PHYS 3033/3053 Assignment 2

Due: 18 Sep 2015 at begin of lecture at 3:00 pm

Problem 1.

a) Ten equal charges, q, are situated at the corners of a regular 10-sided polygon. What is the net force on a test charge Q at the center?

b) Suppose *one* of the 10 q's is removed. What is the force on Q? Explain your reasoning carefully.

c) Now 11 equal charges, q, are placed at the corners of a regular 11-sided polygon. What is the force on a test charge Q at the center?

d) If one of the 11 q's is removed, what is the force on Q? Explain your reasoning.

Problem 2.

One of these is an impossible electrostatic field. Which one?

(a) $\mathbf{E} = k[3xy\hat{\mathbf{x}} + 5yz\hat{\mathbf{y}} + 7xz\hat{\mathbf{z}}]$;

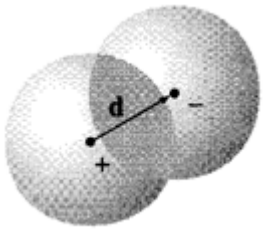
(b) $\mathbf{E} = k[2y^3\hat{\mathbf{x}} + (6xy^2 + z^5)\hat{\mathbf{y}} + 5yz^4\hat{\mathbf{z}}]$.

Here k is a constant with the appropriate units.

Problem 3.

(a) Show that the electric field *inside* a sphere with uniform charge density ρ is given by $\mathbf{E} = \dfrac{\rho \mathbf{r}}{3\varepsilon_0}$, where $\mathbf{r}$ is the vector pointing from the center of the sphere to the observation point.

(b) Two spheres, each of radius R and carrying uniform charge densities $+\rho$ and $-\rho$, respectively, are placed so that they partially overlap. Call the vector from the positive center to the negative center $\mathbf{d}$. Show that the field in the region of overlap is constant and find its value.



Problem 4.

A long coaxial cable carries a uniform *volume* charge density ρ on the inner cylinder (radius a), and a uniform *surface* charge density on the outer cylindrical shell (radius b). This surface charge is negative and of just the right magnitude so that the cable as a whole is electrically neutral. Find the electric field in each of the three regions: (i) inside the inner cylinder ($s < a$), (ii) between the cylinders ($a < s < b$), (iii) outside the cable ($s > b$). Plot $|\mathbf{E}|$ as a function of s.

Problem 5.

a) If the electric field in some region is given by the expression

$$\mathbf{E} = \frac{A\hat{\mathbf{r}} + Br\sin\theta\cos\phi\ \hat{\phi}}{r^2}$$

where A and B are constants, what is the charge density?

b) The electric field in a certain region is given by

$$\mathbf{E} = \frac{A\hat{\mathbf{r}} + B\sin\theta\ \hat{\phi}}{r}$$

Determine whether it is an electrostatic field.