Physics 52 **Exam 1** **Sept. 30, 1996**

Name _________________________

Which recitation section? Wed. ____ , Thur. ____

Work directly on these pages and show your work clearly. Properly labeled figures are important and will figure into the grading.

1. [5 *pts*] Electric field lines intersecting the surface of a conductor are always perpendicular to the surface because
   (a) Gauss's Law requires that the electric field be in the direction of the normal to the surface.
   (b) charges in a conductor are free to move.
   (c) the electric potential of a conducting surface is zero.

2. [5 *pts*] If a dipole **p** is placed into a uniform electric field **E** such that $\vec{\mathbf{E}} \cdot \vec{\mathbf{p}} = 0$, it will
   (a) experience an acceleration in the direction of **E**.
   (b) experience only an angular acceleration.
   (c) not be accelerated at all.

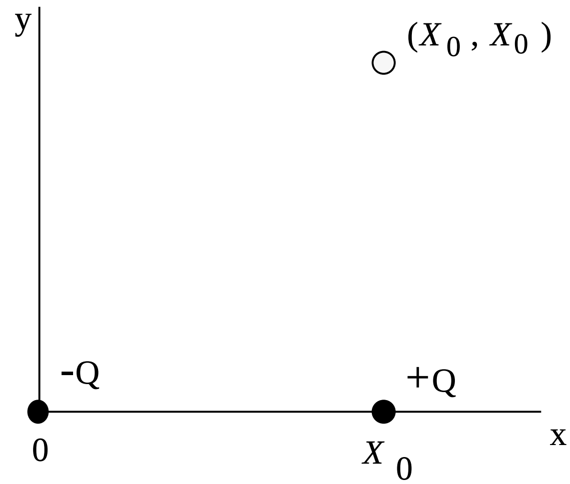
3. [5 *pts*] In the equation for the electric potential $V = -\vec{\mathbf{E}} \cdot \, d\vec{\mathbf{l}}$, the vector d**l** is always in a direction parallel to
   (a) the **E** field
   (b) the radius
   (c) the path
   (d) none of the above
   (e) all of the above

4. [5 *pts*] The equation $d\vec{\mathbf{E}} = \frac{kq}{r^2 dr}$ must be incorrect because
   (a) it has the wrong units.
   (b) it has a vector on one side and not on the other.
   (c) in the limit it becomes zero equals infinity.
   (d) all of the above.

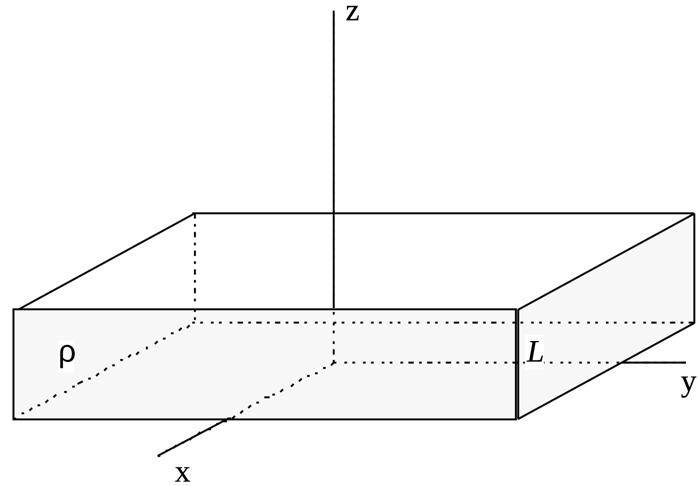
5. [5 *pts*] Indicate **all** of the items in the following list that must be described by vectors.
   (a) Force
   (b) Electric potential
   (c) Electric field
   (d) Potential energy

(e) Dipole moment

6. [*15 pts*] Find a vector expression (in cartesian coordinates) for the electric field at the point (X_0, X_0).



7. [*20 pts*] A dielectric plane of thickness L in the z direction is infinite in the other two directions and carries a uniform charge per unit volume ρ. Everywhere outside the plane (above and below) the electric field has a magnitude $\frac{\rho L}{2\varepsilon_0}$ (this is like $\frac{\sigma}{2\varepsilon_0}$ for a thin plane). The field is parallel to the z-axis everywhere.

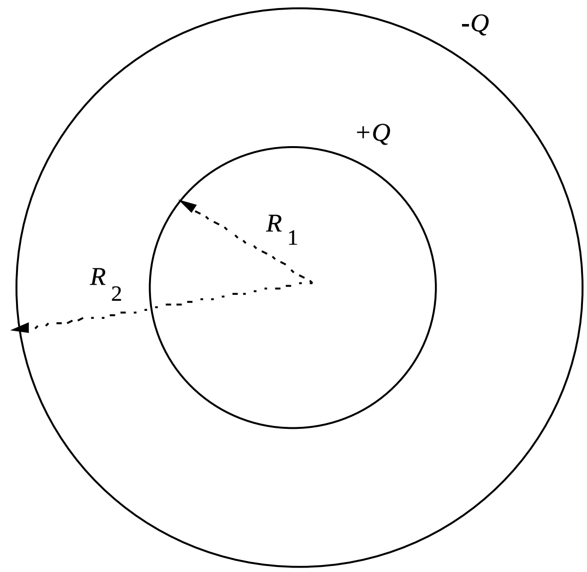


Your job is to use Gauss's Law to determine the electric field as a function of z inside the material. Write the answer as a vector and make sure it indicates the direction of the field properly.

The picture above is only meant to help understand the question. To clearly label your variables you will need to draw a view looking straight in from the side.

Work page

8. [*20 pts*] Two spherical conducting shells have radius R_1 and R_2. The inner sphere (R_1) has charge Q and the outer one has charge $-Q$. Starting with the equation for the field (you should know it, but if not either derive it or assume something reasonable), and the energy density equation $\eta = \frac{1}{2}\varepsilon_0 E^2$, determine an expression of the energy stored in the electric field between the two shells. Hint: First find an infinitesimal volume (only one differential element) over which $\vec{\mathbf{E}}$ is constant.



9. [*20 pts*] Use an integral to find the resistance between the rectangular ends of the semicircular solid object shown in the figure. The material has a resistivity ρ. You are going to be summing infinitesimal resistors in parallel so should start with an equation for $S = 1/R$.