int_0^{R_o} \frac{K\,2\pi r \sigma_o \, r\,dr}{(r^2+x^2)} \times \frac{x}{\sqrt{r^2+x^2}} \cdot \hat{x}$ (6' for $\hat{r}$, 4' for r^2)

$= \int_0^{R_o} \frac{2\pi k x \sigma_o \, r^2 dr}{(r^2+x^2)^{3/2}}\,\hat{x}$

$= 2\pi k x \sigma_o \left[\frac{-r}{\sqrt{r^2+x^2}} + \ln\left(r+\sqrt{r^2+x^2}\right)\right]_{r=0}^{r=R_o} \hat{x}$

$= 2\pi k x \sigma_o \left[\frac{-R_o}{\sqrt{R_o^2+x^2}} + \ln\left(R_o+\sqrt{R_o^2+x^2}\right) - \ln x \right] \hat{x}$ 1'

$\hat{x}$ is pointing outward.