

# Physics 301/571: Electromagnetic Theory I

Read: Griffiths chapter 3.2, 3.4, 4.1-4.2

“G” refers to Griffiths’ book.

Problems with stars are not for credit and will NOT be graded.

## Homework 6

### Exercise 1 (G 3.27)

Four particles (one of charge  $q$ , one of charge  $3q$ , and two of charge  $-2q$  are placed in points  $(0, 0, -a)$ ,  $(0, 0, a)$ ,  $(0, a, 0)$ , and  $(0, -a, 0)$  respectively. Find a simple approximate formula for the potential, valid at points far from the origin. (Express your answer in spherical coordinates.)

### Exercise 2 (G 4.4)

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

### \*Exercise 3 (G 4.6)

A perfect dipole  $\vec{p}$  is situated a distance  $z$  above an infinite grounded conducting plane. The dipole makes an angle  $\theta$  with the perpendicular to the plane. Find the torque on  $\vec{p}$ . If the dipole is free to rotate, in what direction will it come to rest?

### Exercise 4 (G 4.9)

A dipole  $\vec{p}$  is a distance  $r$  from a point charge  $q$ , and oriented so that  $\vec{p}$  makes an angle  $\theta$  with the vector  $\vec{r}$  from  $q$  to  $\vec{p}$ .

a) What is the force on  $\vec{p}$ ?

b) What is the force on  $q$ ?

Calculate a) and b) independently and check the consistency of the result with the Newton’s third law.

### Exercise 5 (G 4.10)

A sphere of radius  $R$  carries a polarization  $\vec{P}(\vec{r}) = k\vec{r}$ , where  $k$  is a constant and  $\vec{r}$  is the vector from the center.

- a) Calculate the bound charges  $\sigma_b$  and  $\rho_b$ .
- b) Find the field inside and outside the sphere.