Problem Set #1

Question 1

Griffiths, Problem 4.1

Question 2

A point charge $+q$ is situated a large distance r from a neutral atom of polarizability α. Find the force of attraction between them.

Question 3

I often tell students in physics 123 that

$$\vec{E} = \frac{\vec{F}_{+q}}{q}$$

defines the electric field at a point if $\vec{F}_{+q}$ is the measured force on a tiny charge $+q$ placed at that point. If I am being careful, I also tell students to let $q \to 0$ to avoid the polarization of nearby matter due to the presence of q. Unfortunately, this experiment is impossible to perform. A better definition uses $\vec{F}_{+q}$ and the force $\vec{F}_{-q}$ measured when $-q$ sits at the same point. In this method, there is no need to let $q \to 0$, even if conductors or (linear) dielectric matter is present. Derive an expression that relates $\vec{E}$ to $\vec{F}_{+q}$ and $\vec{F}_{-q}$

Question 4

Consider two spheres, each with radius R but possessing equal but opposite uniform charge densities $\pm\rho$. The centers of the two spheres are offset very slightly by an infinitesimal displacement vector $\vec{\delta}$. Compute the electric field produced at some *general position* $\vec{r}$ (both inside and outside the spheres) by each sphere and show by superposition that the electric field produced by the combination is identical to the electric field produced by a sphere with a suitably chosen uniform polarization $\vec{P}$. What is the value of $\vec{P}$?

Question 5

Griffiths, Problem 4.9