Physics 208 Quiz 4

February 13, 2008 (due: February 20, 2008)

Problem 1 (20 points)
A circular loop with a diameter $d = 40 \text{ cm}$ is rotated in a uniform electric field until the position of maximal electric flux is found. The flux in this position is $\Phi = 5.2 \cdot 10^5 \text{ Nm}^2/\text{C}$. What is the magnitude of the electric field?

Problem 2 (20 points)
A pyramid with horizontal square base, $a = 6 \text{ m}$ on each side, and a height, $h = 4 \text{ m}$ is placed in an upward vertical electric field of magnitude $E = 52 \text{ N/C}$. Calculate the electric flux through the pyramids four slanted surfaces.

Hint: Think about the total flux through the pyramid first, before you do a lot of unnecessary work!

Problem 3 (30 points)
Consider a closed triangular box resting within a horizontal electric field $\vec{E} = 7.8 \cdot 10^4 \text{ N/C} \hat{i}$ (see figure). Calculate the electric flux, $\Phi$, through

(a) the vertical rectangular surface,
(b) the slanted surface,
(c) the entire surface of the box.

See next page!
Problem 4 (30 Points)

A charge, \( q \), is located in the center of a coordinate system. What is the total electric flux of its electric field through the entire surface of a cylinder with its axis along the \( z \)-axis (reaching from \( z = -h/2 \) to \( z = +h/2 \) and radius \( \rho = R \) (see figure))?

(a) Use Gauss’s Law to find the answer!

(b) Do the integrals to verify it!

**Hint:** Use cylinder coordinates, \((\rho, \varphi, z)\)! The following integrals are needed to solve the problem:

\[
\int d\rho \frac{\rho}{(\rho^2 + z^2)^{3/2}} = -\frac{1}{\sqrt{\rho^2 + z^2}},
\]

\[
\int dz \frac{1}{(\rho^2 + z^2)^{3/2}} = \frac{z}{\rho^2 \sqrt{\rho^2 + z^2}}.
\]