NAME:

Physics 110A: Fall 2009
PRATICE MIDTERM 2

C. Gwinn

Do not start until told to do so.

You *may* use: pencil, eraser, 8.5×5.5 inch sheet of notes (both sides).
You may *not* use: calculator, book, additional notes, cell phone, blackberry. If you need additional paper the proctor will provide a blank copy of the exam. If you need a calculator you are probably not doing the problem correctly.

This exam consists of 3 problems. Each problem contains 1 or 2 parts. Each problem is worth 33 points, plus 1 free point for a total of 100 points.

Explain your answers. A clear, brief explanation is best: let the grader know what you know! As always in physics, the path you use to obtain your answer is more important than the answer itself.

- Give *magnitude* and *direction* for vectors.
- *State* the symmetries that zero out vector components or dependences on coordinates, if you make use of them.
- *Draw a diagram* when it will help you to explain your work.

You need not fill up each page: extra space has been left for those with large handwriting.

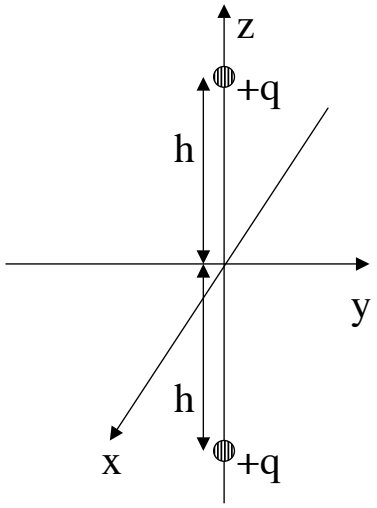
HINT: Many of these problems can be done in several different ways. Often, the easiest way is much quicker than the harder ways. The easiest way yields equal credit, *so long as you explain your work.*

GOOD LUCK!

1) (33 pts) Two charges $+q$ reside at $z = +h$ and $z = -h$.

• State the monopole moment for this distribution, $q_0 = 4\pi\epsilon_0 b_0$. Write out the mathematical expression for q_0, or explain how this moment can be calculated from ρ in a couple of sentences. You need not solve the math explicitly.

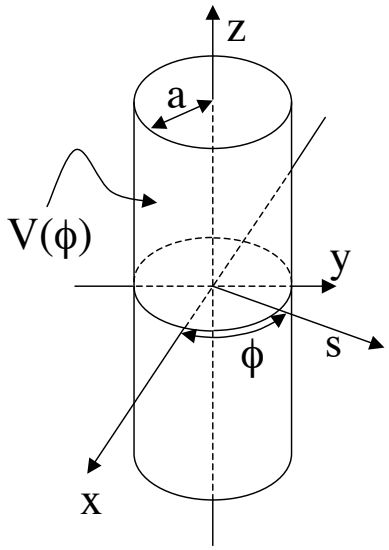
• Explain in a few sentences (and/or an equation or 2) why the dipole moment for this distribution is zero: $p_z = 4\pi\epsilon_0 b_1 = 0$.



2a) (17 pts) An infinitely long tube has radius a. The axis of the tube is the z-axis. The potential on the surface of the tube is

$$V(\phi) = V_0. \tag{1}$$

• State the potential *outside* the tube, V_{out}, at $s > a$. Here, $s = \sqrt{x^2 + y^2}$, and $\arctan \phi = y/x$.



2b) (16 pts) Now assume that the potential is

$$V(\phi) = V_0 \cos(\phi). \tag{2}$$

• State the potential *inside* the tube, V_{in}, at $s < a$. Again, $s = \sqrt{x^2 + y^2}$, and $\arctan \phi = y/x$.

Note: You need not do *any* math, other than write down your answer, so long as you explain in a couple of sentences why your answers are correct.

3) (33 pts) A spherical shell is covered with a surface charge distribution $\sigma(\theta)$. The radius of the sphere is R. The potential outside is

$$V_{out}(r,\theta) = V_0 \frac{R^2}{r^2} \cos\theta. \tag{3}$$

The potential inside is given by

$$V_{in}(r,\theta) = V_0 \frac{r}{R} \cos\theta. \tag{4}$$

• Find the surface charge $\sigma(\theta)$.

• Find the dipole moment p_z of this charge distribution. Explain briefly why p_x and p_y are zero.