

**PHYSICS 110A WINTER 2002**

**MIDTERM I**

**PUT YOUR NAME ON THE EXAM RIGHT AWAY!**

**PROBLEM 1 [25 POINTS]**

An equilateral triangle has a charge  $+2Q$  at one corner, and charges of  $-Q$  at each of the other corners. Consider the point in the center of the triangle.

- a) What is the potential at this point?
- b) What is the direction (if any) of the electric field at this point?

PROBLEM 2 [25 POINTS]

Two dimensional polar coordinates are like three-dimensional cylindrical coordinates, but without a  $\hat{z}$  axis.

A small hill in a park has a height function given by

$$h(s, \phi) = s e^{-s} \cos^2 \phi$$

- a) What are the (polar) coordinates of the highest points on this hill?
- b) What is the magnitude of the slope of this hill at the point  $(1, \pi/4)$ ?
- c) What compass direction corresponds to the direction of steepest descent at the point  $(1, \pi/4)$ ? Assume that  $\phi$  is measured relative to the 'east' axis, and increases as you turn north.

PROBLEM 3 [25 PTS]

An infinitely long insulating cylindrical shell of inner radius  $s_1$  meters and outer radius  $s_2$  meters has a uniform charge density of  $\rho$  C/m<sup>3</sup> smeared throughout it.

a) What is the electric field at every point in space?

Instead, the same amount of charge per meter of the cylinder's length is deposited onto a conductor with the same dimensions.

b) What is the electric field at every point in space?

PROBLEM 4 [25 PTS]

Over all space, the electrostatic potential has the following form:

$$\frac{A}{\epsilon_0} \left( \frac{d^2}{2} - d(x + d) \right) \quad x \leq -d$$

$$\frac{A}{2\epsilon_0} x^2 \quad -d \leq x \leq d$$

$$\frac{A}{\epsilon_0} \left( \frac{d^2}{2} + d(x - d) \right) \quad x \geq d$$

What is the charge distribution function  $\rho(x, y, z)$  for all points  $(x, y, z)$  in space?