1. *Balancing the charges problem* Two free point charges +q and 4q are a distance L apart. A third charge is placed so that the entire system is in equilibrium, that is, the free point charges do not feel a force.

   (a) Find the sign, magnitude, and location of the third charge. Hint: right down all the equations that must hold for the system to be in equilibrium.
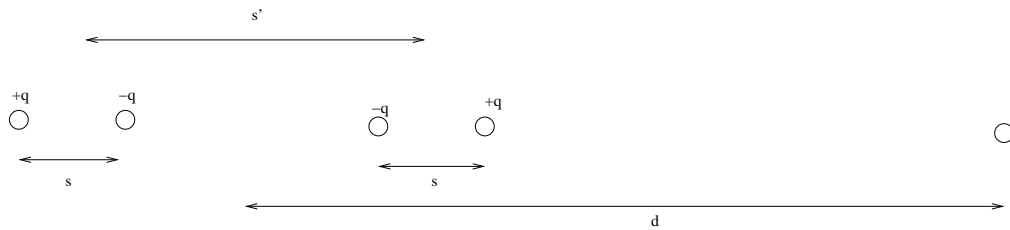   (b) Show that the equilibrium is unstable

2. *A complicated Dipole Problem*

Figure 1: A complicated dipole problem

   Suppose I have two dipoles that are made by two charges separated by some distance s that are themselves separated by some distance s' as shown in figure 1.

   (a) What is the electric field (magnitude and distance) distance d away from the center. Remember to expand out your terms (the numerator) and simplify the expression you have derived..
   (b) Now further simplify the expression by making the approximation that s and s' are both much smaller than d.
   (c) Describe how you would expect the the system to scale as a function of distance and explain clearly the approximations that you made.

3. We can rearrange our dipoles in another configuration. The two dipoles shown as in figure 2 is called a quadrapole.

   (a) What is the electric field a distance d away from the quadrapole. Hint: this is just like the above problem except that the dipoles are now perpendicular rather than horizontal. Again remember to expand out the numerator and simplify your expression.
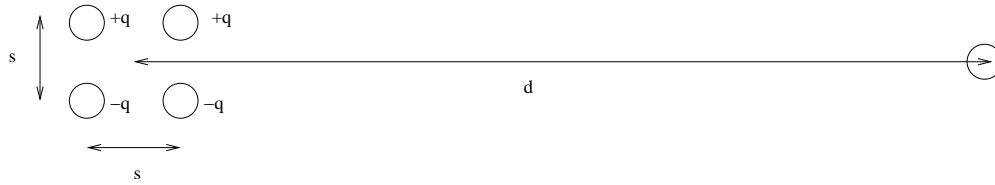
Figure 2: Quadrapole Problem

(b) Further simplify your expression by making the approximation that s is much smaller than d.

(c) Explain clearly how the E field scales as you move further away from the quadrapole and what approximations you have made.

Problems 13.P35, 13.P36, 13.P38, 13.P41, 13.P42