PHY 272: FIELDS
PROBLEM SET 5
due March 4, **before** *class*

A. Vectors are your friends

Consider a square of sides L centered on the origin and with sides parallel to the x and y axis.

i) give the position vector of its vertices (let us call them $\mathbf{r}_1, \mathbf{r}_2, \mathbf{r}_3$ and $\mathbf{r}_4$ counting clockwise starting from the top right vertex)

ii) compute $|\mathbf{r}_1 - \mathbf{r}_3|$

iii) compute $|\mathbf{r}_4 - \mathbf{r}_2|$

iv) compute the length of the diagonal of the square

Consider now a generic point with position vector $\mathbf{r} = x\,\hat{\mathbf{x}} + y\,\hat{\mathbf{y}} + z\,\hat{\mathbf{z}}$.

v) compute the distance from the point $\mathbf{r}$ to the origin.

vi) compute the distance between the points $\mathbf{r}$ and $\mathbf{r}_1$

vii) what is the angle between the vectors $\mathbf{r}_4$ and $\mathbf{r}_1 + \mathbf{r}_2$

Consider now a circle on the $x - -y$ plane inscribed in the square. That means that the circle is inside the square and it touches the square in 4 points.

viii) what is the radius of the largest circle that fits in the space between the circle and the square.

Hint: Make a drawing. Always make a drawing and put all the information you have there.

B. Triangle: déjà vu all over again

Three equal charges $Q > 0$ are held at rest at the vertices of an equilateral triangle of side L.

i) Find the electric potential in every point in space.

ii) Find the electric field at all points in space and make a sketch of the field lines.

iii) When the charges are released they fly apart from each other. Assuming no other force acts on the charge besides the electric force, what will be the total kinetic energy of all three particles when they are very separated from each other.

If you write the field in some coordinate system, make sure you explain what system you are using, perhaps with a drawing.

C. Feel my pain

Imagine you are a writer of a popular science magazine and you need to write an article about the Gauss theorem (divergence theorem). It has to be smaller than one page, including the figures. Do it. You can assume your readers know the equivalent of Calculus I (barely).